Science and Mathematics Education Centre

ASSESSING THE VISITING PUBLIC'S PERCEPTIONS OF THE OUTCOMES OF THEIR VISIT TO INTERACTIVE SCIENCE AND TECHNOLOGY CENTRES

by
David John Johnston

This thesis is presented as part of the requirements for the award of the degree of Doctor of Philosophy of the Curtin University of Technology.

1999

ABSTRACT

This study investigated the problem of how to assess the visiting public's perceptions of the outcomes of their visit to an Interactive Science and Technology Centre. The study was carried out in several phases. First the researcher immersed himself as a participant observer over 15 months in the day-to-day activities of a science centre. Second, data to describe perceptions of visit outcomes were collected from one-to-one interviews with randomly selected visitors and professional staff, and four focus groups of explainers and visitors. Third, these data were used to structure the collection of further descriptions, in visitors' own words, about the visit experience. In the fourth and fifth stages, data from the second and third stages were pooled to develop two new instruments, the Perceptions of Visit Impact Instrument, a semantic differential survey designed to be administered at the point of exit from a science centre, and the Profile of Visit Outcomes Instrument, a nine part survey designed to be administered several weeks after the visit. The two instruments were refined through local review and field testing, and replication using data from large samples of randomly selected visitors at five and three centres, respectively, in Australia and New Zealand. Staff at these centres found the instruments easy to use and considered that they provided valuable data. Implications are drawn for future use of the instruments for evaluation and research.

ACKNOWLEDGEMENTS

I express my appreciation to those people who provided the support which enabled me to complete this study.

- *Dr. Leonie Rennie at the Science and Mathematics Education Centre, Curtin University of Technology, who supervised the development of this project and offered the guidance required to see this task through to completion.*

- *Dr. Seddon Bennington, Dr. Ann Ghiselberti, Ms Vicky Dodds and all the members of the Education team of Scitech Discovery Centre for their continual support, constructive feedback and logistical assistance during the data collection phase of the project.*

- *The staff who collected data in all of the interactive science and technology centres involved in this project. Unfortunately they cannot be named so anonymity can be preserved.*

- *Dr. Arthur Lucas and the staff at the Centre for Educational Studies, King's College, London, who helped with ideas and discussion about this work.*

- *The British Council for an award of a Postgraduate Bursary that enabled my three month attachment to King's College, London.*

- *The Curtin University Postgraduate Studies Award committee who granted a twoyear scholarship that helped support me while undertaking this study.*

Particular thanks are extended to my partner Mignon and my friends for their continual encouragement to me while completing this task.

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CHAPTER 1

INTRODUCTION

Overview

This thesis describes a study concerned with developing instruments for measuring the outcomes of voluntary visits to Interactive Science and Technology Centres (ISTCs). The first chapter provides an overview of the research and the research design. It opens with a background to the study that describes the origins of ISTCs and their characteristics, as well as discussing the use of ISTC as a generic term. The background to the study provides an insight into the rapid growth of ISTCs, and looks at their credibility as providers of informal science education. It also examines their need to be accountable as recipients of public financial support.

In the following sections, the research question is stated, and the importance of the problem in the context of contemporary ISTC development is discussed. The research design and methods used at all of the different stages are described and justified and the significance of the problem is highlighted. The chapter closes with an overview of the remaining chapters in the thesis.

Background to the Study

Origins of ISTCs

ISTCs are a modern phenomenon, a recent offshoot in the evolution of science and technology museums that has been in progress over the last four centuries. The first recorded notions of a science museum are attributed to Bacon about the beginning of the 17th Century (Danilov, 1982; Gregory, 1989) , and the first recognised form of science museums were private collections of artefacts and specimens (McManus, 1992) . The forerunners to technology museums were mechanical models housed in cabinets (Danilov, 1982). Public access to exhibits and displays housed in dedicated buildings has become available over the last two centuries. Initially curators controlled the nature and mode of presentation of exhibits; however, since educators have been employed there has been a shift in emphasis from preservation of items to one of public education. As a consequence, a change in style of presentation has occurred recently that has been described as a shift from the object-oriented traditional science museums to the concept-oriented ISTCs (Danilov, 1982; McManus, 1992) . Over the last three decades ISTCs have proved to be so popular that they can now be seen in many cities around the world.

A more detailed account of the evolution of science and technology museums is provided in Chapter 2.

Characteristics of ISTCs

ISTCs differ markedly from traditional science and technology museums in their physical appearance, philosophical underpinning and their general thrust of presentation. Although both house exhibits, it is the different style and context of the exhibits found in each that provide their most obvious distinguishing characteristics. After reviewing literature about exhibits and displays in science museums, Stevenson (1993) stated there were three broad categories into which exhibits and displays fall: static, reactive, and interactive.

A typical static exhibit is the type usually associated with a traditional museum. It is displayed in such a manner that touching is prevented or discouraged, and it has accompanying explanations in text, graphics, and photographs. Artefacts and dioramas fit into the static exhibit category.

Reactive exhibits respond to some action by the visitor, but the action is unidirectional – visitor to exhibit. If, for example, the only requirement from a visitor to set an exhibit into action is to push a button, or pull a lever, then the exhibit is reactive. Some simulations using models fit into this category. An example is a working model of an engine with a cut-away section showing the moving pistons. The model is driven by an electric motor, and operates for a set period of time after a switch is turned on.

Interactive exhibits take a step further as they respond to a visitor's initial contact and then at some stage require further input from the visitor. The visitor-exhibit relationship develops from an action by the visitor invoking responses by the exhibit leading to further decision points for the visitor. This ongoing procedure of iterative feedback loops continues until the visitor breaks the loop by disengaging with the exhibit. Sometimes the only requirement of a visitor will be the physical manipulation of an exhibit. However, some exhibits will require sensory input and responses. Ideally designed interactives take visitors beyond an "aha! experience" (Chambers, 1990, p. 10) , inviting a deeper involvement with the "real thing" (Duensing, 1993, p. 2) , and invoking a "minds-on" (Gardner, 1994, p. 45) experience. The interactive experience should be able to confront any misconceptions or "naive notions" (Borun, 1989b, p. 1) a visitor may hold and allow them to construct a meaning that is scientifically acceptable. Ideally an interactive exhibit should invite engagement with any visitor while being flexible enough to appeal to the cognitive demands of a range of participants with varying backgrounds in science (Beckmann, 1994) .

According to Stevenson (1993, p. 26) , the term "participatory exhibits" has been used as an umbrella term covering both reactive and interactive exhibits typically found in ISTCs, and to distinguish them from the static displays normally seen in traditional museums. Another less academic description has been used to describe the ISTCs with their participatory exhibits as "hands-on museums" and the traditional museum with static displays as "hands-off museums" (V. Dodds, personal communication, March 7, 1994).

During the course of this investigation, "hands-on" was a term often used by visitors to describe interactive exhibits; however, that description is not strictly correct and a clear distinction needs to be made. An anecdote arising from a separate piece of museum research (Rennie & Johnston, 1996) illustrates the distinction. A traditional museum had a stuffed tiger as an exhibit in one of its exhibition halls. The hall was otherwise occupied solely with static exhibits of stuffed animals that could only be viewed at a distance. People were invited to pat the stuffed tiger's head to feel the fur – a hands-on tiger; not an interactive one. For years the tiger attracted many curious hands to pat its head until it began to develop a bald patch. It suddenly disappeared and was dispatched to a safer place – in storage for perpetuity never to be "hands-oned" again.

This anecdote also serves to illustrate the dichotomy between the philosophy of a predominantly curatorial approach in traditional museums, and that of the ISTCs where exhibits are discarded when they wear out or become outdated. ISTCs do not employ curators because they do not collect and preserve objects – they make their own exhibits or rent them from other ISTCs.

Theoretically, it is the presence of an exclusive grouping of a large number of interactive exhibits in a clearly defined area that constitutes an ISTC. A personal observation is that there is a tendency for some ISTCs to include reactive exhibits in their count of interactive exhibits, when describing themselves in their promotional literature. Participatory exhibits would be a more correct description, but perhaps it doesn't have as much customer appeal.

The difference in exhibit characteristics of ISTCs and traditional museums was encapsulated by Stevenson (1993) when reporting his research at the *Launch Pad*, a gallery of interactive exhibits in the *London Science Museum*. He maintained that an ISTC represents "more than just a collection of hands-on exhibits" (p. 22), a definition that McManus (1992) implies in her taxonomy of science museums. Stevenson observed that the context and style of the *Launch Pad* is in contrast to the other more traditional galleries in the *London Science Museum* as it gives visitors a clear indication "they may touch, handle, take things to pieces and put them back together again – something which is not encouraged in a museum" (1993, p. 22).

The notion of public interaction with exhibits in museums as an educational strategy has evolved through stages since the static exhibits of the last century. Quin (1991) reported that, early this century, working model exhibits appeared (*Deutsches Museum,* Munich) followed by limited controls via knobs and handles for the visitor to manipulate the exhibits (*South Kensington Museum,* London). Later came a period in which materials for experiments were available to those who wished to participate (*Palais de la Decouverte,* Paris). Since Frank Oppenheimer founded the *Exploratorium* in 1969 (Oppenheimer, 1972) , visitors to ISTCs have been able to construct their own understandings of interactive experiences ranging from natural phenomena to contemporary technologies by participating in an interactive way with exhibits (Gore, 1990) .

ISTC as a Generic Term

When reading literature about science museums it soon becomes obvious that there is inconsistent use of terminology. Science centre, interactive science centre, interactive science and technology centre, hands-on science centre, and occasionally science museum, are all terms used by different authors to describe the same style of institution. For example, the term ISTC has been used by several authors (Hughes, McGuigan & Russell, 1995; Stevenson, 1991; Lucas, 1991) when referring to the same style of institution that was labelled a science centre by McManus (1992) and a hands-on science centre by Wellington (1989). Smaller centres in establishments dedicated to informal science education offerings, namely zoos, natural history museums, aquariums and herbariums with sections of interactive exhibits, have at times been referred to as science centres. When adopting the term "interactive science centre" in their recent review of research literature, Rennie and McClafferty (1996) added a caveat that there is an implied notion of technology included. While the lack of consistency is understandable because of the recent evolution of some of the institutions, it is confusing and needs to be clarified.

As the centres involved in this study all have exhibits that overtly provide exposure to modern technology as well as exhibits demonstrating scientific principles, the generic term ISTC will be used to describe them. However, Rennie and McClafferty (1996) warned that there are risks in applying a generic term because ISTCs are heterogeneous institutions. It is acknowledged that no two centres are the same (Danilov, 1982) , as each of the centres has its own uniqueness, a feature termed "Techniquesscence" by Beetlestone (1989) when he wrote about *Techniquest*. However, when the style of presentation and nature of the exhibits are considered, there are sufficient common features for a generic term ISTC to be an accurate indicator of a particular style of science centre.

Expansion of ISTCs

ISTCs initially emerged in Western countries and have since spread throughout Asia, India and the Middle East. There is no sign of a slowing of the spread. For example, the Thailand government recently received approval for a loan from the Asian Development Bank and has plans to establish a ISTC in each of its provinces (G. Bullivant, personal communication, August 20, 1994) Some centres have recently opened in China and on a more modest scale the Philippines has plans for an additional centre.

In Australia and New Zealand, the two countries where this study took place, there are 19 ISTCs that operate either as individual entities or as components of a larger museum. Since *Questacon – The National Science and Technology Centre* (see Figure 1.1) was founded by Michael Gore and opened in Canberra in 1988, ISTCs have spread throughout every Australian state. There is: *Scitech* (Perth), *Sciencentre* (Brisbane), *Powerhouse* (Sydney), *Kidsmuseum* (Sydney), *Supernova* (Newcastle), *Science Centre* (Wollongong), *Science Works* (Melbourne), *Investigator* (Adelaide), *Musbus* (Hobart), *Science Centre* (Launceston), and *Discovery* (Bendigo). In New Zealand seven ISTCs are presently in operation. They are: *Science Centre* (Palmerston North), *Excite Centre* (Hamilton), *Discovery World* (Otago), *Science Alive* (Christchurch), *Capital Discovery Place and National Science-Technology Roadshow* (Wellington), and *NZ Science Centre, MOTAT* (Auckland).

ISTCs are versatile and innovative when it comes to finding a means to display their exhibits to the public. Some have impressive, specially designed modern buildings (for example, *Questacon*, Canberra; *Techniquest*, Cardiff; *Heureka*, Helsinki), while some share a site in renovated buildings that still house working machinery from an earlier era (*ScienceWorks*, Melbourne; *Powerhouse*, Sydney). Not all centres have permanent sites and there are a variety of mobile types designed to take their message to the people in areas with populations too small to support a permanent centre. For example, in Australia *Questacon's* travelling Shell Science Circus uses a large semi-trailer to transport its wares when traversing the vast sparsely populated regions of the mainland states, while the Hobart Museum's *Musbus* operates a bus throughout Tasmania. In the United Kingdom *The Discovery Dome*, a travelling ISTC housed in three tents, was developed and run initially by Stephen Pizzey. It is even possible to sample the ISTC experience while transiting through Changi Airport in Singapore where some interactive exhibits are permanently displayed in the passenger lounge area.

Another indicator of the growth of ISTC influence is the number of central professional bodies networking individual centres across continents and countries. In North America there is the Association of Science-Technology Centres (ASTC), in

Figure 1.1. Questacon – The National Science and Technology Centre.

Europe the European Collaborative for Science, Industry and Technology Exhibitions (ECSITE), in the UK the British Interactive Group (BIG), in India the National Council of Science Museums (NCSM) and the Association of Science and Technology Exhibitors Network (ASTEN) in Australia and New Zealand. At the First World Science Centre Congress held in Helsinki in June 1996, there were 375 registered delegates from 47 countries. A scan of the affiliations of the delegates to the Helsinki congress indicates there are people working privately as consultants, exhibit designers and suppliers, evaluators, and researchers. It is clear that the popularity of ISTCs and their subsequent growth in numbers has spawned a support industry.

Credibility and Accountability of ISTCs

Credibility

In spite of the continued popularity of ISTCs, diverse opinions have been expressed about their true worth. These opinions have come from ISTC professionals, traditional museum professionals and ISTC visitors. Oppenheimer (1968) provides an example of an opinion given in support of ISTCs. Prior to his founding of the *Exploratorium* in San Francisco, he wrote that:

> There is a growing need for an environment in which people can become familiar with the details of science and technology and begin to gain some understanding by controlling and watching the behaviour of laboratory apparatus and machinery; such a place can arouse their latent curiosity and can provide at least partial answers . . . . The demonstrations and exhibits of the museum should have an aesthetic appeal as well as pedagogical purpose and they should be designed to make things clearer rather than to cultivate obscurantism or science fiction. (pp. 206-207)

On the other hand, Wymer (1991) , another museum professional, who worked for a short period of time at the *Launch Pad,* at the *London Science Museum,* stated:

> While the idea of presenting scientific principles in an interesting way is laudable, it must still make sense to do this within some logical and consistent framework – and this is patently not the case. More importantly, if claims are to be made about the effect of such presentations on the learning potential of the participants, some evidence should be forthcoming. There is none. (p. 49)

The views expressed by Oppenheimer and Wymer represent opposite ends of a broad spectrum of opinions to be found in the literature. While the cross section of opinion is heavily skewed in support of ISTCs (e.g., Beetlestone, 1989; Friedman, 1991; Gregory, 1989), there are some who question their value (e.g., Champagne, 1975; Fara, 1994; Parkyn, 1993; Shortland, 1987), usually in terms of the promotion of entertainment at the expense of information.

Furthermore, there has been some reluctance in the traditional museum industry to accept ISTCs as part of their museum scene because they were regarded foremost as places of entertainment with education having a secondary role. Barcow (1983) , in an introductory text to museology, defined a science centre as "a kind of permanent exhibition (like a miniature world fair) which emphasises the spectacular aspects of physical science such as space exploration, optical illusions, television, and electronic cooking" (p. 8). Barcow also stated that a centre is not a museum:

> The essential distinction is this: A centre exists to make possible entertaining activity; a museum exists to make important educational or aesthetic use of a permanent collection . . . . A 'centre' may be, but is not necessarily, a permanent institution, educational, non profit, and the owner and preserver of a collection. (1983, p. 9)

However, ISTCs are gaining credibility as a complementary education facility in some of the traditional museums. Greene (1989) , the founder of *Xperiment!* an interactive gallery in the Manchester science and industry museum, wrote that:

> The decision to establish *Xperiment!* was borne out of a desire to equip visitors with an understanding of basic scientific principles that would provide insights into other displays within the museum. It was also recognised that it would need to be effective in its own terms as well, introducing scientific concepts to people who might only visit *Xperiment!* (p. 11)

The popularity of the ISTC concept with visitors has led some traditional science museums to make pragmatic decisions to introduce interactive galleries in their museums to act as an attraction to increase visitor numbers. Greene (1989) also wrote, "In marketing terms, a science centre is a very attractive 'product' to promote; it is one that generates enthusiastic word-of-mouth publicity as well" (p. 12). He reported that after *Xperiment!* opened "visitors are staying longer, and returning more frequently" (p. 12).

Visitors involved in the present study gave a wide range of opinions concerning their visit to *Scitech* with a large majority supporting the notion of ISTCs having educational value. An example of a statement made in response to a questionnaire in this study by one of those visitors, an adult female, indicating that she thought her visit had educational value was:

> It was an educational, fun, exciting, alive, fast moving adventure, where I learned quite a lot about things that surround me and things in science and technology. I think my visit to *Scitech* was a very worthwhile weekend exercise and I will most definitely go to another exhibition that comes up.

There were a few visitors to *Scitech* who did question the educational value of their visit. For example, a questionnaire response by an adult male was:

> Science and technology still seems like a lot of mumbo jumbo . . . and it costs money to make it accessible to kids.

Considering the diversity of opinions there must be a question about how effective ISTCs are in their quest to educate the public in an informal context. The issue of a need to establish credibility was highlighted by Falk, Dierking and Holland (1995a) when they stated:

> As a field, museum professionals find it extremely difficult to state clearly and succinctly how museums meaningfully affect people's lives. This results in undervaluing of a museum's role in the broad education infrastructure of a modern community. (p. 31)

Accountability

At *Scitech*, the principal site for the collection of data for this study, the Board of Directors has instituted a policy of ongoing evaluation because a considerable amount of public money has been invested in its setting up. That investment still continues on an annual basis, with the Western Australian Government providing recurrent funding (A. Ghiselberti, personal communication, February 10, 1997). Additionally, private sponsorship by local, state-wide, national and multinational businesses has been substantial. The published annual reports of *Scitech* indicate the proportions of its income derived from different sources but do not specify the actual amounts or the total (see Figures 1.2 and Figure 1.3). However, it is clear it is a multi-million dollar operation. For example, when planning commenced for "The Great Australian Treasure Hunt" exhibition in 1993, a projected budget of $1,000,000 was used (Scitech Discovery Centre, 1994b) . The entire amount was raised subsequently from private sponsorship, mainly from the large mining companies in Western Australia (S. Beddington, personal communication, June 4, 1994). *Scitech's* 1993/94 Annual Report states that since its opening "more than $6 million has been raised in sponsorship for exhibits, exhibitions and special programs" (Scitech Discovery Centre, 1994b, p.11) .

On a national level in Australia, tens of millions of dollars of public funds are spent annually to support the ISTCs. For example, the building that houses *Questacon* was purpose-built with a grant of $19.6 million dollars and in 1989 its reported annual expenditure was approximately $6 million dollars (Gore, 1989) . Not all of those funds would be from the Australian government, however, it is

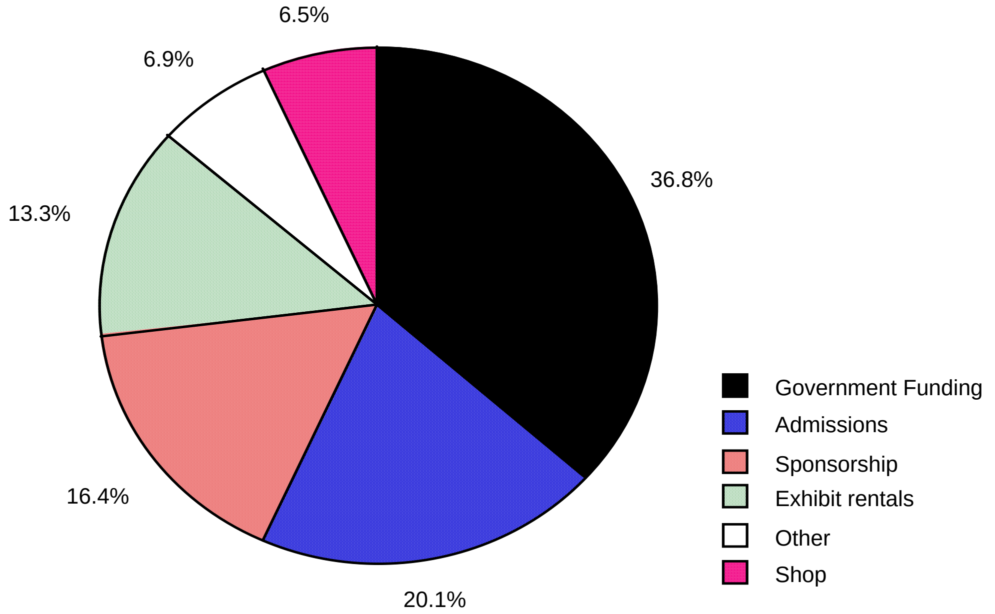

Figure 1.2. *Scitech* income sources 1994-95 [1].

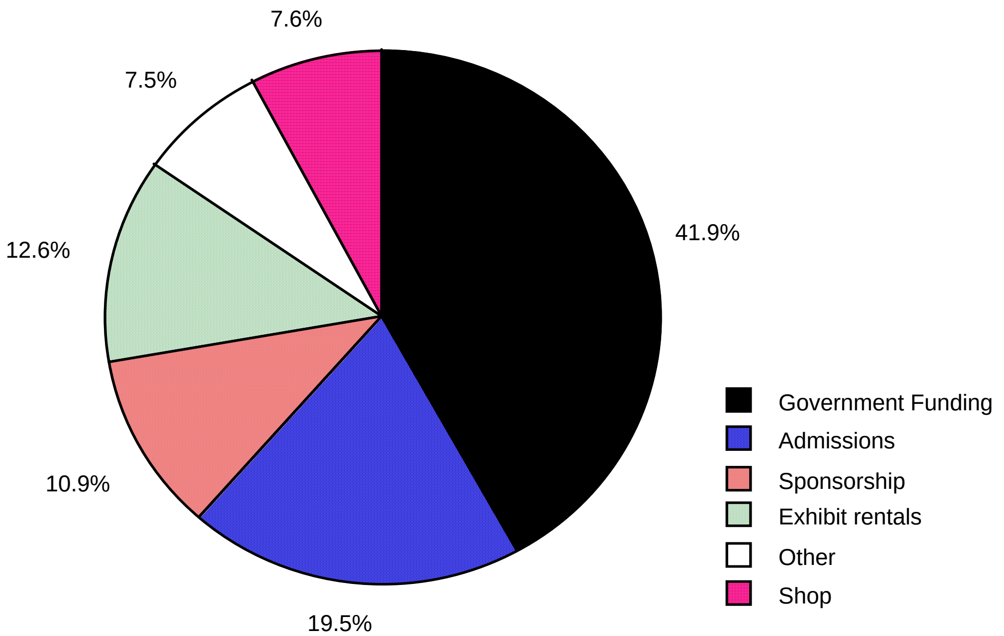

Figure 1.3. *Scitech* income sources 1995-96 [2].

[1] From Scitech Discovery Centre (1995, p. 10)

[2] From Scitech Discovery Centre (1996, p. 8)

reasonable to assume a sizeable proportion is from public revenue. When the global ISTC scene is considered the amount spent in support of science centres must be enormous.

What then has driven the explosion of science centres and why are they able to enjoy continued support by the provision of ongoing funding? Perhaps a clue is given by Bhathal (1985) , who wrote the following statement about the need for Australia to develop a system of science centres.

> Australia needs to nurture and establish full fledged science centres and inject the science centre approach into its traditional museums if it is not only to have a well informed public but also to keep up with its industrial competitors who are moving into high science and technology. It will also ensure for itself a scientifically literate public which will be able to see the issues where science and technology impact on society more clearly. Australia can also expect to have a constant supply of creative young people who will take up careers in science and technology and thus provide the necessary ballast for an economic and industrial take-off in the 21st century. Australia will then be in a position to take on the responsibilities of a major power in the Asian-Pacific region which has been described as the major growth area in the coming decade. (p. 7)

Bhathal's view has support when the political agenda of the Australian Government of that period is examined. There is evidence that science centres were considered to be an important element in terms of the perceived push to move Australia from a resource and commodity-based economy and make us the "clever country", and the Federal government's explicit programs to enhance the scientific and technological literacy of its population (Hawke & Jones, 1989; Oliphant, 1990; Prime Minister's Science Council, 1990) .

That perceived need is still on the political agenda. The Australian Science and Technology Council (ASTEC) is a statutory authority formed to offer independent advice on wide ranging policies and programs related to science and technology. In a report entitled *Matching Science and Technology to Future Needs: Key Issues for Australia to 2010*, six key issues were identified after extensive consultation with leading people in industry and commerce. One of the key issues is a need for a society that is technologically literate. The report states:

> The 21st Century will see an increase in the pace with which we introduce technology into our society. The appropriate response to more technology is not to ignore it, but to accommodate it, respond to it and shape it. We need a society that can make informed choices (Australian Science and Technology Council, 1995, p. 2)

Given the level of financial support provided by both Government and private enterprise, and Government policies aimed at promoting scientific and technological advancement of the Australian population, it is surprising that little has been done in establishing just how effective ISTCs are in repaying the huge capital investment made in them. Before any attempt can be made to determine whether ISTCs are providing either a return on the investment made in them, and whether they are credible informal education institutions, it is first necessary to identify what they propose to achieve.

What Do ISTCs Purport to Do?

While it is clear that ISTCs are established with an intention to bring science to the public in an informal style, specific objectives that are identifiable overtly in a formal education curriculum are not so readily available in ISTCs. There are, however, alternative sources of information about ISTC objectives, for example, mission statements, annual reports, promotional materials and statements of ISTC leaders and founders.

Mission statements are often broad and therefore difficult, if not impossible, to use for determining foci for measuring specific outcomes. For example, *Scitech's* stated mission is "to increase interest and participation by all Western Australians in science and modern technology" (Scitech Discovery Centre, 1994b, p. 1) . However, the mission statement is elaborated upon in a draft corporate plan.

> This participation is an essential pre-requisite to the growth for technological industries in Western Australia. The increased interest by all citizens will lead them to find out more about science and technology from other sources and to make more informal decisions on social issues involving science and technology. Increased interest by young people will lead them to more confident study in these subjects, and to consider careers in these areas. (Scitech Discovery Centre, 1994a, p. 10)

Smith (1995), in an article about investigating the reasons behind the establishment of the 13 science centres around Australia, lists comments made by their leaders that specify desired outcomes of visits. From their reported comments, it is clear there is an emphasis on stimulating public interest in science by presenting it in an entertaining manner and relating it to visitors' everyday life. For instance, he cites Gore as stating, "I want people to see science as interesting, exciting and relevant to their daily lives" (p. 52). Smith (1995) found that some other common aims were to raise the level of public awareness of science and to bring possible career options in science to the attention of children. Other expected outcomes were an increase in scientific literacy and a positive shift in attitudes towards science.

It is interesting to note that there was no mention of learning in the cognitive domain; rather there was an aversion to highlighting factual information. Dodds, then acting Chief Executive Officer of *Scitech*, has been quoted as stating "You've got to get away from facts as the core . . . . Facts discourage enthusiasm and close off curiosity" (Smith, 1995, p. 54). Similarly, Pizzey, the Director of *Scienceworks*, has argued that, "What we're attempting is experiential rather than factual. The challenge is to engage people . . . entertain people, excite them." (Smith, 1995, p. 56) .

In the United Kingdom, although the same outcomes are sought, it is not uncommon for mention to be made of cognitive outcomes. Stevenson (1993) , in seeking the reasons for the establishment of ISTCs in the United Kingdom, cites the comments of some of the founding directors of ISTCs (Greene, *Xperiment!*; Gregory, *Exploratory*; Beetlestone, *Techniquest*; Pizzey, *The Discovery Dome)* and the promotional literature for *Launch Pad*. He found there is an emphasis on the public understanding of scientific principles and modern technology, as well as promoting science "as a quest for knowledge" (Stevenson, 1993, p. 29) and stimulating interest in science and technology.

There is a need for accountability by ISTCs as the consumers of public and private investment. Are they doing what they purport to do? Are they being effective in raising the level of public interest in science and technology? Are they exciting their visitors about science and technology and do those visitors subsequently have a better understanding of science and technology in their everyday lives? In the latter part of the nineties there is a political climate of economic rationalism and funding cutbacks, while in the business world the standard "bottom-line" has become the criterion of effectiveness. Given these contemporary criteria, ISTCs, as consumers of both public and private capital investment, should be accountable in terms of what they purport to do.

There have been calls for accountability. Bitgood, Serrell and Thompson (1994) , when summing up a review of the literature on the impact of informal science education, stated that:

> If museums are to be accountable for providing what they say they are providing, they must measure *something* . . . . If museums take money to help fund an educational endeavour, there is an extra responsibility attached to show what happened, no matter how it is defined. (p. 97)

However, the task of measuring the effectiveness of ISTCs, in terms of what their leaders, reports and promotional materials indicate they intend to achieve, is not an easy one. When advocating the evaluation of scientific and cultural institutions, Collins (1990) warned of difficulties inherent in any such undertaking. He wrote:

> The debate as to whether the outputs of cultural and scientific policies and programs can be measured centres around the intangible nature of the goods in question. These outputs, perhaps more then any other, would seem to defy easy measurement or evaluation, at least in terms the treasury would understand. (p. 3)

The Research Question

The main research question investigated in this study simply asks:
How can the outcomes of a voluntary visit to an ISTC be measured?

Its origin was pragmatic. At the time of commencement of this study *Scitech's* Board of Directors was instigating a new management system designed to follow a corporate model. Part of the corporate plan was to put in place a means of evaluating their organisation in terms of its effectiveness in presenting science and technology to the visiting public. Consequently they were keen to be involved with the project and offered their support.

A meeting with the Chief Executive Officer, the Education Manager, and the Marketing Manager of *Scitech*, resulted in the target population for this project being defined. Little was known about the outcome of visits for those people who came voluntarily to *Scitech* as a leisure activity, even though this group constituted the majority (approximately 75%) of visitors.

In order to answer the research question there were two primary questions that first needed to be addressed. They were:

- What are the personal outcomes of visits to *Scitech* as perceived by the visiting public?
- How can research instruments capable of measuring those perceived outcomes be developed?

To be successful, the research instruments will need to meet five criteria. First, any instrument or instruments will be based on the public's own perceptions of their experiences while visiting an ISTC, not on the preconceived ideas of the researcher. Second, any instrument or instruments will be reliable and valid. Third, any instrument or instruments will be administered easily and the data analysed and interpreted readily. Fourth, any instrument or instruments will have flexibility by incorporating items to measure generic outcomes across different ISTCs as well as items responsive to individual features of the same ISTCs. Fifth, any instrument or instruments will be acceptable by staff of ISTCs or they will never use them.

Two additional points about the nature of this study need to be stressed. First, the participants in this study are the general public, including children and adults who attend of their own volition. They will be referred to as the visiting public whenever there is a likelihood of confusion with organised school groups. This term is different to "the public" as it is used with varying connotations in some of the literature about the public understanding of science (see, for example, Irwin & Wynne, 1996; Macdonald, 1996). Second, the main focus of this study is the visiting public's perceptions of outcomes of a visit and not about the public understanding of science which is a different issue. Macdonald (1996) sees the public understanding of science as a complex relationship between the communicators of science and the recipients of that communication whereby there is a consideration that the "public's wishes and definitions need to be taken into account" (p. 156). She also believes there is no one, universally accepted notion of the public understanding of science. Although one outcome of a visit may be increased understanding of science, the study is designed to measure much broader outcomes, and looks to the visiting public to define what those outcomes might be. Clearly this has profound implications for the design of the study.

Method

Two primary but interrelated research tasks are central to this study: identifying the personal outcomes of voluntary visits as perceived by visitors, and developing valid instruments to measure those outcomes. The research procedures used to address those tasks employed elements of both qualitative and quantitative methodologies. Initially, a qualitative approach was adopted for two fundamental reasons; namely, a lack of existing research in the field, and the nature of the research question that is not conducive to an experimental approach.

The qualitative approach followed a constructivist paradigm, detailed by Guba and Lincoln (1989, emphasis in original) , where the outcomes are "not 'facts' in some ultimate sense but are, instead, literally *created* through an interactive process that *includes* the evaluator . . . as well as the many stakeholders" (p. 8). This method gives rise to "one or more *constructions* that *are* the realities of the case" (p. 8). The constructions evolve from a hermeneutic methodology which "involves a continuing dialectic of iteration, analysis, critique, reiteration, reanalysis, and so on, leading to the emergence of a joint (among all the inquirers and respondents . . .) construction of a case" (p. 84).

During the initial phases of this study, due to the small body of existing research, an "emergent design" (Patton, 1990, p. 196) using open-ended methods, was followed. With this design the research methods are adapted to suit the unfolding circumstances and changing needs of the investigation. No hypotheses are being tested, rather it is a search for establishing hypotheses or assertions to be validated (Borg & Gall, 1989).

The techniques used in the initial stages of this study included: informal conversational interviews, a general interview guide approach, standardised open-ended interviews (Patton, 1990) , participant observation (Lincoln & Guba, 1985), focus groups (Krueger, 1988) , member checks (Lincoln & Guba, 1985) , questionnaires with closed and open questions (Fowler & Mangione, 1990) , and a case study (Merriam, 1988) . All of these techniques are methods typically used in qualitative research with its underpinning constructivist paradigm and ensure that any findings will be based on a wide range of data sources – a form of grounded theory (Glaser & Strauss, 1967) . Grounded theory itself is a form of emergent design as it also does not attempt to verify any existing theories.

Once the prototype instruments were developed on the basis of the qualitative approaches, a quantitative methodology was followed when collecting and analysing data for testing the validity of the instruments. By using the techniques of the positivistic paradigm – random sampling, large samples, and statistical analysis – claims for objectivity, replicable measures, generalisable results and possible cause-effect relations are strengthened (Guba & Lincoln, 1989) . In the validation process, some constructivist techniques were used with expert panels and member checks by respondents as a supplement to quantitative research techniques.

Sites and Subjects

Data were collected from five different ISTCs, three in Australia and two in New Zealand. Most of the research was conducted at *Scitech* where all the data used to develop the two prototype instruments were collected. All the participating centres were given an undertaking of anonymity and confidentiality of any information they provided. The management of *Scitech* voluntarily gave permission to publish all details of the study that related to them. However, when data and results from all the ISTCs are reported together, all the ISTCs are given pseudonyms so that anonymity is preserved.

Participants in the study were members of the public and ISTC professionals. Almost all of the participants were randomly selected visitors who came voluntarily to the five ISTCs and were 8 years of age or older. There was a small number of members from the public, both voluntary visitors and non-visitors, who were specifically targeted to supply information and to review data collection instruments during the study. Specific subjects from the ISTC professionals at *Scitech* were targeted both for interviews, and for providing critical comments during the process of developing the instruments.

Generally people were willing to participate and refusals were rare. Where questionnaires were mailed out, return rates were usually in the range of 70-80 percent when an incentive of a return pass was offered and 50-60 percent when no incentive was offered. Both rates are considered to be satisfactory. McManus (1993a) reported a return of 21 percent for a mail-out survey, however, she also stated that in her experience "a response rate of between 45 and 60 percent could be expected" (p. 371).

Procedure

At the beginning of the study an extensive literature search was conducted to locate studies that measured outcomes of voluntary visits to ISTCs identified by this study. While some published studies that identified outcomes were located, only a few of those measured specific outcomes, and none were sighted that dealt with instruments for measuring outcomes. Consequently, the initial steps involved investigative field work gathering information to form a data base for developing instruments. The later steps involved statistical analyses, supplemented with qualitative checks, for refining and validating the instruments. Because of the investigative nature of the study it evolved in a sequence of discrete stages.

At the outset, an anthropological approach was adopted where the researcher immersed himself in the culture of the ISTC day-to-day activities. This was necessary to get a basic working knowledge and feel for an ISTC environment, so considerable time was spent in observation and casual conversations with visitors and staff. During this period, time was also spent acting in a participant observer role at education and marketing team meetings, whole of staff meetings, exhibition planning meetings, exhibition launches, docent training sessions, explainer training sessions, education standing committee meetings, and an in-service session for conducting focus groups.

The next step involved a series of formal interviews conducted with randomly selected visitors, and key members of *Scitech's* professional staff in the areas of visitor services, education, marketing, exhibits, and management. As well, formal discussions were conducted with separate groups of visitors and explainers. Pooled information, gleaned from the discussions, interviews, and casual conversations, was used for constructing the Post Visit Questionnaire (PVQ) for use in the following step of the data collection.

The PVQ was field tested in a pilot study before being administered to randomly selected volunteers from casual visitors. This procedure was conducted in two phases using some different questions on the PVQ in each phase. The data from the PVQs were collated and analysed, and then pooled with the data from the interviews to provide a base for developing two instruments.

The two instruments for measuring outcomes of voluntary visits, entitled the Perceptions of Visit Impact Instrument (PVII), and the Profile of Visit Outcomes

Instrument (PVOI), were then constructed. They were refined and tested using data collected from ISTCs in Australia and New Zealand. As well, some visitors, ISTC professional staff, educators, and non-visiting members of the public, provided supplementary information and critical appraisal at different stages of the development and validation process. All the participating ISTCs were provided with a confidential, individual report based on the data each had collected.

Significance of the Study

The research question is significant because answering it contributes to educational research about ISTCs by enabling the measurement of the perceived outcomes of voluntary visits. At the formative stages of this study a review of the literature on educational research in ISTCs showed that most had been directed at the visitors; their behaviour at the museum, and their interaction with exhibits. The data thus collected have aimed at improving individual exhibits and the arrangement of exhibits on the museum floor (Rennie, 1991) . Some studies (Diamond, 1986; Feher, 1990; Huber, 1989) , have focussed on children's learning when they interact with exhibits designed to prompt specific learning. However, "the literature, especially related to ISTCs and what goes on in them is insubstantial, scattered and diverse" (Stevenson, 1991, p. 522). McClafferty's (1991) review of recent research methodologies used in ISTCs found few studies prior to 1991 that evaluated outcomes by non-school group visitors. Of 29 references related to measuring learning outcomes in museums, Donald (1991) found only seven were based on learning in science museums. Donald did not specify how many of those seven studies focussed on voluntary visits to ISTCs. Falk, Dierking and Holland (1995b) acknowledge that the problem of identifying outcomes for voluntary visitors still existed in 1995. They stated that a great deal of educational research work has been conducted with school groups that visit ISTCs, but "outcomes for voluntary visitors are less well understood" (p. 27).

The main research question is also significant because in endeavouring to answer it, two practical research instruments, which have been validated in two countries, were produced for measuring the outcomes of visits. Both instruments are used easily for research, and they can be used by staff of ISTCs to establish accountability and credibility. The notion of measuring outcomes in museums has been around for over two decades. In 1974 Screven wrote, "Museum professionals have strong beliefs that something is happening to their visitors, but there is great difficulty in defining what it is, much less measuring it" (p. 10). Screven's assertion about the task being difficult proved to be correct, as 20 years later the problem still existed. In 1994, the National Science Foundation funded a conference of museum professionals to look at ways to identify the outcomes of museum visits and how to measure them. When reporting the proceedings of that conference Falk et al. (1995b) wrote that "museum professionals are still trying to define reasonable, measurable, outcomes for which they could conduct a factor analytic study" (p. 29).

The main research question, then, encapsulates a problem that has been defying researchers for at least two decades. In the process of answering it, tools have been produced that will enable ISTCs to collect data easily and present quantified measures of their outcomes, or in business terms, a measure of their product. Those measures will provide an indication of their credibility as educational institutions, and consequently, provide some proof of accountability as recipients of public funds and private sponsorship.

Overview of the Thesis

Chapter 2 reviews the literature purporting to identify outcomes of visits to ISTCs, with particular attention given to studies attempting to measure outcomes. It also reviews the methods used in research about voluntary visits to ISTCs, and methods of developing survey instruments that have potential for measuring outcomes from such visits.

Chapters 3, 4 and 5 report the methods and procedures followed to collect and analyse the data that were used to develop the prototypes of the two instruments to measure outcomes. Chapter 3 provides an overview of the study and reports the initial stage of the investigation in the form of a small case study of *Scitech.* In Chapter 4, the second stage of the study, a series of interviews with *Scitech* staff and members of the visiting public, is described. As well, an analysis of the data collected from all the interviews is provided. Chapter 5 is a report on the third stage of the study, the development and use of the PVQ to collect written data from voluntary visitors about their experiences while visiting *Scitech*. It also provides an analysis of the written responses.

In Chapters 6 and 7, the fourth and fifth stages of the study, processes of refinement and validation of the two instruments, the PVII and PVOI, respectively, using qualitative and quantitative techniques, are described. Both chapters provide full details of all the statistical analyses for developing both instruments using data collected from the different centres. A full description of the qualitative procedures that were used to develop the items and to ensure construct validity is given.

Chapter 8, the last chapter, provides a summary of the study, followed by a critical discussion of the research methods employed. Finally, the implications of this study are explored, and suggestions for further research are made.

CHAPTER 2

LITERATURE REVIEW

Overview

This chapter commences by outlining the historical development of ISTCs so they can be seen in the overall context of the science museum environment. The learning environment of a voluntary visit, particularly to an ISTC, is then described followed by details of outcomes of such visits. Studies representative of those that have been undertaken to determine and measure outcomes are then reviewed, followed by a summary of the methodologies used in studies to measure outcomes. The chapter concludes with a summary of the main points that have implications for this study.

Evolution of ISTCs

The Beginnings

ISTCs have evolved from traditional science and technology museums. The earliest recorded notions of science museums date back to the beginning of the 17th Century (Danilov, 1982; Salmi, 1993) , when Francis Bacon proposed highlighting the growing importance of emerging technology by establishing a museum to house inventions, and to hang portraits of their respective inventors. Soon after, René Descartes proposed a museum to house a collection of scientific instruments and mechanical models. It was the plans and writing of Descartes that gave rise to one of the first science and technology museums – the *Conservatoire des Arts de Métiers* in Paris in 1794 (Danilov, 1982). According to Danilov (1982), Liebniz, in 1675, proposed that exhibitions should "entertain and enlighten the public" (p. 14) by using Magic Lanterns, models, illusions, rare plants and simple experiments demonstrating natural phenomena. The *Ashmolean* Museum founded in 1683 in Oxford, England, is commonly believed to have been the first science museum (Salmi, 1993) . It was originally used to house natural history collections and it is now a museum of science, along with other objects and artefacts, with a collection dating back to medieval times.

Stages of Evolution

McManus (1992) outlines the development of science museums and describes four stages in their evolution. The first stage to emerge has been referred to the "Cabinet of Curiosities" by both McManus (1992) and Salmi (1993) . These were small, static collections accommodated in rooms or galleries of private houses and were popular amongst people of wealth in Europe during the seventeenth and eighteenth centuries. The Sir John Sloane Museum in London provides a snapshot of the original form of museum which McManus labels the "Ancestral Form Museum" (p. 159). It is located in his former house that was turned into a museum following his death in 1837.

The next three stages of science museums are termed first, second and third generations by McManus. The first generation evolved when the collections began to be housed in large buildings. The British Museum, founded in 1753, is an example of a first generation science museum. During the nineteenth century, they were organised formally with links to universities and employed salaried, highly ranked staff to organise, preserve and present the collections and conduct research on them. In practice, their main goal was to "contribute to scientific knowledge" (McManus, 1992, p. 160) while public education played a minor role. Education staff and designers were lowly ranked, with the educators employed solely to look after visitors and school children, and they did not have any input into exhibit development. Recently, to maintain public interest, many of the first generation science museums have changed their emphasis, with the focus of their displays now being on explanations of scientific concepts rather than a grouping of exhibits based on taxonomy. A good example of the shift in emphasis is the thematic ecology exhibition in a clearly defined section at the *Natural History Museum* in London. There, visitors are able to walk past, and through, a wide variety of exhibits portraying basic ecological concepts and principles integrated with exhibits linking those concepts and principles to real-life situations including contemporary environmental issues. It should be noted that this change, instigated by Roger Miles, at the *Natural History Museum* was accomplished with difficulty, as there was quite a deal of opposition to the new format by some of the staff with more traditional views on the presentation of science and technology (J. Cooper, personal communication, February 27, 1995).

Development of the second generation of science museums commenced with dedicated applied science and technology museums in which the items were used by industry as vehicles for training future practitioners of design and craft. They functioned in a practical role and preservation of historical items was not in their domain – they were, in essence, applied science and industry museums. The first museum that characterised this stage was *Conservatoire des Arts et Méteriers* in Paris in 1794. McManus (1992) states that these museums had a status as "authoritative sources of information" and promoted the "world of work and science" (p. 162). This type was the forerunner to the present science and technology museums, which McManus believes came about because of a new concept in presenting science and technology that became popular across Europe and America during the period between 1850 and 1939. The new idea took the form of travelling exhibitions and trade fairs with a science and technology theme, all of which were designed to entertain, demonstrate, amaze and inform, while at the same time promote industry and its latest technological products and achievements. This researcher witnessed a science show that was part of a travelling exhibition featuring some of the latest working machinery during the mid 1950s in Australia. It was eagerly attended by what seemed to be an audience of thousands crammed into a large public hall. One theme involved demonstrations of natural frequency using glass as the medium. The audience was enthralled as a demonstrator used a variable frequency sound generator to shatter wine glasses standing on tables at the opposite side of the stage.

The science and technology museums of today came about from a fusion of the artefacts of earlier training-oriented technology museums and the popular industrial exhibitions, a trend that commenced at the beginning of this century. Examples are the *Science Museum* in London, the *Museum of Science and Industry* in Chicago and the *Deutches Museum* in Munich. These still retain historical artefacts of technology as well as working machinery and emphasise the progress of science. Instead of the training of specialist groups they have taken on a mass public education role, using specialised education sections, and have begun to incorporate a hands-on element in their communicative repertoire.

The third generation is characterised by museums that are quite different from any of the other types. They are concept-based instead of object-based (Danilov, 1982) with an emphasis on visitor participation rather than looking and wondering. They are clearly aimed at public education using a lively, informal format encouraging visitors to become actively involved by manipulating the exhibits. There are no curatorial items and exhibits that are no longer of use are discarded rather than preserved. Their focus is on science and modern technology, and exhibits are purpose built by project teams of specialists covering a wide range of skills. McManus (1992) identifies two styles of communication that feature in the third generation of science museums.

The first style has interactive exhibits arranged in groups to present elements in a theme that lead to an overall picture of a concept. This is similar in style to the recent trend in some first generation science museums (for example, the Ecology exhibit in the *Natural History Museum*, London). *Eureka*, a children's museum in Halifax, United Kingdom, portrays a number of science-related messages in this way. For example, one clearly defined section contains exhibits arranged to take a visitor along a path of discovery about vision. The basic science involved is portrayed in a series of interactive exhibits, each presenting basic scientific principles underlying a particular concept. Each exhibit explains a scientific principle and then shows how that principle may relate to a visitor. For example, a myopic person would learn how light refracts, then how it refracts through a lens, and then how it passes through the lens of an eye. They are then able to understand how that principle is applied when spectacles are used to correct short-sightedness.

The ISTC characterises the second style of communication of the third generation of science museums. This style McManus (1992) describes as "a decontextualised scattering of interactive exhibits, which can be thought of as exploring stations of ideas (usually in the physical sciences)" (p. 164). They are typically housed entirely in a dedicated building (for example, *Questacon – The National Science and Technology Centre*, Canberra) or as a complete gallery in a more traditional science museum (for example, *Launch Pad*, London Science Museum).

Examples of the third generation of science museums given by McManus are *Palais de la Découverte* in Paris (considered a forerunner), *The New York Hall of Science* (1964), the *Lawrence Hall of Science* (1968), and the *Exploratorium* (1969). It is generally accepted that the *Exploratorium* in San Francisco is the model on which most contemporary ISTCs are based (Rennie & McClafferty, 1996) . Gore (1989) attributes his first visit to the *Exploratorium* as the source of inspiration that stimulated him to establish *Questacon*. It is still visited by people from different countries who are seeking ideas and advice when developing new ISTCs (G. Delacôte, personal communication, July 21, 1994).

The ISTC Visit Experience

Much of the literature relating to what happens during a visit to an ISTC incorporates research in museums, zoos, aquaria and, in some instances, art galleries. As Laetsch, Diamond and Gottfried (1980) point out, "zoos share many characteristics of science centres and museums, especially in use by family groups" (p. 16). Rennie and McClafferty (1996), in their comprehensive review of literature, state that although they "drew primarily from literature relating to science centres, some research refers to interactive exhibits in galleries or exhibitions at more traditional museums" (p. 57). In this literature review, the same philosophy will apply. Where possible the literature will focus on research about voluntary visitors. However, where it is appropriate reference will be made to research into school visits to ISTCs as well as other settings such as museums, zoos and aquaria.

When people visit an ISTC, there are many factors in operation that contribute to their experiences. It is important to explore the factors that comprise the context of a visit because they influence outcomes for individual visitors. In trying to understand the nature of a visit experience, it is useful to examine two models that provide a framework. The first, the Interactive Experience Model, was proposed by Falk and Dierking (1992) and the second, the Visitor Experience Model, was developed by the researchers in The Museum Impact and Evaluation Study (MIES) (Anderson, 1993a).

The model of Falk and Dierking (1992) is based on their extensive experience in museum research and has three components: the physical context, the social context and the personal context. The physical context relates to the architecture and ambience of the ISTC itself, as well as the exhibits it houses, their layout and labelling. The personal context refers to a visitor's background of experience, knowledge, interest and needs. Falk and Dierking believe the elements of the personal context merge to form the visitors' agenda that influences their behaviour and attitude during the visit experience. The social context concerns the interpersonal interactions that occur while people are visiting.

The three components should be seen in varying degrees of combination rather than in isolation because they all contribute to the visit experience. When describing their model, Falk and Dierking stated that:

> The Interactive Experience Model suggests that all three components should contribute significantly to the museum experience, though not necessarily in equal proportions in all cases. The model also predicts that, although the three contexts can be viewed separately, they function, in fact, as an integrated whole. (p. 7)

The Visitor Experience Model (Anderson, 1993a) consists of three "intertwined" elements which the MIES researchers termed Educational, Personal and Social. When discussing the Visitor Experience Model, Anderson claims the personal and social factors appear to be similar to the corresponding elements in the Interactive Experience Model. Based on the results of research conducted at three exhibits, Anderson believes the educational element is "often as important to visitors as social and personal aspects, and is sometimes more important" (p. 11). Anderson points out that this differs from the work of Falk and Dierking, in which he claims, "visitors' immediate cognitive gains seem to be lesser parts of the whole museum experience than do many other social and physical factors" (p. 11).

While both models highlight the combination of factors influencing the visit experience, it is the Interactive Experience Model that is particularly useful because of the fine detail provided by Falk and Dierking. The detail is based on many examples of research conducted by themselves and others, enabling the factors influencing a visit to be seen in relation to each other. The overall museum visit is seen by Falk and Dierking as a holistic experience and they use the term "Gestalt" (p. 83) to describe it.

For most voluntary visitors, a visit is a group leisure outing and therefore a social experience, with each member of a group contributing elements of their personal background to the group dynamic and hence influencing the visit experience. As well, individuals will have their own reasons for visiting and seek different experiences which will impact on other members of the group. It is the combination of these factors that ultimately define the visit experience and subsequently the outcomes for individuals.

Individuals' agendas during a visit will also be driven by their reasons for attending, and these vary. Some research has shown that voluntary visitors generally have come in a predominantly leisure mode, a notion supported by data collected during the MIES (Anderson, 1993c) and research conducted by Hood (1992) . Their finding is not universal, as Kelly (1991) found visitors arrive with a desire to learn something new, to provide their children with an educational experience, or to experience interesting exhibits. Rosenfeld (1979) observed that visitors will frequently attribute the cause of their visit to their children, but noted that adults also enjoy themselves. A similar observation was made by the Manager of Education at *Scitech* (V. Dodds, personal communication, March 7, 1994).

In reporting a study about visitors' behaviours while visiting a zoo, Rosenfeld (1979) listed the following reasons people came to visit: to watch people, to walk in a safe place, to have fun, to eat food not eaten at home and to strengthen family ties. It is interesting that the animals were not mentioned in the five most frequent reasons. It is possible "animals" as an answer may have seemed so obvious that respondents chose to omit it. Rosenfeld also notes that over two thirds of the reasons supplied were not related to the zoo's goals.

Visits are typically of short duration. In a careful study at the *National Museum of Natural History*, Falk (1991) tracked 69 visiting families and recorded their behaviour during the visit. He reported that for this group a visit had four discrete components:

- Orientation, lasting 3 to 10 minutes;
- Intensive Looking, lasting 15 to 40 minutes;
- Exhibit Cruising, lasting 20 to 40 minutes; and
- Leave Taking, lasting 3 to 10 minutes.

Falk also notes that the Intensive Looking phase was usually less than 30 minutes, which means that during a visit of one and a half hours the behaviour most conducive to learning is relatively brief. This finding is similar to that reported by McManus (1992), who stated that a museum visit usually lasts about two hours with attention to exhibits ranging from a cursory thirty seconds to more concentrated sessions that last three to five minutes. Diamond (1986) found the average visit lasted about just over two hours (M = 124 mins, SD = 47 mins) and during that time interaction with exhibits was typically brief, with 57% of exhibit visits being for less than one minute and only 18% lasting more than three minutes. Because visits are of relatively short duration and exhibit engagement is likely to be of a fleeting nature, there is an important implication for any potential learning. As Falk and Dierking (1992) point out, learning is a cumulative process which takes time and if exposure to an exhibit is short then little learning can be expected. Another factor to be considered, especially for school group visits, is the relative novelty of the visit experience. A careful study by Falk, Martin and Balling (1978) demonstrated that the exploratory activities which are provoked in visitors experiencing a novel environment can interfere with the educational outcomes of the visit. For school visits orientation activities might need to be considered by teachers with firm educational objectives in mind for their students. This aspect may be less important for the visiting public, but nevertheless, new visitors need to familiarise themselves with the ISTC environment, and this is an activity which consumes some of the visit time.

In summary, an ISTC visit experience is a dynamic interface of multiple factors. Voluntary visitors are most likely to arrive with their own agenda, typically stay for a short period of time and interact as much as they wish with exhibits of their own choice. They come from different backgrounds and varying levels of existing knowledge and ranges of attitudes and "take-away" (Rennie, 1995b, p. 1) personal and often shared experiences about which they may later ponder, act upon, or do both. Indeed there is very little that any two visitors will have in common other than they have both visited the ISTC. Given the varied ages, backgrounds, expectations and visit experiences of the voluntary visitors, what then are the likely outcomes for those visitors? It is the outcomes that will be explored next.

Outcomes of Visits to ISTCs

ISTCs have been established to present science and technology to visitors in an interesting format, and hence, the professionals who run them and their sponsors would expect people to learn something while enjoying themselves. For example, Boyd (1993) , an experienced ISTC manager, believes the educational outcome is paramount as he wrote that ISTCs "are avowedly and explicitly educational institutions" (p. 763).

To a casual observer of visitors interacting with exhibits at an ISTC it is obvious that most are having fun (*Scitech* Visitor Services Manager, personal communication, February 1, 1994), but that has led some visitors to question the educational value of the experiences. For example, Wellington (1990) and Beetlestone (1993) both cite anecdotal instances when adult visitors have commented that younger visitors are obviously having fun but the experience seems like play and therefore nothing is being learnt. There are practising educators who have contrary views. For instance, a group of teachers interviewed by Wellington (1990) who had taken school children on visits to ISTCs all believed the experience contributed to their pupils' science education. Some researchers claim that the element of play is a legitimate strategy to enhance learning (Watson, 1995; Yahya, 1996) , while Bitgood, Serrell and Thompson (1994) emphasise that a visit is educational recreation.

The synthesis of learning and enjoyment as an outcome has given rise to terms such as "edutainment" (Wolf & Tymitz cited in Donald, 1991, p. 372) and "info-tainment" (Lucas, 1991, p. 495) , both of which imply a mixture of entertainment and education. However, for those who associate learning with a formal style of curriculum and assessment, or with the traditional museum style of presentation, the informal nature of the ISTC experience could easily be seen as akin to that of a "Sunday afternoon fun-parlour" (S. Beddington, personal communication, June 4, 1994).

Learning in ISTCs is usually described in the literature as informal learning, a term McManus (1992) believes arose because instruments traditionally used to assess learning in schools failed to detect any learning in either ISTCs or museums in general. Some authors have made clear distinctions between formal and informal learning and listed characteristics of each (see, for example, Griffin, 1994; Wellington, 1990) . Falk, Dierking and Holland (1995) report that now there is a general consensus amongst researchers and museum professionals about the futility of trying to make any distinctions. That notion receives support from Falk and Dierking (1992) who simply state that "learning is learning" whether it occurs in "classrooms, museums, homes, and shopping malls" (p. 99).

Learning outcomes in schools have been described in behavioural terms following Bloom's taxonomy, which categorises learning objectives into three domains: cognitive, affective, and psychomotor. The cognitive domain encompasses all levels of knowledge and understanding, ranging from remembering to comparing and synthesising information. The affective domain relates to feelings, emotions, interests, attitudes, appreciations, values and emotional sets or biases (Krathwohl, Bloom & Masia, 1964) . The final domain, psychomotor, involves neuromuscular systems (for example, hand-eye co-ordination), and is particularly pertinent to the experiences involving repetitive movement like computer games and typing.

Wellington (1990) provides an interesting variation of Bloom's categorisation of learning. He describes it as a "potted version" (p. 249) applicable to learning in the ISTC context (see Table 2.1). In the cognitive domain, Wellington argues that knowledge that something happens is of more value to most people than knowing how and why it happens. For example, knowing that installing fluorescent tubes instead of incandescent bulbs results in less electricity consumption and consequently reduces a power bill is more important to people than understanding the scientific principles underlying each of the light sources. He suggests that ISTCs "in practice contribute almost exclusively to *knowledge that* and rarely contribute to a knowledge of how and why phenomena occur (unless the centre has an exceptional guide!)" (p. 250). This has implications for learning because it implies practical scientific literacy, a concept discussed later in this chapter.

Wellington (1990) emphasises the importance of the affective domain when he highlights developing "interest, enthusiasm, motivation, eagerness to learn, awareness and general openness and alertness" (p. 250) as a feature of ISTCs. He postulates that success in the affective domain will promote interest and motivate people to seek high levels of understanding – the *how* and *why* aspects of knowledge. In the area of the psychomotor domain, he believes that the hands-on nature of ISTCs promote manipulative skill and manual dexterity that are traditionally the province of art and crafts, and have a role to play in promoting those skills in science and technology. All three areas according to Wellington are interrelated in the learning process and ISTCs can contribute in some way to all three domains.

Table 2.1
Wellington's "Potted Version" of Educational Aims

Cognitive	Psychomotor	Affective
Knowledge *that*	Manipulative skill	Interest, enthusiasm
Knowledge *how*	Manual dexterity	Motivation, involvement
Knowledge *why*	Hand-to-eye co-ordination	Eagerness to learn
Synthesis		Awareness and openness
Understanding		

Note. From Wellington (1990, p. 249)

Some researchers believe ISTCs are strong in the affective domain of science learning, but are weak in improving understanding of scientific principles. Hughes, McGuigan and Russell (1995) cite Bradburne as stating that "while science centres are superior in nearly every regard in exciting their audience about science, there are serious misgivings about the extent to which they are effective in conveying an adequate understanding of scientific principles" (p. 3). This view has been echoed by Mardell (1995), who cited Holligan as stating that "a science centre promotes the image 'science is fun'. It makes that link – people learn relatively little, but it acts as an inspiration" (p. 751). Both of these views are consistent with the ideas of Russell (1990) who wrote that, "science centres have so much to offer: perhaps not so much in the imparting of factual knowledge, but certainly a great deal in terms of developing interest both in classroom science and in the real physical world around us" (p. 262).

Roberts (1993) believes the term "affective" in the context of museum learning has not been specified clearly and has "come to serve as a catch-all for the slippery feelings and responses that visitors invariably have and that museums typically neglect" (p. 97). This may provide a clue about why so little research has been conducted into the affective domain of learning in ISTCs. In two recent major reviews of the literature by Rennie and McClafferty (1996) and Ramsey-Gassert, Walberg III and Walberg (1994) , no studies are mentioned that focus on the affective domain for voluntary visitors. There are however, studies that mention affective outcomes of visits by school children (see for example Smith, 1996; Dymond, Goodrum & Kerr, 1990; Stronk, 1983).

Roberts (1993) argues that affective goals should be evaluated in museum exhibitions and programs, however she concedes there are "few good models of interpretative or evaluative tools which deal effectively with the affective domain" (p. 97). She also advocates that "affective factors are fundamental to the way we think and know" (p. 97) and makes a plea for developing a means of measuring the elements of affect. However, Russell (1990) warns the task is likely to be difficult when he states, affective learning is a "subtle shadowy thing: hard to test, or even demonstrate, yet very precious" (p. 260).

So far, this discussion has focussed on the nature of the learning that takes place in ISTCs based on learning domains taken from a school context. There is, however, an additional factor that needs to considered about learning in informal learning environments such as ISTCs, museums, zoos and aquaria. A visit experience for the voluntary visitor is most likely to be a social occasion and that has implications for learning because it is reinforced by social mediation (Falk & Dierking, 1992). McManus (1988) stated that "the social aspect of visits to the museum is not a mere enjoyable overlay adding pleasure to the museum experience for visiting groups. It is, rather, at the core of that experience and a fundamental source of satisfaction" (p. 43). The nuclear family, usually consisting of at least one adult-one child dyad, is the largest single social group to visit museums (Stevenson, 1993) . It is not surprising then, that many researchers investigating learning in museums have used the family unit as a focus for their studies. In a recent review of the literature on family visits, Borun, Cleghorn and Garfield (1995) provided an annotated bibliography with a total of 39 individual studies and literature reviews of family visits since 1978.

An increase in scientific literacy is one of the desired outcomes of visits that were identified by some of the ISTC directors in the report by Smith (1995) and detailed in Chapter 1. But what is scientific literacy? Ucko (1985) cites Graubard, the editor of an issue of *Daedalus* wholly about scientific literacy, as concluding that "there are no generally accepted criteria for defining scientific literacy" and that it is "clearly an elusive concept" (p. 287). In a paper about science museum exhibits and scientific literacy, Ucko (1985) notes that scientific literacy has been identified in different ways and refers to articles by Lucas (1983) and Miller (1983).

Lucas (1983) , in a review of literature concerning informal learning in science, and Riley (1996) both refer to the work of Shen (1975) to clarify the meaning of scientific literacy. Shen categorised scientific literacy into three types: practical scientific literacy, civic scientific literacy and cultural scientific literacy. Practical scientific literacy enables the holder of scientific and technical knowledge to use it to help in immediate practical situations. It is used in community health education campaigns, such as the "Slip, Slop, Slap" slogan used as a basis for a series of commercials on Australian Television. The aim was to make people aware of the dangers of skin cancer if they expose themselves to direct sunlight and that they should take precautions by wearing appropriate clothing, applying sun-block lotions and wearing a hat when venturing outside. Civic scientific literacy enables citizens to make informed decisions on issues, for example, sand mining for minerals in sensitive sand dune areas. Cultural scientific literacy is the realm of those who value science and technology as forms of human endeavour. These people are those who, for example, attend conferences about science, watch science documentaries on TV, or buy magazines with a science theme. Lucas believes visitors will have needs in all three areas.

Miller (1983) lists three constitutive dimensions that have been used to measure scientific literacy. They are: norms and methods of science, cognitive science knowledge, and attitude towards organised science. He reports the results of a survey conducted by the National Science Foundation in 1979 using criteria based on those three dimensions. The criteria were understanding the scientific approach, understanding basic scientific constructs, and understanding of science policy issues. The results showed that at that time only seven percent of the adult population of the United States of America could be regarded as scientifically literate.

Ucko (1985) reports a modest exhibit evaluation study focusing on scientific literacy conducted by Adams by interviewing 72 visitors. The findings showed over 80 percent were able to describe, at least in part, the scientific process. The study also showed a positive shift in attitudes towards science and scientists. Adams concluded that the precise impact for a visitor is difficult to measure statistically or even describe.

Smith (1995) also reports that some of the ISTC directors he interviewed expected visitors would be motivated to do something as a consequence of their experiences while visiting. Those anticipated actions could be watching a science related show on TV, reading a scientific article about something seen on their visit or choosing a career in science. All of these potential post-visit actions can be attributed to learning while visiting. If people are motivated to do something as a result of their visit it can be implied that their learning while visiting belongs to the affective domain. The actions that follow a visit provide a tangible indicator of affective domain learning.

Each of the outcomes that have been identified from the literature are learning related. This view is supported by Rennie and McClafferty (1996) who used the Interactive Experience Model as a framework to demonstrate that outcomes of a visit result from many variables. They stated that the visit should be considered as a total experience which is essentially a learning experience that is multidimensional. In their view, it consists of elements of affect, cognition and social interaction.

Clearly, learning in ISTCs is a complex issue. Wellington's point that the learning takes place in all three domains was not disputed in any of the research that was reviewed. However, it is most likely that is the affective domain that encompasses most of the learning in ISTCs. It is also clear that the domains are hard to separate (McManus, 1993b) and therefore would be difficult to measure separately. Falk and Dierking (1992) make the point that measuring learning in ISTCs is also made difficult as existing definitions of learning have tended to focus on learning environments where controls can be applied and changes measured.

Defining Learning in an Informal Science Setting

Finding an acceptable definition of learning in the context of visits to ISTCs, museums, zoos and aquaria, and measuring it, has been an ongoing and difficult problem (Falk & Dierking, 1992; Lucas, McManus & Thomas, 1986) . In 1995, a conference was sponsored partly by the National Science Foundation and the American Association of Museums with the express purpose of exploring how and what people learn in informal environments so that appropriate research methodologies could then be explored for measuring that learning (Falk & Dierking, 1995) . Falk and Dierking report that the 48 conference attendees were from diverse backgrounds and institutions, and included social scientists, investigators of learning in museums, museum directors, educators, curators and designers. As well, there were representatives from agencies that fund museums.

The issue of formal and informal learning was raised and although there was general agreement that making the distinction was less important than documenting where and when learning happens, there still continued to be references to formal learning linked with school and informal learning linked with museums. No real conclusions were reached on a definition for learning in an informal context except that it was "complex, personal, social and experientially based" (p. 18). The general consensus was that attention should be focussed on "defining *what, when, where, why* and *for whom* museum learning occurs" (p. 18), rather than spending more time defining learning in museums.

The conference developed a set of visit "product" outcomes that were considered to be "what people learn as a consequence of museum experiences" (p. 20). These outcomes are:

- Museums make content and ideas accessible, facilitating intellectual "connections" and bringing together disparate facts, ideas and feelings.
- Museums affect values and attitudes, for example, facilitating comfort with cultural differences or developing environmental ethics.
- Museums promote cultural, community and familial identity.
- Museums foster visit interest and curiosity, inspiring self-confidence and motivation to pursue future learning and life chances.
- Museums affect *how* visitors think and approach their worlds, in contrast to what they think.

Examining these product outcomes shows there is an emphasis on the affective domain with some attention paid to cognitive outcomes, but there is no explicit mention of outcomes in the psychomotor domain. The report on the conference did not offer much information about how to measure any of the product outcomes.

What does need to be taken into account for any notion of learning as a consequence of a visit is the fleeting nature of the visit. A typical visitor has brief exposure to exhibits and has little chance to reinforce learning so that any new information can be assimilated into their personal construction of knowledge. The likelihood of factual recall is small (Falk & Dierking, 1992) and hence ISTCs are not considered to be good places to learn facts (McManus, 1992) . Any learning is more likely to be an awareness (Perry, 1993) , also described by Falk and Dierking (1992, p. 109) as "broad-brush learning".

Falk and Dierking (1992) use the constructivist theory as a basis for defining learning in a museum context and link it to the personal, physical and social components of their visitor experience model. They emphasise that learning is a personal, dynamic, continual process in which "reinforcement, consolidation and reshaping of knowledge are critical aspects of the learning process" (p. 120). They also make the point that any learning will be dependent upon the perspectives of individual visitors. For example, a person who is an expert in a field will have a different mental construction to that of a novice. Consequently, visitors will take away different mental constructions of their experiences and any attempt to measure their learning must take this into account.

For the purpose of this study an operational definition of learning that is based on measurable outcomes will be adopted. The definition is simply that learning has occurred if, as a consequence of a voluntary visit, a person is able to articulate or demonstrate an increased knowledge or awareness, a change in attitudes or opinions, or has been motivated to engage in some activity.

While this definition is unsophisticated, it does have a pragmatic value because it is based on detectable signs of learning. Another important point is that it is visitor focussed and allows for the visitors' perceptions (Falk & Dierking, 1992) of their experiences to be expressed. In other words, visitors can have an active role in indicating whether or not they have learned anything. Usually, tests to determine learning in a formal setting have a rigid design framework and the participants play a passive role in the sense that they react to a researcher's prompts. The nature of an ISTC learning experience would be decontextualised if an experimental design were to be used. With this definition, a naturalistic approach can be used to measure learning.

Measuring of Learning in ISTCs and Museums

Most early research about visitors to museums focussed primarily on their demographics, their movement about the exhibit floor, and the popularity of exhibits (Anderson, 1965; Kimche, 1978) . There were some attempts to measure learning (see Screven (1974) , for example). Over the last two decades there has been much written about visitor learning and, although it is useful information, little of it can be regarded as research (McManus, 1992; Ramsey-Gassert et al., 1994) .

Historical Direction of Research into Learning

McManus (1993a) outlined the changing foci of recent research into visitor learning. Initially, the focus was to follow the assessment procedures of formal education where the subjects were tested for learning of the specific content of the exhibits. McManus believes this approach is now inappropriate and suggests three reasons why this style of measuring learning has generally been unsuccessful. Briefly, these are first, people have different experiences at the same exhibit; second, they have different levels of entry knowledge; and third, there is no time for reinforcement of any learning experience.

During the mid to late 1980s, the emphasis shifted to investigating the social behaviours of groups of visitors (usually families) while they were interacting with exhibits. Interactions between members of groups that could indicate learning became the source of data. These were successful in finding evidence that people do engage in teaching and learning behaviours but it could only be inferred that learning was occurring (see Diamond, 1986; Hilke, 1988; McManus, 1989). Only in one recent study on families was a claim made for a statistically significant link between learning behaviours and learning (Borun, Chambers & Cleghorn, 1996).

In the late eighties and early nineties, recollection studies were used to explore possible visitor learning (see Falk, 1988; McManus, 1993a; Rennie, 1995b; Stevenson, 1993) . These focussed on visitors' memories at different times following a visit and were successful in showing that most people were able to remember their experiences. They also showed that some people have vivid memories for lengthy periods following a visit.

Review of Studies to Measure Learning

Studies that have been designed to measure learning are reviewed next. They are organised into the categories of learning discussed so far in this chapter, and also presented in an order that generally reflects the historical development of the educational research in museums and ISTCs. Mostly they have been selected because they have voluntary visitors as subjects. However, studies with school groups have been included where appropriate if there is a paucity of research with voluntary visitors.

Cognitive Domain

Studies to measure knowledge gain with children on school visits have been successful in some cases (Dymond et al., 1990; Gottfreid, 1980; Javlekar, 1989; Schibeci, 1992) . A trend has emerged that suggests that if a visit is structured, then it is more likely learning can be measured (Falk & Dierking, 1992) . However, there have been difficulties in establishing knowledge gain for voluntary visitors. Two studies conducted at *Scitech* will be reported in some detail to illustrate this point.

The first study focussed in part on voluntary visitors and was conducted by Schibeci (1992). Its stated aim was an evaluation of knowledge gain and attitudinal shift for 171 school students on organised visits and 137 adult voluntary visitors. The students were from six Government schools in different areas of Perth. Three of the schools participated because of known contact people and three were randomly selected. Schibeci does not report whether the selection of the adult voluntary visitors was random.

Both groups were exposed to a set of interactive exhibits along a "pathway" or series of exhibits related to a theme involving sport and health. A pre-test post-test design was adopted to gather data. Pre-visit and post-visit tests were used for the students while point of entry and point of exit tests were administered to the adults. The test instrument consisted of a mixture of multiple choice, yes or no, and open-ended questions. No details of the development of the items for the instrument were given. Subsequent telephone interviews, involving open-ended questions, were conducted with 12 adult participants.

The results showed that for the school students there was a significant gain in knowledge, but adults' knowledge, as measured by the post-test, did not increase as a result of their visit. Schibeci does not explicitly report any attempt to measure attitudes. The results support other studies that have been successful in measuring school students' knowledge gain. However, for voluntary visitors they are of limited value other than to illustrate that knowledge gain, even with designated exhibits, is difficult to measure.

There were some additional points of interest that arose in Schibeci's study. One data collection day, 20 out of 70 adults left without completing the post-visit test even though they had been provided with free entry in return for their having given an undertaking to do so. Difficulties in getting a larger number of adults to participate in the study were encountered by Schibeci. That particular group of adults indicated they went to *Scitech* to take their children or visitors, and not with any intention of being educated themselves.

The second study, by McClafferty (1995), focussed on individuals' learning at a specific exhibit and used a structured interview technique for collecting data. The exhibit was "Whispering Dishes," where principles of reflecting and focussing sound are demonstrated. He interviewed visitors immediately after they disengaged from the exhibit to determine their understanding of the exhibit, and the principles it demonstrated. The results showed very few people did fully understand the "Whispering Dishes" and those that did frequently relied on prior knowledge for their understanding. McClafferty (1995) conducted another study with "Parabolic Reflectors" at *Questacon* as a follow-up, where he investigated the extent to which visitors understood principles of reflection and focussing of sound prior to interacting with the exhibit. Using this data as a baseline he was able to establish that some visitors did learn from the exhibit. He also established that some visitors were able to transfer their existing knowledge of related principles to the exhibit.

There are studies that have shown that learning in the cognitive domain occurs when visitors engage with exhibits. Feher and Rice (1985) used a Piagetian clinical interview technique which explored children's understanding of the phenomena of vision when they interacted with exhibits. They concluded children were able to understand their experiences by developing their own correct interpretations and explanations through repeated interactions with a series of related exhibits. Borun

(1989) used an exhibit about gravity that had been designed to correct misconceptions of visitors. Using interviews, she was able to discern that many of the people who interacted with the exhibit had their existing ideas confronted and, eventually, did understand what it was supposed to show. Tulley and Lucas (1991) used video-tapes and interviews to measure cognition at an exhibit that required people to assemble a lock without instructions. They found that the mean time for participants to reassemble the lock was slightly more than four times faster. This, they concluded, demonstrated immediate cognitive gain.

Affective Domain

Studies that focus on learning in the affective domain are not common, which is surprising given that many writers consider it to be the most likely outcome. Most of the studies about affect sighted in this review, have focussed on school groups and been done in conjunction with measuring knowledge gain. For example, Dierking and Falk (1994), in a review of literature about group learning in museums, cite four studies that combine both affect and cognition. The four studies by Borun (1977), Ostend (1985), Hage and Gennaro (1987), and Anderson (1991) provide both direct and indirect evidence that visits to zoos and ISTCs can produce more favourable attitudes. Few details are supplied by Dierking and Falk about the methodology each study used for measuring the affect of a visit.

There are two studies sighted in the literature that focussed solely on affect. The first was conducted by Smith (1996) at *Scitech* and investigated the influence of a school visit on developing positive attitudes towards science. Smith developed her own instrument for measuring learning in the affective domain. It consisted of four subscales; interest/enjoyment, confidence, usefulness and school science versus everyday science. The test was used to gather pre- and post-visit data from a group of 200 students from nine different primary schools in Western Australia who visited *Scitech* on an organised school visit. Smith found that there were no significant overall changes in students' attitudes as a result of one trip. She did, however, find that for students who were engaged in small group cooperative activities there was a measurable change on the confidence subscale.

The second was a major study published in 1993, the Museum Impact and Evaluation Study (MIES), and it investigated the role of affective learning as an outcome for voluntary visitors to museums. It is important because it is the largest study found and provides details of a range of methodologies used when attempting to measure affect. For these reasons it will be reported in detail. However, the MIES was found only after all the data had been collected for this study and the two instruments had been developed and validated. Consequently, it provides an interesting comparison of methods and findings to those in the current study. It should be noted that the MIES focused on repeat voluntary visitors and only a subset of subjects in this study were repeat visitors.

The MIES was a collaborative research project involving nine institutions headed by the *Museum of Science and Industry*, Chicago. The other eight were the *Carnegie Science Center*, Pittsburgh; the *Chicago Academy of Sciences*; the *Children's Museum of Indianapolis*; the *Discovery Place*, Charlotte, NC; the *Field Museum*, Chicago; the *Reuben Fleet Science Center*, San Diego; the *Franklin Institute*, Philadelphia; and the *New York Hall of Science*, Flushing Meadows, Corona Park, NY.

The two and a half year project had a director, a full-time manager and a consultant adviser. Each institution also had designated co-ordinators and researchers on site for the whole study while other research professionals were engaged for advice during different stages of the study. It is difficult to ascertain the specific goal of the MIES project even from reading the three volumes of the report. It seems likely, however, that the general emphasis was on the affective relationship visitors have with specific exhibits, because in Volume 3 of the report, Anderson (1993c) writes that the "mission of the Museum Impact and Evaluation Study is to identify the affective components of the visitor relationship with specific exhibits" (p. 1-2).

In all, there were eight different studies conducted with some institutions working in collaboration. A wide variety of techniques was used for gathering data. Two techniques, interviews and a survey instrument, used in the MIES were similar to those used in this study. The interviews in the MIES involved structured one-to-one interviews, both at the time of the visit and for post-visit interviews via telephone. At other times, open-ended, in-depth interviews were used to allow the interviewer the freedom to take new directions. All of the interviews were audio-tape recorded and transcribed later.

Written surveys were used in the MIES to collect data from a large sample of visitors at two institutions when investigating issues concerning repeat visitors to two icon exhibits and a resource centre. The survey instruments each had approximately 30 items to which people could respond on a Likert scale with four alternatives: strongly agree, agree, disagree, strongly disagree. There was an allowance in the response scales for some items for people to indicate that the item was not applicable to them. There is no allowance for those who simply may not have an opinion (i.e. neither agree nor disagree), or for those who were undecided. An extract from one of the survey instruments showing the structure of the survey instruments and the content of some of the items is illustrated in Figure 2.1.

All three written survey instruments are generally similar in content with some adaptations for different exhibits and centres which are reflected by the different stems which are shown in Table 2.2. Other techniques used for data collection in the MIES will be reported in summary form near the end of this chapter.

THE COAL MINE

Here are some of the reasons people say they come to the Coal Mine.
For each statement, circle the response that best describes how you feel.

1)	Being down in the Coal Mine thrills me.	SD D A SA
2)	I really like sharing the Coal Mine with others.	SD D A SA
3)	I learn something when I visit.	SD D A SA
4)	Seeing how things work interests me greatly.	SD D A SA
5)	It's important that my children experience it.	SD D A SA N/A
6)	The Coal Mine seems very familiar.	SD D A SA
7)	I like to look at the little details in the Mine.	SD D A SA
8)	The exhibit gives me a warm, comforting feeling.	SD D A SA
9)	It makes me think of how life would have been.	SD D A SA
10)	I get a sense of family togetherness at the exhibit.	SD D A SA N/A

Figure 2.1. An extract from the written survey instrument used in the MIES. From Anderson (1993c, p. 1-26).

Table 2.2

The Three Stems of the Written Survey Instruments in the MIES

Focus of Survey	Stem of the Items
Coal Mine Exhibit	Here are some of the reasons people say they come to the Coal Mine. For each statement, circle the response that best describes how you feel.
Christmas Around The World Exhibit	Listed below are some of the reasons people say they come to the exhibit. Please read each statement and decide how well it fits your experience at Christmas Around the World. For each statement, circle the response that best describes how you feel.
Weber Resource Centre	Here are some of the things people say about the Weber Resource Centre. For each item, circle the response that best describes how you feel.

Note. Adapted from Anderson (1993c).

The conclusions reached by Anderson about the MIES research methodologies have important implications for the current study as the underpinning research paradigms were similar. Anderson (1993b) claimed both positivistic and naturalistic paradigms to be satisfactory platforms for developing measures of affective and social outcomes. He also claimed both paradigms can form the basis for measuring educational value of a visit from the viewpoint of the voluntary visitors. He made the following statements about both paradigms:

> In fact, we found the positivistic paradigm to be a workable approach to assessing outcomes in a museum environment. In particular, it provided an appropriate set of glasses through which to view the world when we wanted to find to what extent a particular phenomenon existed in a certain population. Did most visitors to the "Coal Mine" value it as an educational activity? (p. 39)
>
> The naturalistic paradigm also worked well for investigating museum-related issues. It was particularly useful when we wanted to learn of the breadth of experiences in visitors' own words . . . . The strength of the naturalistic paradigm was apparent when it brought out some issues we had not anticipated. (p. 40)
>
> One of our initial assumptions was that the positivistic paradigm would be more suited for measuring immediate cognitive gain and the naturalistic would be more useful for attitude and affective issues. In fact, we found that both paradigms can yield methods useful for measuring affective and social outcomes and subjects' perceptions of educational gain. (p. 40)

The general findings reported by Anderson (1993b) tend to concentrate on the experiences of the research team and the methods employed rather than providing specific answers to the goals of the study. In particular, it is very difficult for the reader to find answers to the stated research questions. Repeated searches through the different studies provide some answers, but the reader is left with questions to which the answers should have been explicitly stated. For example, trying to find what people did as a result of their visit requires a search through the written survey items and then attempts to unravel the intricacies of a Rasch analysis data presentation before drawing a conclusion, which is at best uncertain. It is not unreasonable to expect that reports should make their conclusions explicit.

It was also inconvenient to check on some of the assertions made in the report, as the reader needs to cross reference constantly between the different volumes to check the authenticity of some of the claims. For instance, there is a claim that the results of the studies using written surveys about "The Coal Mine" and "Christmas Around The World" exhibits at the *Museum of Science and Industry* were generalisable, yet in the detailed report of the individual studies given in Volume 3 there is no indication whether the samples were random or purposive which can affect generalisability. Indeed, little detail is provided about the administration of the surveys. The reader has to search Volume 2 of the report to find a statement by Anderson (1993b) which indicated the samples were random.

The headings on all of the questionnaires may be misleading. On the top of the page at the beginning of the questionnaire it states that, "Here are some of the reasons people say they have come to the Coal Mine" (Anderson, 1993c, p. 1-26) , yet it appears from other sections of the report that these reasons were formulated by the researchers themselves at meetings prior to data collection. It is explicit that the three intertwined elements or categories for items about a visit – Educational, Social, Personal – were decided by the researchers and the study coordinators before collecting any data. The report states that "survey items were composed using these three categories as a guideline" (Anderson, 1993b, p. 1-3) . The reader is left to ponder where the researchers sourced the content for the items.

There are some features of the study that are useful to note. These concern methodology and the importance of explicit report writing. The inductive constant comparative method used to categorise qualitative data was the same as that used in this study. It was difficult to determine from the report that the large sample of visitors in the survey studies at the *Museum of Science and Industry* were randomly selected and little information was provided about administration of those surveys. A full description of the method of subject selection and survey administration needs to be explicit in the report.

It is of interest that few of the items on the MIES written survey instruments used for the large sample study are similar to those developed in the course of this study. Therefore, it is difficult to triangulate between the items developed in this study and those of the MIES study. The MIES report also lacks explicit information about the source of their items and whether they were validated. Furthermore, the MIES report fails to provide explicit answers to its stated research questions and that is frustrating as a reader has to search to find some answers.

Social Groups

A review of literature about family behaviour and learning in informal science settings by Dierking and Falk (1994) classifies studies focussing on family group learning into two groups: those that explore behaviour indicative of learning and those that attempt to determine whether learning has taken place by measuring it. The behaviours that may be associated with learning have been identified as attention to exhibits, reaction to an exhibit (moving towards it, appearing excited by it, discussing its content and even gazing at it) and information exchange between group members.

An example of the first group of studies, about exploring behaviour indicative of learning, was conducted by Diamond (1986). Diamond's study established base line data about family behaviour in ISTCs using ethological observation to record the behaviour of 28 family groups at the *Exploratorium*, and *Lawrence Hall of Science* for the duration of their visit. The families exhibited different behaviours. There was a tendency to "shop around" (p. 144) with children engaging in manipulating exhibits more than adults and joint adult-child manipulation of an exhibit occurring at 13% of the exhibits. Social behaviour, such as the frequency of reading of text and giving verbal descriptions of exhibits, diminished throughout the visit. The behaviour of repeat visitors did not differ significantly from first-time visitors based on overall frequencies of 21 different categories of behaviour, although nuclear family groups engaged in "showing" behaviour significantly more than non-nuclear families. Teaching-related behaviours, "show" (13%) and "tell" (9%) occurred at the exhibits. Adults seemed to use graphics for teaching and learning purposes, and reading was observed at 9% of exhibits.

Diamond (1986) concluded that

> Learning in a science museum does not occur only or perhaps even primarily as a result of the interaction between individual visitors and the exhibits. There is substantial evidence that social interactions between visitors may be important in stimulating learning at exhibits. Visitors commonly arrive at science museums in groups that remain in close proximity, and they provide a continuous and extensive reciprocal influence in their exhibit interactions. (p. 152)

With regard to the teaching behaviour, Diamond concluded that not only did it provide information but it also "influenced the attitudes of people as they interact with and ultimately learn from the object and phenomena" (p. 152). Diamond's study and other studies into family or group behaviour depend upon behaviours that indicate potential learning as evidence for learning. It is difficult to prove conclusively that learning is an outcome of those behaviours (Borun et al., 1996). That connection is important as one of the instruments developed during this study has an item concerning the extent of visitors' conversations following a visit.

Two examples of the second group of studies, about measuring learning using instruments, are described next. The first focussed on school groups and the second on voluntary visitors. Dierking and Falk (1994) refer to a study conducted by Falk into measuring learning among school-aged children at an exhibit using a written test about major concepts covered by the exhibit. He then tested these results against the exhibit-related behaviour of the children that he had already observed. As there was a "highly significant relationship between exhibit attending behaviours and exhibit learning" (p. 65), he then proposed that attention to exhibits can be used as an indicator of learning.

Borun et al. (1996) report a three year study, part of which was designed to identify and measure family learning in science museums. It is worth noting that when deciding how to measure learning, they considered a traditional cognitive test to be inappropriate. Their reasons were: the time it would take to administer, the variations in visitors' previous experiences, the visitors' random attendance to exhibits and the difficulty in arriving at a single measure that would accurately reflect the experiences of a group.

After reviewing the informal learning literature to glean the types of visitor behaviour that researchers have used to indicate learning, Borun et al. (1996) identified three learning levels that gave a measure for group learning. They conducted a study with 154 families to determine which visitor behaviours were significantly related to their three learning levels. The learning levels and observed behaviours at the exhibits are shown in Table 2.3. They are termed identifying, describing, and interpreting and applying.

Table 2.3
Learning Level and Corresponding Observed Behaviours

Learning level	Criteria
One – Identifying	One word statements or answers. Few associations to exhibit content. Connections to content miss the point of the exhibit.
Two – Describing	Multiple-word answers. Correct connections to visible exhibit characteristics. Connections to personal experience based on visible exhibit characteristics, not concepts.
Three – Interpreting and Applying	Multiple-word answers. Correct statement of concepts behind exhibits. Connection of exhibit concepts to life experiences.

Note. From Borun et al. (1996, p. 126)

The results showed that most families (88%) engage in level one and two learning, which Borun et al. (1996) regard as moderate, and is "learning of concrete, visible exhibit information" (p. 133). Similarly to Falk, they found the relationship between time spent at an exhibit and learning level to be significant. More importantly for previous research, was their claim that they were able to establish that "a clear relationship between these behaviours and learning level implies that if we see these behaviours, we can infer learning is taking place" (p. 134). This finding gives support to those who claim that some behaviours at exhibits can be used as indicators of learning (Hilke, 1988; Bitgood, 1993; Diamond, 1986; Dierking & Falk, 1994) .

Post-visit Memories

It is likely that for many voluntary visitors, memories of their experiences at an ISTC will be the main outcome of the visit. These memories are also used as evidence for learning, because if something is not remembered then it would be difficult to claim it had been learned.

There is evidence that most people retain clear memories of at least parts of their visit. White (1990) reported a pilot study to ascertain the long term impact of a visit to HERPlab, a discovery room at the National Zoological Park. She conducted telephone interviews with 21 families about two to three months following their visit and found that "all persons interviewed had vivid memories of what they had done or learned in the lab" (p. 8). White did not, however, provide any specific examples of what they said they learned or did during their visits.

Other researchers into recollections of visits (Falk, 1988; McManus, 1993a; Stevenson, 1991, 1993) , have reported similar findings, with some memories extending for long periods. Falk and Dierking (1992) report the memories of a person who was able to recall graphic details of his experiences and thoughts at the time of seeing Lindbergh's aeroplane, the Spirit of St Louis, hanging in the *Smithsonian Museum* 40 years previously.

McManus (1993a) has been critical of memory studies because of cuing of respondents prior to their recalling details of their visit. For example, Stevenson (1991) in his study used photographs to prompt responses. As well, responses from individuals in the family groups he interviewed would have memories cued by other family members.

In a study about visitors' memories of a visit to Gallery 33 at the *Birmingham Museum and Art Gallery*, McManus (1993a) was careful to avoid any contamination of subjects responses by cuing. She stated, "They were not told during, or after, their visit that they would be asked for their memories of it and the request for their memories was expressed in very neutral terms" (p. 368). Subjects were obtained from the addresses of 136 people who had provided comments on Gallery 33 at the end of a visit that had occurred up to ten months previously. Each of these people was sent a reply paid envelope with an explanatory letter indicating the study was about the long term impact of a visit to Gallery 33. They were then asked to help by "writing about your memories of your visit to Gallery 33 on the attached sheet" (p. 371)

She analysed the data collected from 28 essays into four categories of memories: descriptions of objects or things (51%), episodes and experiences (23%), feelings and judgements at the time of a visit (15%), and "summary or distilled" (p. 377) memories (10%). McManus identified an average of five memories per essay and, importantly for this study, concluded that a wider range of memories can be gained by an open, uncued approach than when using structured face-to-face interviews.

It should be noted that the response rate of 21 percent is low and that 18 of the 28 respondents were in the 8-15 years age group. While McManus does suggest some plausible possibilities for the low response rate, she does not include the use of an essay format for data collection as one of them. An essay format may have been a deterrent as some potential respondents may feel intimidated by the prospect of writing at length. While the study does provide a useful insight into uncued visitor memories, its outcomes are limited by the low response rate and the skewed age group of respondents.

The main recollection study to be reviewed was by Stevenson (1991) . It is important because some of the methods he used in collecting the data were used as a model for the current study and it was conducted in a similar environment. Stevenson focused on family groups and sought to determine the long term impact of interactive exhibits on the visiting public. Post-visit, lengthy interviews with 79 non-school group visitors were conducted approximately six months after their experience at the *Launch Pad*, an ISTC located in a gallery of the *London Science Museum*. Data were collected at four stages: tracking one family group member through the ISTC; questioning the whole family group at the end of their visit; answering of a questionnaire by each family group member about two weeks after their visit; and an interview of approximately one hour with the same group after six months.

Data collected by Stevenson while tracking 20 visitors were used to provide a basis for establishing background information about visitor behaviour and for formulating some questions in the follow-up interviews and questionnaire. In all, 383 visitors in 109 groups were given post-visit interviews at the point of exit. Nine questions were asked of each family member. Stevenson does not provide details of all the questions but indicates they were designed to prompt memories of exhibits and their most appealing features as well as interpersonal dialogue about the exhibits. The questionnaire and final interview addressed the same questions. In addition, the final interview used open-ended questions to evoke responses about the feelings of the respondents towards the ISTC and what they gained from the experience. Another question was designed to discover whether their ISTC visit had prompted some follow-up activity. In order to prompt additional responses in the final interview session, Stevenson used photographs of exhibits to stimulate recall.

Analysis of the tracking data showed visitors to *Launch Pad* followed the usual patterns of behaviour as in other museums, however, their attention span was greater and they were not as likely to show "museum fatigue" (Stevenson, 1991, p. 530) . It also showed that no gender differences were noted with exhibit interaction. Post-visit interviews and questionnaires revealed that visitors had enjoyed their visits, and were able to recall exhibits. It was also apparent that visitors talked freely about the exhibits with people who had not been visiting with them.

Stevenson found that 27% of the memories were spontaneous and the remainder were prompted either by photographs (61%) or another family member (13%). He categorised the visitors' memories into three groups: descriptions (60%); thoughts and recollections about understanding the principles underlying the exhibit (26%); and 14% were feelings or emotions associated with an exhibit.

The delayed interviews gave a clear indication that there were long term effects. People "were able to recall in vivid detail . . . what they did with the exhibits" and "how they felt and thought about them" (Stevenson, 1991, p. 530). Many of the responses led Stevenson to conclude that cognitive processing had occurred. There had been no overt attempt to measure attitudinal changes, however a positive shift was apparent from responses to questions in interviews and that shift had not diminished with time.

There are some difficulties in using memories for measuring learning as they can be inaccurate. Falk (1988) reports that he knew that eleven subjects he interviewed in a recollection study supplied "partially faulty" (p. 62) information. Rennie (1995b) provided brief details of her family's recollections of their visit to an art gallery. When Rennie interviewed her family about their memories of a visit to the National Art Gallery in Washington her 15 year-old-daughter recalled a "really big painting" (p. 1) that she thought may have been *La Promenade* by Suerat. Rennie points out the painting was *A Sunday Afternoon on the Island of La Grande Jatte* and they saw it in The Art Institute of Chicago. It should be noted that her daughter's memory of the size was accurate as "it really is a big painting" (L. Rennie, personal communication, March, 1998)

People have different perspectives of the same event or experience and, consequently, they will have different memories of the same event. Falk (1988) reports that five individuals in his study had experienced the same event at a similar time "yet constructed very different recollections of that event" (p. 65). He suggested the differences may be due to individual differences in prior experiences of similar events, individual differences in perceptions of the actual event, and the cues used to invoke responses about recollections.

Career Choice

Only two studies were found that relate an influence of a visit to an ISTC on career choice. The first was an investigation by Woolnough (1991) into the factors operating in schools that can be linked to students electing to choose physical science or engineering for study in post school education. It found extra-curricular activity in science was a factor and one of the recommendations was for schools in the United Kingdom to "give priority to extra-curricular activities such as science competitions, science clubs and nationally organised lecture demonstrations" (p. 8). Although the report does not specifically mention visits to ISTCs, such school excursions would be in the extra-curricular activities recommended if an ISTC or museum were accessible.

The second was a recent study commissioned by *Scitech* to determine the extent to which a visit or visits to *Scitech* had a positive influence on career choice (Coventry, 1997) . A survey questionnaire was administered to a sample of 661 first year undergraduate students at five post secondary education institutions (three universities and two technical and further education colleges) in Perth, Western Australia, after having first been trailed in a pilot study. The students were not aware that the study was being conducted on behalf of *Scitech.* The report does not state whether the sample was randomly selected and no claims for generalisability were made. The results indicated that a visit to *Scitech* was a relatively minor influence in career choice when compared to influences such as: subject enjoyment at school, employment prospects, parents/relatives/friends, career counsellors and teachers. However, the report concludes that the results indicate a visit is beneficial, and that "*Scitech* is meeting its objective of encouraging young people to study science and take up careers in science and technology" (Coventry, 1997, p. 4) .

The results show that for both science/engineering and arts/business students, a visit to *Scitech* ranked along with a visit to the zoo and the museum as a reason for a career choice. The data also indicate that of the students surveyed, those studying science and engineering had visited *Scitech* more often than those studying arts and business; a result which is used as a basis for Coventry to claim "*Scitech* has some impact on those choosing science-based careers at tertiary level" (p. 3) . The claim is not valid because there is no proof of cause and effect. The results of this study highlight the difficulty in establishing any link between career choice and a visit to an ISTC. Both the Woolnough and Coventry studies show that it is possible that a visit to a place presenting science in an informal setting can influence career choice but the influence is not as strong as other factors, such as parents or teachers.

Post-Visit Actions

Three studies were found that refer to post-visit actions by visitors. In the study by White (1990) , almost all people from the 21 families who were interviewed by telephone said they had done something as a consequence of their visit but she reported only two examples of actions: purchasing a book and having a discussion with friends.

Johnston (1995) conducted a study into the impact of an exhibition titled "SPORTS 2000" at *Scitech* consisting of a series of exhibits based around a theme of sport and exercising for health. The study used a written survey instrument to collect data at the point of exit and again three weeks following a visit. The results showed that 5% of the 63 randomly selected visitors who responded to the post-visit survey did take up a sport or commence an exercise regimen as a consequence of their visit.

The report of the MIES stated that it sought to establish whether people did anything as a consequence of their visit, however, it was not possible to determine any explicit answer to that research question in the report.

Summary of Review of Studies to Measure Learning

Attempts to measure learning in both the cognitive and affective domains have met with mixed success. Measurement of cognitive outcomes using written measures has been successful using school groups as subjects but has proven ineffective with voluntary visitors. This can be attributed to differences in the background of the groups, the nature of their visits and their visit experiences. School groups can be considered to have a similar background in science, however, the collective background for voluntary visitors is heterogenous. School groups are a captive population and it is therefore comparatively easy to administer pre- and post-visit tests. As well, it is possible to adopt an experimental approach with school groups which is not possible with voluntary visitors because of the open nature of their visit and their varied backgrounds.

Interview techniques have been successful in establishing that cognition does occur during a visit. Studies in the affective domain have also shown mixed results, with Smith's (1996) careful study using written measures unable to detect any significant gain for a group of school students. The MIES study did demonstrate that using written measures was able to measure change in the affective domain for a group of repeat voluntary visitors. No studies of attempts to measure learning in the psychomotor domain were sighted, even though learning in the psychomotor domain is mentioned as a most likely outcome by both Javlekar (1989) and Wellington

(1990) . Thier and Linn (1975) do, however, report an observation that visitors manipulating lenses and mirrors at an exhibit "resulted in greater ability to focus a beam of light" (p. 10).

Learning in an informal learning environment is often socially mediated and some researchers believe the impact of discussion and teaching behaviours is at the core of the learning experiences for visitors in groups (Falk & Dierking, 1992; McManus, 1994) . Studies have been able to show there are plenty of observable learning behaviours exhibited by visitors from which learning can be inferred. However, only two studies have claimed to show there is a statistically significant relationship between those behaviours and learning. The methods of observation, taped conversations and interviews used in the studies of groups have produced consistent results that point towards learning as part of the visit experience for those groups. This is an important point as most people visit in a social group.

The studies on memories have been able to show people do learn things during their visit and there is evidence that those memories are long lasting. Although uncued memories are clear indicators of learning, there is a concern that some of the studies did invoke cued memories. Any instrument that sought data about memories as an outcome would need to be developed and administered in a manner that avoided cuing.

When people state that they have been motivated to do something as a result of their visit, it can be said that learning in the affective domain has occurred. It could also be speculated that choosing a career as a consequence of a visit is also a result of learning in the affective domain. Only a small amount of data exists for either of these indicators.

There is sufficient evidence to show some learning can occur in the affective and cognitive domains for voluntary visitors to ISTCs and that it is measurable. However, the studies that have been successful in establishing learning as an outcome often involve methodologies other than traditional pre- and post-test written responses. In the next section the methods that have been used to measure outcomes are summarised.

Methods Used to Measure Learning

In 1978 Kimche wrote that:

> The present educational and anthropological evaluation models that have been imposed on the science and technology centre environment are inadequate. To ascertain the full potential for learning in science centres, systematic data must be gathered about the characteristics and effectiveness of the informal learning environment offered by science centres. Methods for collecting evidence that are not

> dependent on the exogenous variables that each visitor brings to the science centre environment must be devised. (p. 273)

Recently, Rennie and McClafferty (1996) noted that since Kimche's call for new methods, some modest progress has been made.

There are a variety of methods used to collect data for evidence of learning. They are: video taping of visitors' behaviours, audio taping of visitors' conversations, unobtrusive observation, written measures, structured, partially-structured and unstructured interviews, stimulated recall, comparative studies and phenomenology. These methods have met with enough success to show some learning does take place according to Rennie and McClafferty (1996) . However, most are time consuming and labour intensive and so are expensive to use.

If measurement of outcomes is be conducted on a large scale, any method will need to be efficient as well as effective. That method will also need to be able to produce data that are easily analysed. Interviews, unobtrusive observation, audio- and video-taping, for example, involve relatively few subjects and are time consuming and labour intensive methods that would be too costly for ISTCs to use on a large scale. Written measures would be the most appropriate method as they are more cost effective due to their relative ease of administration and data analysis procedures. This study focussed then on developing written instruments for measuring outcomes of visits to ISTCs.

A study by Aikenhead and Ryan (1992) is reviewed next even though it is not specifically related to ISTCs. It is about developing qualitative instruments and, along with Stevenson's (1991) study, influenced the methodology adopted for this study during the initial stages and also provided it with a general direction. Aikenhead and Ryan (1992) developed a qualitative instrument to monitor school students' views on a broad range of science technology and society topics. Their instrument is titled *Views on Science-Technology-Society* (VOSTS). It consists of a pool of 114 multiple choice questions, all of which were developed empirically over a six year period with Canadian High School students. The underpinning methodology was naturalistic and so sought "to uncover the perspective of the participants and to accept the legitimacy, in the participants' eyes, of that perspective" (Aikenhead & Ryan, 1992, pp. 487-488). The domain of the items and the alternative responses were derived empirically from participants' responses. Participants' feedback was used to modify the format of the items, all possible responses and the instrument itself. This approach assists in developing an instrument with a strong claim to construct validity, and is an approach which had a significant influence on this study.

Conclusion

There is much that has been learned from the literature review that is useful for this study. There are some minor but important points that have been noted throughout the chapter, such as the importance of explicit report writing and using incentives to encourage potential respondents. They will not be repeated here.

ISTCs are unique in bringing science and technology to people. They offer an alternative to the traditional style of science museums with their dual curatorial and educative roles. The most obvious difference is in the style of presentation by ISTCs where the focus is on scientific and technological ideas and visitor interaction with exhibits is foremost. A visit experience to an ISTC is unique for each visitor as they have different backgrounds, agendas, perceptions and interact with different exhibits for different periods of time with differing levels of intensity.

In the open learning environment provided by ISTCs, entertainment is an integral part of the experience and the outcomes are many and varied. However, the outcomes for a visitor can all be linked under a broad banner of learning which includes an increased knowledge or awareness, a change in attitude or opinions, and being motivated to engage in some activity.

Measuring the learning that takes place in ISTCs has proven to be difficult. Written measures have met with some success, but the results have not been consistent. Other methods, such as interviews, audio-taped conversations, and observations of individual and group behaviour have also met with some success. Studies of peoples' memories of visits have been able to show that learning does occur, and that some memories can endure for long periods. There is overall enough evidence to suggest that learning does occur, however, there were no studies found to indicate the extent of learning in the total population of visitors.

It is the nature of the learning and the circumstances under which it occurs that make it difficult to measure. Findings of the research into learning in ISTCs and the anecdotal evidence of experienced ISTC professionals indicate that, while some cognition can be expected, learning is predominantly in the affective domain. Rather than recalling fine details of their engagement with exhibits, visitors are more likely have a general awareness of the experience which has been termed broad-brush learning (Falk and Dierking, 1992). This is not surprising given the cursory nature of a visit, the atmosphere of freedom and that, for most, a visit is a leisure event. It is also noted that both researchers and ISTC professionals agree that any learning should be seen as a whole experience consisting of integrated elements, rather than a sum of discrete parts.

While ISTC exhibit planners and developers have clear aims of what they want visitors to experience, the outcomes for a visitor may be quite different. There was no research found that focussed on learning in ISTCs as an outcome from the perspective of the visitors themselves. Consequently, determining the outcomes of a visit from the visitors' point of view became one of the main focal points in the initial stages of this study.

CHAPTER 3

OVERVIEW OF RESEARCH DESIGN AND STAGE 1: IMMERSION IN *SCITECH*

Overview

The purpose of this study was to provide a way of measuring the perceived outcomes of voluntary visits to ISTCs. This chapter provides an overview of the five stages in the study which was evolutionary in nature. It also provides a description of the first stage of the study when the researcher used an anthropological approach to immerse himself in the daily operations of *Scitech*. The remaining four stages, including the subjects and their selection as well as the research procedures that were followed, are detailed in later chapters.

Overview of Research Design

The study uses a mix of qualitative and quantitative methods in five stages which took three years. Each stage built upon the previous one. The five stages were: first, an immersion at *Scitech*; second, interviews with staff and visitors; third, development of the Post Visit Questionnaire (PVQ) and its field testing; fourth, development of the Perceptions of Visit Impact Instrument (PVII) and its field testing; and fifth, development of the Profile of Visit Outcomes Instrument (PVOI) and its field testing. Table 3.1 and Figure 3.1 provide an overview and times of the stages.

Stage 1 – Immersion in Scitech

During the first stage the researcher became immersed in the daily operations of *Scitech*. There were three reasons for beginning the study in this way. First, there was a need for the researcher to gain a general understanding of the working culture of an ISTC using *Scitech* as a case study. Second, the researcher needed to be familiar with the processes used at *Scitech* to get their message across to their visitors. Third, there was a need to ascertain what the staff at *Scitech* expected people to get out of a visit to their centre.

Initially the researcher approached *Scitech* and obtained permission to interview the staff and visitors as well as attend meetings and observe the daily operations of *Scitech*. Subsequently, the CEO introduced the researcher to all the staff of *Scitech* at one of their regular meetings where the purpose of the study was explained. The Manager of Education followed the public introduction with a memorandum to all staff restating the purpose of the study and requesting all staff to

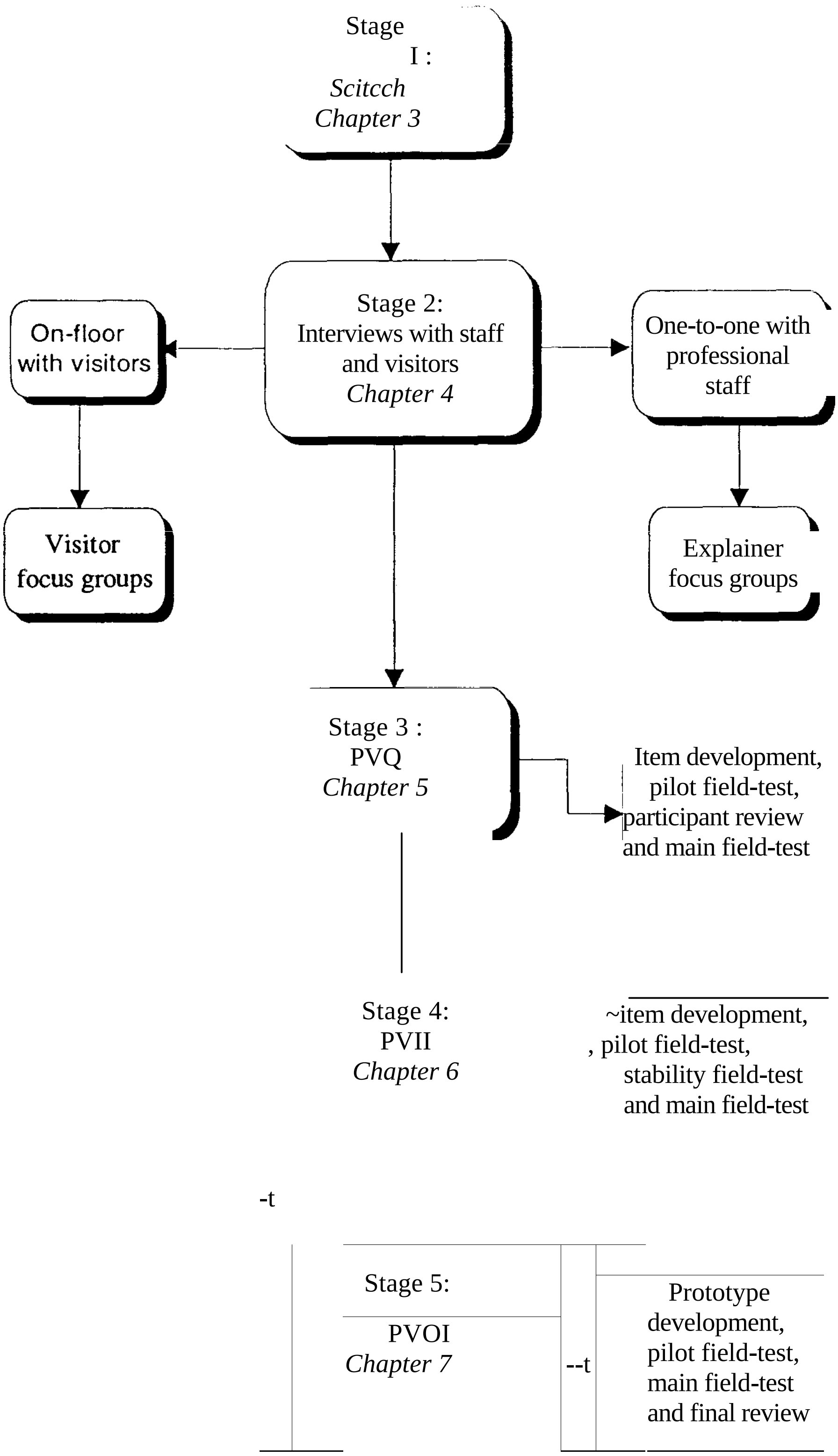

Figure I An overview of the research design. 54

regard the researcher as an honorary staff member (See Appendix 3-A). A desk in the general staff area was made available for the researcher's exclusive use.

Most of the initial data gathering concentrated on gaining an understanding of the culture and ethos of *Scitech* as a model of an ISTC. The initial research used an investigative approach and so was qualitative in design. The first steps were for the researcher to be immersed as a participant observer (Lincoln & Guba, 1985) in the daily operations of *Scitech*. These activities included attending staff meetings, education team meetings, explainer training programs, strategic planning sessions, exhibition planning sessions, exhibition openings and presentations by visiting experts from overseas ISTCs. As well, documents that detailed the daily functioning processes of *Scitech*, policies, strategic planning, job descriptions and materials developed for education programs were examined. As much as possible, visitors were engaged in casual conversions on the exhibit floor and informal discussions were held with members of the professional and voluntary staff.

During the course of the study the researcher was able to extend his knowledge of ISTCs by visiting the following ISTCs and science museums in Australia: *Questacon–The National Science and Technology Centre* in Canberra, *Scienceworks* in Melbourne, *Powerhouse* and *Earth Exchange* in Sydney, and *Sciencecentre* in Brisbane. As well, visits were made to the *Science Museum* and *Natural History Museum* in London, *Techniquest* in Cardiff, *Eureka* in Halifax, *Heureka* in Helsinki and the *Exploratorium* in San Francisco. At each of these centres discussions were held with professional staff from education, management and exhibit design teams about their respective roles and the general organisation and running of the ISTC.

Stage 2 – Interviews with Staff and Visitors

Once the researcher completed the familiarisation process at *Scitech*, investigations continued by interviewing some of the staff and a random sample of the visiting public. The purpose of the interviews with staff was to determine the role of different personnel in the functioning of *Scitech* and to obtain their views on how they may contribute to any outcomes the public may experience as a result of a visit to *Scitech*. The first were some of the volunteer explainers who were part of the staff who dealt directly with the public. Two separate sessions were conducted with the explainers using a focus group procedure. Questions were formulated to elicit explainers' perceptions about the visiting public, searching for any information that may give an indication of possible outcomes for these visitors. As well, professional staff in the areas of education, floor management, marketing, theatre presentation, large exhibition design, finance and administration were interviewed individually.

Following the explainer focus groups and some of the staff interviews, a series of 70 individual interviews were conducted with a random sample of members from the visiting public at the time of their visit. The purpose of these interviews was to collect data about visitors' perceptions concerning the impact of their visit and ascertain whether they were motivated to any further action as a consequence of their visit. Two groups of visitors were also interviewed in separate sessions following the focus group procedures and they were asked to comment on the perceptions of the explainers.

The individual visitor interviews were conducted in three phases. In the first phase a random sample of visitors was interviewed by the researcher and the data were pooled to form a preliminary summary of their responses. This procedure was adopted to ascertain that the interview protocol was proving effective in eliciting useful data. The second phase was conducted by trainee explainers and involved a different sample of visitors. This second phase of interviews using different interviewees was intended to elicit any additional information that may have been forthcoming by using a different interviewer. The third phase of interviews was conducted with another random sample of visitors during a different exhibition to cover a further set of experiences and hence incorporate any additional reactions into the final data base of visitor responses.

Stage 3 – Development of the PVQ and its Field Testing

The Post Visit Questionnaire (PVQ) was designed to elicit written responses from voluntary visitors about their reflections, actions and attitudes approximately three to four weeks following a visit. Items for the PVQ evolved from the data previously collected from the interviews with the staff and visitors, generally following the procedure used by Aikenhead and Ryan (1992). All the responses were pooled and analysed to try to identify all the reported outcomes of a visit. Once the general outcomes were established, the PVQ was developed. It was a survey questionnaire consisting of a series of items requiring written responses relating to those outcomes. The purpose of the PVQ was to develop a data base of responses in the written language of visitors. This would then be available to formulate items for use in the future development of the final two survey questionnaires.

The PVQ was field tested in two phases. The first was a pilot field-test administered to targeted volunteers from the first phase of the visitor interviews. The pilot field-test was used to review how well the PVQ generated written data as a source for future survey items and if necessary, make alterations to the PVQ. After the data from the pilot field-test had been analysed, the first visitor focus group was held with ten volunteer subjects from the pilot field-test approximately three months after they had completed the PVQ. The discussion session was used to get participants' feedback on the PVQ and to obtain any information that was additional to that they had already provided on the PVQ.

The PVQ was changed for the second phase which was the main field-test. Some items were omitted from the main-field test PVQ because they had generated little information and some additional items were included following the visitor focus group comments. In addition, most items were spread across two versions of the PVQ, Version A and Version B, to shorten its length in an attempt to stimulate longer responses. The main field-test PVQ was administered to randomly selected samples of visitors, unlike the pilot field-test PVQ which was administered to specially targeted volunteers.

Stage 4 – Development of the PVII and Its Field Testing

Data from all versions of the PVQ and interviews were then pooled and two separate instruments were subsequently developed. The first, the Perceptions of Visit Impact Instrument (PVII), was designed to be administered to visitors at the point of exit at the completion of a visit. It provides a measure of visitors' perceptions of the immediate impact of their experiences at an ISTC. The PVII uses a semantic differential format so it can be completed quickly and provides a simple quantified measure of perceived impact of the visit from the visitors' perspectives.

The PVII was developed and refined using both qualitative and quantitative procedures. Items on the PVII were extracted from some of the written responses to questions on the PVQ. The PVII was then developed and validated through four phases: item development, pilot field-test, establishment of test-retest reliability, and main field-test. In the first phase, educators and lay persons from the public were specifically targeted to provide qualitative data to assist in developing the items. In the following three phases, quantitative data were collected from random samples of different cohorts of the visiting public. Parametric statistical procedures were used to analyse that data for refining and validating the PVII. Data were collected at *Scitech* for all the phases with the main field-test also using data from four other ISTCs. A brief description of the features of these ISTCs is included as Appendix 3-B.

Stage 5 – Development of the PVOI and Its Field Testing

The second instrument, the Profile of Visit Outcomes Instrument (PVOI) is quite different in its purpose and format to the PVII. The PVOI is designed to be administered approximately three weeks following a visit to an ISTC when visitors will have had some time to react to their experiences while visiting. It consists of a mixed format of responses using mainly Likert scales, some open-ended questions and some closed questions. The data it captures enables an ISTC to establish a comprehensive profile of outcomes for voluntary clientele. The profile is multidimensional and includes five scales for all visitors, three optional scales for target populations and a space for written comments. Consequently, the PVOI takes much longer than the PVII for respondents to complete and for an administrator to collect and analyse the data it produces.

This instrument was developed in four phases using both qualitative and quantitative procedures. The four phases were: prototype development, pilot field-test, main field-test and a final review. Most items for the prototype were developed using data from the PVQ with some developed from the interview data. A constant comparative method was used to develop the different categories of items which gave the instrument its dimensions. The prototype instrument was refined using critical comment from ISTC professionals, educators, researchers and members of the visiting public. A pilot field-test was then conducted at *Scitech* using a small random sample of visitors. In the main-field test, data were collected from random samples of visitors to three ISTCs and analysed using parametric statistical procedures to validate the instrument. During the main field-test, some respondents volunteered written comments critical of the efficacy of some of the items on the PVOI. Consequently changes were made, and during the final phase those respondents from *Scitech* who had volunteered critical comment were contacted and asked to review the amended PVOI.

Researcher Responsibilities

Confidentiality

Scitech gave permission for any results of the study relating to them to be used for publication. However, an undertaking was volunteered to pass on all documentation to the CEO of *Scitech* prior to its being submitted for publication. All of the other ISTCs were given a written undertaking of anonymity and confidentiality of the information they provided. In order to preserve anonymity, the five participating ISTCs will be referred to as *Centre A, Centre B, Centre C*, *Centre D* and *Centre E.* As an added precaution to preserve anonymity, *Scitech's* alias will be used when data and results from all five centres are presented together.

Additional Obligations

In return for their participation, an undertaking was given to provide two sets of individual reports to the ISTCs; one based the PVII instrument and the second based on the PVOI instrument. Consequently, separate reports were sent to each of the ISTCs after the data from both Stage 4 and Stage 5 were analysed. Shortly after those reports were provided, the ISTCs were sent a short survey form that asked for their feedback regarding the applicability and usefulness of the two instruments.

These feedback forms also sought critical comment for any improvement of the instruments.

Stage 1. Familiarisation with an ISTC: A Case Study of *Scitech Discovery Centre*

All of the items used in the instruments were developed using data collected at *Scitech*, hence the content of those instruments is grounded in that context. The generalizability of any findings is also dependent on the same context. A detailed description of *Scitech* will be given in the form of a case study so that the context of the fundamental data is clear. Data for the case study were collected from a variety of sources, with the main source being formal interviews with *Scitech* staff.

Interviews were conducted with 17 professional staff from the following areas: education, visitor services, marketing and public relations, management, exhibits and finance. This group included all of the managers and most of the staff in each of those teams. Appointments for the interviews were arranged verbally and took place on site at *Scitech*, either at people's work desks or in a quiet withdrawal area. Every person approached agreed to be interviewed. All were informed at the time of requesting an interview they were to be asked about their role at *Scitech* and a verbal assurance of anonymity and confidentiality was given. Each interview was conducted individually, was audio-taped with the participant's permission and subsequently transcribed. The interviews varied in length from 12 to 90 minutes. After each transcription the tape was replayed and a check made on the accuracy of the transcription. This process proved to be a useful check as some errors were found and subsequently rectified. Individual transcripts were given to each of the participants to read as a further check for accuracy and to make any addition to the information they had provided. None added any information.

These data were supplemented by evidence gleaned from annual reports and informal discussions with staff and standing committee members, which also served as a form of triangulation with the interview data. The case study also provides a unique insight into the operations of an ISTC as no published reports of this nature were found in the literature.

It must be noted that there was overwhelming support from all the staff who assisted in this study by consenting to formal interviews and providing feedback and advice during all stages. Each of the three CEOs of *Scitech* over the duration of the study were completely supportive and enthusiastic about the study. For their cooperation, warm welcome and continual support the researcher is very grateful.

Site

Scitech is located peripherally to the Perth Central Business District in a modern complex of shops adjacent to an omnimax theatre. Visitors have easy access using public transport as there is a train station close to the site which provides passage from the central business district. For those who use their own cars there is a large free car park in an undercover area. *Scitech* has a total floor space of 4500 square metres taken up by an exhibit area for 160 interactive exhibits, a workshop, an administration area, a 150 seat theatre for demonstrations, a science shop and a small hands-on laboratory. The laboratory provides specialised hands-on, science-related activities for secondary school students on pre-arranged visits and is not open to the visiting public. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) funds and manages the laboratory as part of its education program. Such laboratories, called CSIRO Science Education Centres (CSIROSECs), are in each Australian state and territory but not always in conjunction with an ISTC. In Perth, the staff of CSIROSEC operate in co-operation with *Scitech* management and education teams, and schools often arrange joint visits to *Scitech* and CSIROSEC.

History

The idea for establishing *Scitech* came in 1987 from the then Deputy Premier of Western Australia. He was enthused by a visit to the *Singapore Science Centre,* and on his return to Perth set about establishing a science centre in Perth. A public meeting was arranged to gauge interest in the concept, to gather ideas and to seek possibilities for a location. As a result of the meeting a steering committee was established and a feasibility study was undertaken. Subsequently, a press release published in the *West Australian* newspaper on August 17, 1987, read,

> The WA Science and Technology Foundation recently launched under the intent of the Premier will establish a science centre in a building now under construction in Western Perth. The centre will provide an exciting introduction to the role of science and technology in the everyday life through hands-on interactive exhibits and will provide a venue for conventions and a focal point for leading edge technology.

One year later, on August 13, 1988, *Scitech Discovery Centre* opened making it one of the first ISTCs in Australia.

Visitors

Scitech has proved popular with the Western Australian public and attendance numbers have generally increased after its opening peaking at 269,783 in 1993/94 and since then have levelled out. Table 3.2 shows the trends in attendance figures. Over 1.6 million visitors have entered *Scitech* over the eight year period (to June 30, 1996) since it opened which is an average of 218,340 visitors per annum. Admission records show 75% of visits are by members of the public on casual visits that occur mainly on the weekends and school holidays, while the remaining 25% are by school children on organised school visits during school time. The centre services an immediate city population of approximately one million people and a rural population of approximately half a million spread over a very large area.

Table 3.2

Annual Attendances at *Scitech Discovery Centre* (1989 to 1996)

Year	Attendance
1988-89 [1]	109293
1989-90	168036
1990-91	146289
1991-92	206133
1992-93	226018
1993-94	269783
1994-95	263015
1995-96	242462
1988-96 [2]	218340

Note. Attendances are taken from July 1 to June 30.
[1] From January 1989 to June 1989.
[2] Average annual attendance from January 1989 to June 1996.

Staff

In 1995 *Scitech* had 35 full-time staff, 23 part-time staff, and 86 volunteers (Scitech Discovery Centre, 1995) who work in the following teams: administration and finance; exhibit design, construction and maintenance; education; marketing and public relations. The operational structure is a three-tiered hierarchy based on teams each with a manager. All the teams and operations are overseen by the Chief Executive Officer (CEO) who in turn reports to the *Scitech* Board of Directors.

The paid or professional staff are engaged in the following activities: management; education; exhibit design, construction and maintenance; marketing; public relations; finance; clerical; visitor services; and the shop sales. The volunteer staff are engaged mainly as explainers, termed "Sciguides" at *Scitech*, and their role is to facilitate visitors' experiences with exhibits (see Figure 3.2). Some volunteers are also engaged in different forms of clerical work.

Figure 3.2. An explainer (Sciguide) with a visitor at the Angular Momentum Exhibit.

Management

The management is structured following a corporate model. The centre is overseen by a voluntary Board of Directors and four standing committees – Business and Audit; Education; Exhibits and Marketing; and Corporate Support – that include prominent people representing a broad spectrum of the Western Australian community. They include representatives from business, industry, communications, marketing, research and both the school and university sectors of education.

The teams from each area meet formally on a fortnightly basis with the manager of each area chairing the meeting. Decisions are reached by democratic procedures and recommendations are made to be put to all the staff at a meeting also held on a fortnightly basis. There is a strong emphasis on team work and cooperative planning. This cooperative style is demonstrated by the process of developing a new exhibition. For example, at the time of the development of "The Great Australian Treasure Hunt" the researcher witnessed members from each team communicating and working together in a constructive and cohesive manner.

Each team also reports to a standing committee. The standing committees consist of representatives from each team as well as professionals in related fields who act in a voluntary capacity. The standing committees function in an advisory role and offer support and expertise in contemporary industrial, commercial, managerial and educational practice for each area. They also serve as a potential network for researching and resourcing new projects and ideas.

Exhibits and Exhibition Development

The exhibits at *Scitech* are built to provide a variety of experiences for visitors using a wide range of "ideas and concepts, stimulating visitors to explore scientific principles, examine modern innovations and inventiveness, and understand some of the applications of these in new technology" (Smith, 1996, p. 1). The ideas for new exhibitions are driven by a philosophy of bringing science to the people by presenting it in a format that is meaningful and accessible (S. Beddington, personal communication, June 4, 1994).

There is a need for regular renewal of exhibitions at *Scitech* so that repeat visitors are attracted. Early in *Scitech's* life, annual attendance dropped from 168,036 in 1989-90 to 146,289 in 1990-91 (see Table 3.2) as people did not want to go back to revisit the same range of exhibits. The CEO initiated a plan for a feature exhibition to run each six months, surrounded by standard exhibits. Subsequently, the attendance figures increased and have recently stabilised with an annual average of 258,420 for the three years to June 1996.

Typically, the development of a new exhibition begins by involving all staff in an opening brainstorming session where all ideas are taken on board and a committee is formed for the planning stage. Any member of staff is invited to be part of the planning committee, however, there will be at least one representative from each section included in the committee. A budget limit is determined by the CEO based on estimated sponsorship that can be arranged, not on estimated exhibition cost.

Most of the exhibitions are constructed on-site and have later been rented out to other ISTCs both in Australia and overseas. Sometimes exhibitions are rented from other institutions, for example, "Whales" from the *Pacific Science Centre* in the United States and "Gargantuans of the Garden" from the *Australian Museum* in Sydney.

A recent example of exhibition development was "The Great Australian Treasure Hunt", a series of interactive exhibits about mining and its associated industries in Western Australia (see Figure 3.3). The operational budget was one million dollars raised by sponsorship from mining companies. A qualified professional geologist with expertise in gold mining was contracted for one year to provide expert content advice in the development process of the exhibition and its subsequent evaluation. It was her brief to be the linchpin for all the procedures and decisions for planning, organising, developing and evaluating of the exhibition. She worked in conjunction with all the different *Scitech* teams and committees, and acted as a contact person around whom the whole process operated. The time from conception to the exhibition opening was nine months.

Funding

Scitech is set up as a not-for-profit organisation with revenue coming from Western Australian State Government funding, corporate sponsorship, admission charges, exhibition rentals, sundry functions and shop sales. The proportion of total funding from each source in 1994-95 and 1995-96 were reported earlier and shown in Figure 1.2 and Figure 1.3. The monies received from recurrent State Government funding and admission fees cover all operating costs except for the design, development and maintenance of exhibits, the development of special exhibitions or presentation of other public programs, for which sponsorship is essential (Scitech Discovery Centre, 1996) .

Achievements

Scitech regards itself as a place of innovation, and claims an international reputation for exhibit development with some of its exhibitions rented out to other centres in Australia, South Africa, Hong Kong, The Philippines, Singapore, New Zealand, the United Kingdom and the United States. These were developed by teams

Figure 3.3. An exhibit in "The Great Australian Treasure Hunt" exhibition.

involving *Scitech's* specialist staff in collaboration with leaders in the fields of science and technology, education, marketing and visitor service (Scitech Discovery Centre, 1995) . On a local level *Scitech* has received recognition from the Western Australian State Government as the premier tourist attraction in Western Australia in both 1994 and 1996, while in 1995 it received the top tourism award for marketing.

The Sections and Their Roles

Education

The education team is multi-functional with major roles to play in exhibition development, exhibit design, exhibit floor plan layout, graphics, public demonstrations of scientific principles and technology, provision of workshops and in-service as well as ensuring educational quality. One of the features of *Scitech* at this time, which it pioneered among ISTCs, was the provision of pathways for visiting school children (V. Dodds, personal communication, March 9, 1994). Pathways comprise series of exhibits that provide coherent experiences for children linked to themes in their school work. These are sometimes employed for areas other than science. For example, when the exhibition "Special Effects" was featured, most of the secondary school visitors came from media studies classes rather than science. Pathways are prepared for both primary and secondary school students with primary students being the most frequent visitors and hence users. One possible explanation for the imbalance between primary and secondary students was given by the *Scitech* secondary school education officer, who suggested that the comparative inflexibility of a secondary school timetable made half day excursions difficult to organise.

All education team members are involved in the professional development and in-servicing of teachers. Teachers who bring a class to *Scitech* are expected to complete an in-service session prior to a visit. Financial incentives by way of reduced admission prices have led to a high participation rate by teachers in the in-service sessions. The in-service courses are held after school hours and are geared towards assisting teachers to maximise the benefits of a visit, familiarise themselves with *Scitech* and be better equipped to develop pre-visit activities with their classes. In the area of professional development, members of the team regularly go to primary schools and present workshops that provide a resource of science-related activities for classroom teachers. These sessions are conducted at schools all over Western Australia including some in remote areas. They also assist the staff plan the science programs for some primary schools.

The education team participates in all exhibit and exhibition planning processes, their brief being to ensure that the educational objectives of an exhibit are clearly defined and met in a manner that is suited to the general level of public comprehension. For example, the level of language used on exhibit graphics has to cater for a wide range of visitors so the team monitors and guides this process.

The public demonstrations of scientific principles are coordinated by a person attached to the education team. This person is responsible for developing the "shows", training other demonstrators and administering a separate budget for that area. The demonstrations take place in a purpose-built theatre that is separate to the exhibit floor. According to another demonstrator, all the demonstrations are interactive with the audience being "questioned, challenged and they respond well no matter what their ages are. The exceptions are the 10-12-year-old boys who don't like to be put in a position of being seen not to know the answer."

Some demonstrations were developed to complement specific exhibition themes, while others are run constantly. For instance the "High Voltage Show", a series of demonstrations that involve the audience with static electricity, is a visitor favourite and is described as the "flagship show" by the co-ordinator of demonstrations. At the time of the interview, he estimated he had personally conducted 1500 demonstrations of the show. (J. Ball, personal communication, April 21, 1994)

All education initiatives are put to the education standing committee, an advisory body that meets every two months. The education standing committee consists of up to 20 members who are invited from universities, the State Education Department and Catholic Education Office, schools, industry and professional associations, and members of the education team.

Marketing and Public Relations

The Marketing and Public Relations team has two full-time and one part-time staff and is responsible for enticing the public through the front door. One person was solely responsible for paid advertising in the media and operated a set advertising budget. She also gave talks to public meetings and clubs, and on occasions over the radio, all of which were aimed at promoting the exhibitions and activities at *Scitech*. Some corporate organisations as well as individuals in Perth regard *Scitech* as a worthy cause and have donated free advertising space while others have provided heavily discounted rates. Some well known actors have donated their services for appearing in commercials. For example, a local actor Ernie Dingo, who played a minor role in the internationally renowned movie "Crocodile Dundee", helped with a commercial for no fee.

Another member of the team operated with a smaller budget and was responsible for public relations. It was her role to create interest stories and events that attracted media attention and consequently free advertising. For example, just prior to the "Gargantuans of the Garden" exhibition (see Figure 3.4 and Figure 3.5), a

Figure 3.4. An exhibit in "The Gargantuans of the Garden" exhibition.

Figure 3.5. Another exhibit in "The Gargantuans of the Garden" exhibition.

public competition titled "Build a Bug" (see Figure 3.6) was organised and prizes were awarded as an incentive for children to participate. The purpose was to contact people who may not be reached by mass advertising, and to get media exposure at little cost. Another event was a "Bug Show" – a demonstration of interesting insects and their characteristics by *Scitech* staff – featuring at a hosted breakfast in a large Perth department store.

During school holidays special activities are arranged to attract media coverage. An example was a staged cockroach race as a prelude to the "Gargantuans of the Garden" exhibition. It attracted the attention of a commercial TV station and featured on local news in peak viewing time. The public relations officer stated that she needs to commence talking to the media about six months ahead of an exhibition.

Opening of exhibitions by high profile community figures also attracts free media promotion. The recent opening of "SPORTS 2000" exhibition had the Deputy Premier of WA carrying a model of an Olympic flame racing against a series of electronic images of Cathy Freeman, an Australian athlete who is the current world 400 metres champion (see Figure 3.7).

Sometimes school parent bodies hire *Scitech* out as a fund raising venture where families have exclusive use of the facilities. The marketing section also organise and conduct product launches and meetings at *Scitech* for a fee. The company launching a product has exclusive use of the centre and *Scitech* staff are on duty. One company had recently staged a mobile telephone launch and another had 400 anaesthetists at a bi-annual dinner. It averages two functions a week. The covert objective of all these activities is to generate public awareness of *Scitech* and what it offers the public.

A third person has responsibility for a science club for students organised by *Scitech* and for providing activities for its members who are termed "Scitrekkers". In 1995 it had a membership of over 2500. Annual membership subscription carries an entitlement to attend workshops with science activities and presentations by specialist speakers as well as being able to visit *Scitech* an unlimited number of times over the year.

Visitor services

A full-time manager is responsible for 25 trained part-time staff who were involved with admissions, ticketing, exhibit maintenance and interaction with visitors. Another person co-ordinates a group of up to 80 volunteers trained as explainers who assist on the floor by facilitating the visitors' experiences. There is another member of the visitor services team who conducts birthday parties at *Scitech*, where for a small fee family and friends attend demonstrations. All are able to participate in activities related to science, witness a special demonstration and

Figure 3.6. Some of the entries in the "Build a Bug" competition.

Figure 3.7. The Cathy Freeman Exhibit in the "SPORTS 2000" exhibition.

consume soft drinks and cake. As well, each person gets a floating balloon. Overnight "sleep-ins" are another activity organised by visitor services.

Exhibits

There is a team of exhibit designers with specialists in engineering, computing, electronics and design, along with technicians who maintain the exhibits. Members of this team work closely with the education team when developing exhibits so elements of pedagogy are integral to any exhibit design. The exhibit construction workshop has a designated area adjacent to the exhibit floor but it is not visible nor accessible to the visiting public. Most of the permanent exhibits at *Scitech* have been designed and built by this team.

Science shop

The science shop is a commercial venture and returns a profit to the centre. It is situated at the point of exit and is stocked with a wide variety of games, kits, books, puzzles and artefacts all especially selected because they are based on science and technology themes (see Figure 3.8). Schools and teachers visiting from isolated areas often use this shop to purchase items to use in their primary school science courses. The general public is able to access the shop without entering the centre and it does a brisk trade during a peak buying period just before Christmas. Whenever it is possible the manager tries to obtain stock that is linked to a specific exhibition.

Finance

The CEO and a finance officer are responsible for raising funds by approaching private companies for sponsorship. Donations may be recognised by the advertising that can accompany exhibits or by a permanent designated wall display of plaques to acknowledge different levels of financial support (e.g., gold, bronze, etc). When a particular exhibition is conceived, companies in industries allied to that theme are approached for support. For example, as soon as "The Great Australian Treasure Hunt" exhibition was mooted mining companies, of which there are many in WA, were approached for donations. When the exhibition on "Flight" was conceived, QANTAS, the Australian national airline, was approached for sponsorship, while for the exhibition "Sparks," Western Power agreed to provide major sponsorship. "SPORTS 2000" was sponsored by Healthways, a government agency promoting healthy lifestyles (see Figure 3.9). On some occasions companies have volunteered support by approaching *Scitech*. For example, the West Australian Wheat Board donated the funds for an interactive exhibit that demonstrates how grain is bulk loaded into ships at the port city of Fremantle (see Figure 3.10).

Figure 3.8. A section of *Scitech's* science shop.

Figure 3.9. An exhibit in the "SPORTS 2000" exhibition.

Figure 3.10. The Bulk Grain Loading Exhibit.

Summary

The case study of *Scitech* in this chapter is important for two reasons. First, it places the study in a context which enables readers to judge the value of any generalisations they may make. Second, it helps to illustrate the perception that the visiting public may have of *Scitech*. In the following chapters, the other stages of the study are presented, beginning with the results of interviews with specifically targeted *Scitech* staff and a random selection of adult voluntary visitors at the time of their visit.

CHAPTER 4

STAGE 2: INTERVIEWS WITH STAFF AND VISITORS

Overview

This chapter reports Stage 2 of the study which involved a series of interviews to collect data concerning visitors' perspectives about their visit. The data were subsequently used for developing items on the PVQ. All of the interviews were conducted at *Scitech* and they focussed on three target groups: professional staff, volunteer staff and members of the visiting public. There were different rationales and formats for the interviews with each of the three groups. Consequently, the methods used, the procedure followed, the results and discussions for each target group are reported separately.

Professional Staff Interviews

Rationale

There were three main purposes for interviews with professional staff. The first two related to a need for the researcher to become familiar with *Scitech* and were reported in the previous chapter. It is the third purpose – to ascertain what the professional staff at *Scitech* expected people to get out of a visit to their centre – that is reported in this section.

Method

Professional staff were chosen to provide a cross-section of all the teams operating at *Scitech*. Individual interviews were arranged and assurance of confidentiality was given. The method used to conduct the interviews was reported in detail in the previous chapter. All gave their consent to their identities being used in the reporting of this study.

Results

During the interviews with the professional staff, one question asked of all respondents was, "What do you think the public get out of a visit to *Scitech*?" It is the analyses of the answers to this question that are reported in this section. The data were analysed by perusing the transcribed responses to seek a broad overview of the *Scitech* professionals' views.

There was universal belief among *Scitech* professionals that people enjoy themselves as well as experience some form of learning. This experience takes place in a unique situation, where people have the "freedom to be able to explore" without being told "hands-off" and "don't touch" – a novel experience for many of the first-time visitors. As one respondent stated,

> It [a visit] invites an opportunity to play, fiddle, and find things in a unique environment – no one will growl or frown at you for touching things. People are able to find out in an unstressed environment the consequence of which is they learn without being consciously aware they are learning.

There were other outcomes some of the ISTC professionals identified. Some indicated they expected the visit experiences would stimulate an interest and, in some cases, a change of attitude toward science and technology. Some also indicated that a visit provided a social opportunity for families and friends to interact having "quality time." One person raised the issue of making science and technology more inclusive by catering to "all age ranges, races, people with disabilities and both sexes."

Some other points raised were of a pragmatic nature about functional issues. There was a concern that the visitor, as a paying customer, should have value for money and be satisfied with the standard of customer service provided. The only perceived possible adverse effects were due to the physical environment. They were: a high noise level caused distress to some visitors, a lack of signage caused confusion, and frustration experienced when exhibits were not working.

During the interviews it became clear that the professional staff are working towards a common goal of presenting science and technology, but not all had enough direct contact with the public to gauge the public's reaction to a visit. It also became apparent that it was the exhibit floor staff and the demonstrators who have direct contact with the public and that they were the people most likely to be able to provide any specific evidence of outcomes of the visiting public's experiences.

The floor manager, who is the full-time staff member with the most direct contact with visitors, said he had a lot of direct feedback clearly indicating that visitors enjoyed themselves, however there was little overt feedback about learning. In the five years he had been floor manager, he believed almost all visitors enjoyed themselves and he'd only had two strong complaints. He cited one of the complaints from a letter stating the visit was a "waste of time" and the place was an "over-rated amusement park." However, the complainant continued to write that her "kids enjoyed themselves but she didn't."

From his observation of people's engagement and behaviour with exhibits, as well as his reactions with visitors, the floor manager believed learning was definitely taking place. Part of his role as floor manager involved watching people on the floor. If they were having difficulty, or it seemed they were missing the point of the exhibit, he would encourage them to read the graphics, or in some instances, to try a different approach. He acted as a facilitator by "getting them [visitors] to use their own initiative to find answers." He believed most children and some adults found the first visit "interesting rather than any particular learning taking place." His belief was based on his observation that those children tend to run around excitedly. However, on return visits they would tend to head to favourite exhibits and become intensely involved without much distraction. That was when he believed "learning was more likely to be taking place." The floor manager's assertion is reminiscent of the findings reported earlier of a study by Falk, Martin and Balling (1978) about the novelty effect of first-time visits on children's exploratory behaviour and cognition.

Two additional points the floor manager made are relevant to this study. First, it is usual for a number of parents to get concerned that unaccompanied children are "just playing around." This raises the issue of the relationship between enjoyment and learning and the perception of those who may have little experience in education. The notion that learning and enjoyment are not connected is not an educational issue with staff of ISTCs. For them, the issue is more pragmatic. If the experiences they provide were not fun, would people pay to visit? When this question was put to the marketing staff and to the 20 members of the two visitor focus groups, the answer was a resounding "No!"

Second, some parents who had obviously spent a lot of their visiting time occupied looking after their children had made "tongue-in-cheek" comments such as "leave the kids at home next time and bring myself." He believed that although the remarks may have been made in jest, it is a "comment that I've heard on enough occasions from different people to make me think there is a serious element in it."

The theatre demonstrators see the outcome of their shows as having a priority to "raise interest in science" rather than people to learn anything in particular, although they did cite evidence of learning and learning behaviour. The person in charge of the theatre stated that as shows last only 20-25 minutes he was under "no illusions" he could "teach a [whole] topic in that time but it certainly did stimulate interest." He did, however, believe some learning took place and cited anecdotal evidence in support. He related one instance when he'd done the "old egg-in-the-bottle trick," a person came out at the end and said "that experiment you did I have known that for 40 years and that is the first time I have had anyone explain it so that I can bloody well understand what is going on." He also cited an instance when another person had gone home and replicated an experiment he'd seen demonstrated that involved a small Rieke Tube.

The theatre demonstration manager thought that the usual outcome of demonstrations was an arousal of curiosity in some members of the audience, and he cited examples of people staying behind to ask questions after the show. Another demonstrator related instances of people being stimulated, as they indicated they intended following up what they have seen. She cited questions she had been asked after giving a demonstration. An example was, "Where can we get the materials so we can do it when we get home?" This question, she added, was usually asked by parents with primary school aged children.

A third demonstrator said there was evidence of learning that could be inferred from comments like, "I didn't know that before" and, following the high voltage show, people commenting on the shocks they have got from their car and saying, "Now I know why." This demonstrator used a definite strategy to challenge people's preconceived notions of scientific principles and concepts by being aware of a "need to demonstrate concepts in such a manner as to allow for the prior constructs in people's minds." The awareness and approach of this particular demonstrator carries an invitation for members of her audience to engage in higher levels of thinking and possible learning.

The anecdotal evidence provided by the demonstrators indicating that some of the visitors are likely to apply knowledge they have gained during a visit, or to make links to previous experiences, is consistent with visitors' experiences reported by Tulley and Lucas (1991) and Rennie (1995a). Tulley and Lucas (1991) relate an instance where a repeat visitor told Tulley about repairing her sister's door lock after learning how to assemble a lock that was an interactive exhibit at the *Launch Pad.* Rennie (1995a) reports part of her conversation with a visitor at an exhibit designed to demonstrate how pulleys reduce the effort required to lift the load. The visitor had heard that information previously and was delighted to be able to make cognitive sense of it by the physical experience. It is worth noting that Rennie and McClafferty (1996) suggest these types of anecdotes indicate that learning is occurring in the cognitive, affective and psychomotor domains. They also acknowledge the difficulty of measuring such learning in an objective manner.

The ISTC professionals were unanimous in their expectation that visitors would learn something from their experiences while visiting *Scitech*, but opinions about the type of learning differed. Staff from the education team expected visitors would become more "aware of scientific principles and their applications" but believed it is "difficult to ascertain how much they effectively learn about science." They thought that visitors will get an "idea of how things happen but not necessarily why." There was also a common belief that when visitors next encounter a real life example of something they experienced at *Scitech* they will make the link, although the extent of the comprehension would depend on the individual. One education team member said,

> [I] have a gut feeling that they will apply the science and technology knowledge they have acquired. It may be for the general public that [the application] will be at the level of knowledge they are required to use.

Among the education team there was evidence that they were quite confident that a message about science being accessible, meaningful and that it can be enjoyable, was reaching the visiting public. A statement made by the manager of education summarises their collective responses. She said she was

> Very confident that they [the visiting public] get in this place, some enjoyment and an interest in science. What they see is relevant to their everyday life and not just something that happens in the laboratory. For example, when they turn their iron on and the longer it is on the more it costs. Another example is the comparative costs of running a fridge and other electrical appliances. As well, they learn about different heat absorption rates.

The type of learning expected by the professionals in the exhibit team was in contrast to that of the education team members. While the three members of the exhibit team who were interviewed did not provide any evidence of learning, they were firm in their belief that learning of factual information should be a priority. The manager of the exhibits section was adamant that a direct acquisition of scientific facts and principles as well as specific scientific nomenclature should be the priority. He believed any dilution of science from pure science should be avoided. He said, "I strongly believe the term thermodynamics should be used instead of heat in any exhibit text." Another person in the exhibits team stated he would "be very disappointed if a visitor left without learning at least one fact."

It is worth pointing out that the marketing team have, in recent times, made the educational aspect of a visit central to their advertising themes. This was done following the advice of a consultant advertising agency who pointed out that *Scitech* was a unique leisure destination in Perth as it offered an overtly educational experience. In contrast, other similar leisure destinations such as the *Perth Zoo* and *Underwater World* do provide educational experiences, but they are much more implicit in that function.

One newspaper advertising campaign over the school holidays exhorted parents to turn "bored kids into smart kids" either by taking or sending them to *Scitech*. Other advertisements were more explicit about the educational emphasis of the *Scitech* experience and that visitors can expect to learn something. For example, one film clip shown on commercial TV challenged people to find out how visual illusions were achieved in film making. There is however, an element of fun and excitement along with the educational theme in most of the advertisements. A recent feature is an exhibition titled "Sparks" which has electricity as its central theme. The newspaper advertisement read:

Bolt in Now!

> It can tear a tree apart in an instant. It can make your skin tingle and your hair stand on end! It's electricity, the star of *Scitech's* new show "Sparks." Come and see this awesome display of power and energy today at *Scitech*.

Beside this column is a picture of a Herman Munster/Frankenstein style person with steel bands wrapped around his head and electrical discharge trails shown arcing around all of it. Beside him stands a teenage girl with her mouth agape and eyes shining with excitement as she stares at the wonder of the display of electricity. The whole image is of action, excitement and awe in abundance. Such advertisements would surely create a distinct expectation for the paying visitors, that they will be entertained by being involved in an exciting, interesting environment and learn something in the process.

The public relations officer recounted an interesting anecdote that demonstrated the attraction (and hence potential for providing learning experiences) some of the interactive exhibits held, even for people who were professionals in science. At the function for the anaesthetists she witnessed a large number actively engaged with the exhibits and when it was announced that the champagne was being served, few left their activities. She also recounted that, "further reminders luring them to the champagne and eats seemed to fall on deaf ears," and their reluctance to move from the exhibits was the "only time I've seen people not gravitate immediately to the free drinks and food."

The founding CEO gave a broader perspective of the anticipated outcomes of a visit to *Scitech*. He stated that since *Scitech's* inception the overarching objective has been to focus on showing how "science and technology relate to people's everyday life, from pre-school through to adulthood" (S. Beddington, personal communication, June 8, 1994). Under his direction the philosophy behind *Scitech's* planning has been to bring the public to science and technology rather than science and technology to the public. To illustrate, he gave the example of opening a brainstorming session for a new exhibition. He said to the staff, "Let's take some events on TV and see what scientific principles they are linked to." He also stated, "We look at it from the [visiting] public's point of view."

Summary

There is an expectation among all the professional staff that the visiting public do learn something while enjoying themselves immensely in a unique environment. There is, however, a variation among those staff in their expectations of the type and level of learning that may be happening. Few of the professional staff were able to cite any direct evidence of learning. That is understandable given that few deal directly with the visitors and therefore have little or no opportunity to substantiate their expectations. The floor staff, who have most contact with the public, were able to provide anecdotal evidence that people have fun, learn something, are stimulated by their experiences, and in some cases actually do something as a result of those experiences. However, precisely what people do learn could not be made clear. In an attempt to establish the nature of the learning outcome, the next step was to interview the volunteer explainers as they had the most contact with the visitors.

Explainer Focus Groups

Rationale

Two focus group sessions were conducted with the explainers and aimed at identifying learning outcomes. The explainers were in the best position to comment on this as they witnessed first hand the behaviour and experiences of visitor reactions with exhibits. Surprisingly, at the time of these interviews, little published research was available using volunteer guides as sources of data, and only two articles were found. One was a longitudinal study conducted at the *Exploratorium* in San Francisco aimed at identifying any long term impact their experiences as explainers may have had (Diamond, St. John, Cleary & Libero, 1987) . The other was a quality control evaluation study by Butler and Loomis (1992), where explainers were required to evaluate their roles and performances when dealing with visitors. The information was used to develop new management procedures. No study examined the views of explainers about the learning of visitors.

Method

Subjects

"Docent, volunteer, interpreter, and instructor are some of the names given to those who 'translate,' 'decode,' or explain and describe exhibits" (Grinder & McCoy, 1989, p. 3) . Explainer is another name and is used at the *Sciencentre* (Brisbane), *Exploratorium* (San Francisco) and *Questacon* (Canberra). The roles for explainers generally include informal welcome of visitors, assistance at and interpretation of exhibits to visitors when appropriate, encouraging visitors to extend their interaction with displays by supplying background information, suggestions and anecdotes and assistance with demonstrations.

All the explainers at *Scitech* are volunteers, but their selection is made very formally. Recruitment is by word of mouth and notices on university noticeboards. Applicants for explainer positions must be a minimum of 18 years of age. Each applicant participates in a formal interview conducted by the Explainer Coordinator, during which the applicant is assessed for suitability according to the following criteria: friendly, outgoing personality; willingness and ability to extend their own knowledge of the centre's displays; commitment to act as an explainer for five hours per month; and preparedness to undergo a training program and 20-hour probationary period.

The training program involves two six-hour sessions in which permanent staff familiarise explainers with administration, public relations, visitor service, exhibit design and construction, theatre demonstrations, school tours, and exhibit floor layout. Trainees also spend time observing experienced explainers interacting with visitors and are expected to focus on the skills of facilitating learning. They are then required to practice being an explainer with their peers playing the role of visitors. Next they are assigned to an experienced explainer who acts as a mentor for their probationary period. After they have completed the training program and probationary period they are able to act as an explainer without supervision.

For the purpose of this study, the Explainer Coordinator selected a sample of ten explainers from a pool of approximately one hundred to form a focus group for discussion. She had been informed of the objectives of the discussion prior to that selection being made. Experience as an explainer and potential to articulate ideas in a group setting were considerations when prospective participants were approached to be part of the focus group. The group totalled eleven, with six females and four males as well as the female Explainer Coordinator. Their ages and backgrounds were varied. Some were retired and others were university students. Most had a background in science, but two who were retired primary school teachers did not. The experience of the explainers ranged from one to five years.

Procedure

The most convenient and efficient method of collecting data from the explainers was to hold a group discussion. This approach allowed for the development of a pool of data that would give an insight into the explainers' perceptions of visitors' experiences. The session is described as a focus group because it was "a carefully planned discussion designed to obtain perceptions on a defined area of interest in a permissive, non threatening environment" (Krueger, 1988, p. 18) . The number of participants fell within the range of eight to twelve, considered to be optimum for a focus group. When an investigation is designed to find out how people regard an experience or event, focus groups are considered to be an appropriate environment (Krueger, 1988) .

The group met on a Sunday afternoon (November 14, 1994) for a period of one hour with the researcher as facilitator. Prepared questions were put to the group and discussion among them was encouraged. Most questions were open-ended and dichotomous questions were avoided where possible (Patton, 1990) . At the beginning of the session it was emphasised "there are no right or wrong answers, but rather differing points of view" (Krueger, 1988, p. 25) . The intention was to provide an environment where participants were able to react to each other's comments and stimulate responses and ideas that may not be forthcoming in a formal interview setting.

The first question invited explainers to use one minute each to relate their experiences with science when they were at school. That question gave each participant an opportunity to speak and was designed to be an "ice-breaker." At times probing questions, different from those which had been prepared, were used. The facilitator was careful not to pass judgement on any statement. "It is the role of properly conducted focus groups to 'unpack' the cabin trunk of experience and piece together the answers to these questions" (Hall, 1991, p. 238) . The second and following questions were intended to open up discussion about visitors and their possible learning experiences. A series of five questions were prepared, as follows:

- Do you think people are having fun?
- Does what they have seen make sense to them?
- I'd like you to describe some encounters you have directly experienced or observed that would lead you to think that learning has occurred.
- Do you think they link scientific concepts to their everyday life?
- Do you think their experiences at *Scitech* lead them to learn something other than what the exhibits intended?

These questions were amended as the discussion progressed, in terms of responses of the explainers, and additional questions asked to elicit further information. For example:

- If I can just take you up on that point. When you say people don't want to know – do you think there is any particular reason?
- Did you hear any actual comments?
- Could you relate any experience that would verify those observations?
- Did you hear any comments that they actually learnt anything or is it just your observations?
- Have you heard people make the link themselves without you giving an analogy?

The session was recorded on an audio-tape with prior consent of all the participants, who were given an assurance of anonymity. When the audio-tape was transcribed, all responses were coded to maintain anonymity and to provide for a guide to each individual's input through the session. A check on the accuracy of the initial transcription was carried out by replaying the tape and some minor corrections of wording were made.

Data Analysis

The transcripts were analysed by carefully reading and comparing all responses which related to explainers' perceptions about the visitor experience. Natural categories, grounded in those responses, were developed. Data were summarised by preparing generalisations, described as general perceptions, based on those categories. The validity of these generalisations and their source statements were tested using another group of ten explainers approximately two months after the focus group session. This second group were volunteers from a larger group of explainers who had met at the ISTC to receive instructions about a new exhibition from the Explainer Coordinator. The researcher again acted as facilitator for the discussion with this second group, which will be referred to as the review group. On this occasion there were ten participants, three of whom were participants in the original focus group. This allowed a process called member checks (Lincoln & Guba, 1985) to assist validating data. The participants worked in pairs. Six sheets, each with a generalisation together with its confirming and any disconfirming statements gleaned from the data collected from the original focus group, were given to each pair to read and discuss. The group as a whole were then involved in a discussion to comment on the appropriateness of each of the generalisations and associated statements.

Results

The results are reported in terms of the general perceptions identified from analysing the data, and illustrated by some of the comments made by the explainers in the focus group. In addition, confirming and, where possible, disconfirming statements given by the review group are reported.

Perception 1: Members of the visiting public have fun at the centre.

When the question, "Do you think people enjoy their visit to *Scitech*?" was put to the focus group there was an animated reaction. A cacophony of affirmative comments indicated the extent of certainty by the explainers that visitors did indeed have fun when they visited *Scitech*. Some example comments from the focus group were:

> [The] only thing they don't enjoy is when you [parent] take them [children] home.

> One old lady was having a ball. [She said] "my grandchildren talked me into coming and I think it's wonderful."

> Even the school groups [have fun].

The unanimous agreement among the focus group is not surprising as all of the advertising aimed at getting the public to visit the centre has both obvious and subtle messages emphasising enjoyment (M. Henry, personal communication, April 22, 1994). This perception was supported by the review group. One review group participant commented "that a large proportion of visitors return voluntarily and pay money to do so makes it obvious they enjoy their visit(s)." Research conducted by the *Scitech* marketing section lends support to that respondents' view as it revealed 83 percent of visitors have been before (M. Henry, personal communication, February 8, 1994).

Perception 2: Learning is not the main purpose of the visit.

"While they (visitors) are having fun are they learning anything?" was the second question put to the focus group. One explainer was quite emphatic in her view of the philosophy behind *Scitech*. Quite in contrast to the view of the Explainer Coordinator, this person firmly believed that learning was not part of the reason for the existence of *Scitech*. She stated,

> Philosophy behind this place is not a teaching institution but entertainment.

When she made that point there was no direct support of her view from the other explainers. However, during later discussions arising from other questions to the focus group, there were some statements made that added support for her belief.

> People enjoying themselves and learning something are two very distinct things and if they are out to enjoy themselves they are not out to learn science whether they are learning or not.

> Somewhere to go to have fun. Ten to thirteen [year-old] bracket don't listen. They have a glazed look and just want to go and play by themselves.

> A lot of people think "I'm here to have fun and not to learn" and they turn off [when taught] if you like. Especially the young teenagers.

One member of the review group commented that the first statement would be appropriate only if it referred to some people rather than a lot. Another statement indicated qualified support for the notion that *Scitech* exists for enjoyment only. However, that explainer clearly believed a visit to *Scitech* was not exclusively for enjoyment and that some learning was associated with the experience.

> I go to [the] Art Gallery and [the] Museum. A lot of expressions on faces are entirely different. [The] Art Gallery and Museum are definitely learning and *Scitech* [is] fun and learning.

The review group indicated their support of this perception.

Perception 3: The role of an explainer is to facilitate understanding of the exhibits, not to teach.

When explainers at *Scitech* undergo their training program, part of that time is spent learning how to "encourage visitors to extend their interaction with displays through anecdotes, background information and suggestions" (J. Pyke, personal communication, July 22, 1993). One focus group respondent succinctly stated they were "not taught to teach." Explainers in the focus group saw their role as that of assisting visitors with explanations of exhibits when they believed it to be appropriate. A typical comment was, "Part of the job is being able to discern who wants to know what and who doesn't."

They perceived their primary role as assisting people to think about and understand the scientific concept or concepts an exhibit had been designed to demonstrate. Didactic explanations were seen by explainers to be of secondary importance and not the preferred method of interacting with visitors.

> Some people come in here and think people [explainers] who go to university are very clever people and expect them to remember [the] basis of DNA. We are about understanding principles rather than rote learning.

However, some explainers in the focus group felt that although they tried to encourage people to seek their own answers, there were occasions when direct imparting of knowledge was appropriate.

> Although we are not [here] to teach people we may roll [end] up doing that. For example, [the exhibit about] the tongue and its relationship to smell and [the visitor is] often very interested and appreciate having it explained to them. Some want to know . . . others don't.

The members of the review group were unanimous in their support of this perception and there was little discussion by them about it.

Perception 4: Learning occurs when visitors relate experiences at the centre to experiences in the outside world.

Explainers in the focus group were able to describe a number of instances when visitors had been able to understand the scientific principle being demonstrated by an exhibit when they linked it to a previous experience away from *Scitech*. In some cases the visitors were from a science background and, in their job, they had been using specialist equipment or had experienced related scientific phenomena. By using their experiences at *Scitech* and the outside world they were able to understand better the scientific principles involved in their work.

> Gyros! [One visitor was] an engineer and when we [*Scitech*] used to have a suitcase with a gyro, [she/he] said, "Oh yes, we used to use gyros in engineering". They apply it to their own experiences. Another worked in aeroplanes. He related static electricity to his experience at getting a shock from aeroplanes. So when they saw the science

> behind the experiences, it was interesting. It's mainly from people with engineering experience that can apply [the principle] if they’ve never seen the science before.

Some of the focus group explainers indicated they had seen scientific principles at *Scitech* that helped them personally understand an outside experience. One stated:

> . . . for me the Special Effects [an exhibition that focussed on creating illusions on film] has helped understand movie effects. Aha! I know how that is done now.

Two other respondents indicated their agreement with the statement.

One focus group respondent indicated that he had been involved in a technical occupation before retiring and becoming an explainer at *Scitech*. Since being at *Scitech* he had been able to link some scientific concepts to his previous occupation. He said he was

> . . . now able to understand the science behind a lot of things I did. When I was working I did things without thinking about it.

Other focus group explainers were able to relate comments made by visitors that clearly indicated a link was being made from some exhibits to the world outside *Scitech*.

> A boy playing with archway . . . said he had archway in his house. It's wedged together like this (see Figure 4.1).

> [An] eight year old looking at damage to the lung (see Figure 4.2) said, "My dad smokes. Does that mean he is going to die?"

> . . . one of the girls had once smoked a cigarette and she was worried that her lung was going to be like this all the way through.

> Heart coronary by-pass [exhibit] (see Figure 4.3) . . . [the visitors] relate to [their] families.

> Lung also. "So and so has that disease" and they are all pointing to it.

In reference to two exhibits designed to demonstrate differential rates of thermal conductivity, a focus group participant reported that:

> [It] amazes people that [the] steel one [toilet seat] feels colder than one of the other ones (see Figure 4.4). Three cars also [different colours] (see Figure 4.5). Often see people talking about that.

Figure 4.1. The Archway Exhibit.

Figure 4.2. The Lung Exhibit which "pulsates" as people walk through it.

Figure 4.3. The Heart Exhibit.

Figure 4.4. The Heat Conduction Exhibit.

Figure 4.5. The Heat Absorption Exhibit.

The review group supported this perception. There was considerable confirming discussion by the review group about the experiences visitors bring to *Scitech* and how it affects their reaction to exhibits.

Perception 5: Analogies facilitate understanding.

When visitors were having difficulty being able to understand the scientific concepts that an exhibit was designed to portray, explainers found that the use of an analogy could be useful. One member of the focus group reported that:

> Analogies work . . . people go "Ah I get it." I use simple analogies to explain and be able to link principles.
>
> For example spinning chair is like a skater on ice [angular momentum].

Another focus group explainer gave an example of using an analogy that linked the exhibit to the visitor's occupation. In doing so an analogy was used to link to a very direct outside world experience. He was explaining cancer to a motor mechanic.

> . . . cells [behave in an] unregulated fashion like having your foot stuck on the accelerator. He clicked onto that straight away. [I was] tailoring that analogy to something he was familiar with.

Rather than using an analogy that is directly related to the principle it is being used to explain, it is possible to use an indirect analogy in order to facilitate understanding. A focus group member gave the following example.

> Sometimes you need to link the opposite analogy for people to click. For example [the exhibit that shows] air pumped out and water boils. [The] classic example [is] you can’t boil an egg [at 100°C] on top of Mt Everest. But for most of us, that isn’t particularly relevant . . . . If you turn it the other way round . . . higher pressure water boils at a higher temperature can be illustrated by a pressure cooker. Most people have seen food cooking faster.

The review group also indicated that analogies were an important tool for them to use when helping some visitors understand particular exhibits.

Perception 6: Incidental learning, unrelated to the intention of an exhibit, often occurs.

Exhibits are developed according to specific educational objectives. These objectives are taken into account early in the planning stage of an exhibit. They are arrived at in meetings between staff of *Scitech* in the areas of education, graphics, marketing and technical services who construct the exhibit on site. The objectives indicate anticipated learning experiences as a result of a visitor interacting with an exhibit designed to demonstrate scientific principles (V. Dodds, personal communication, May 3, 1993). The focus group explainers were able to give a number of examples where learning had occurred that was different to the educational objectives of an exhibit.

> People learn without realising it. I've got two children between six and eight who come in very frequently with me. They don't understand the science behind it, but they know what happens if they press a button due to the frequency of their visits they have learnt what to expect. They really do pick up a lot of knowledge.
>
> Whispering dish. [Visitor] played around with the telescope piece to see how it works. . . . looking at the ball and socket joints rather than see how the telescope works (see Figure 4.6).
>
> Lot of fun spinning it [telescope piece of whispering dish] around and see how joints work. Observe parent explaining to a child.
>
> Chicken exhibit designed to show hatching (see Figure 4.7). Most people are looking at behaviour rather than purpose [of exhibit]. Tapping on edge may sound like the mother.
>
> Mice behaviour . . . food. Most just look at them running and how they eat the food [exhibit designed to demonstrate heredity].
>
> Very small children going up and down [the] parabolic dish. Parents realise their child can actually climb up and down without hurting themselves. Parents learn themselves. Even very small babies' eyes light up perhaps reacting to noise . . . originally I thought there was nothing for little children, then I realised there was a lot.

All members of the review group concurred that unintended learning does occur at *Scitech*.

Discussion

The data showed there was considerable agreement between the explainers involved in this study enabling their ideas to be summarised into six general perceptions about the visitors' learning. The agreement becomes more significant when the variety of backgrounds and ages of the explainers are considered.

The last four perceptions are important to this current study when considering learning as an outcome of a visit. All four perceptions imply that the learning involved is not superficial, in the sense people do more than just observe an event and remember one or two facts, but they actually engage in some form of complex cognitive processing. When explainers act as facilitators, they are putting the

Figure 4.6. The telescope piece at the Whispering Dish Exhibit.

Figure 4.7. The Chicken Hatching Exhibit.

responsibility for processing information back to the visitor, with gentle assistance to point them in the desired direction. The emphasis is on understanding, a higher level of cognitive activity. Similarly, when visitors are able to make connections with their own experiences outside an ISTC, meaningful learning occurs (Ausubel, 1960) .

Unintended learning as expressed by Perception 6, is also a powerful learning experience (Bruner, 1988) and has been referred to by Lucas (1983) as "unintentionally educative" (p. 3). Whether it is related to science and technology or not, it is still a cognitive process that can have a lasting effect as the person has discovered it for themselves (Bruner, 1988).

The remaining two perceptions, that visitors have fun, and that learning is not the main purpose of the visit, are both supported by other studies (see for example, Hood, 1992; Rosenfeld, 1979) and by data collected from other subjects in this study. Those data will be referred to at appropriate stages in this thesis.

Interviews with Visitors

Once data had been collected from the staff at *Scitech*, the providers of visit experiences, additional data were collected from the consumers of those experiences, the visiting public. The data were collected by interviews which were conducted in two formats: individual interviews at the time of a visit and two focus group sessions; the first, about three months following a visit and the second, about six months after a visit.

The six perceptions developed from the explainer focus groups were tested by using the two focus groups of visitors. Both visitor focus group sessions are reported at this point, even though these took place well after the explainer focus group sessions and the first two phases of the on-floor interviews. They are reported at this stage because their purpose was to test the congruence between the explainers' perceptions and those of the visitors. Thus it is convenient to describe this section here. The first focus group of visitors was also used to provide a check on the PVQ and the second focus group of visitors reviewed the PVII prior to its pilot field-test. These functions are reported later at appropriate points.

Visitor Focus Groups

Method

Subjects

The two groups of visitors each consisted of ten volunteer members of the visiting public (36 had been asked) and all had visited as a family group member. The structure of the families included wife or husband only, two parents and three children, one parent and child and one parent with children. The ages ranged from 11 to 60 years. One member of each family had been interviewed at the time of their visit to *Scitech* and had agreed to participate further in the study. All members of both groups had completed the PVQ about their visit approximately one month after that visit. No one in either group had revisited *Scitech* after the initial interview.

Procedure

The discussion meetings followed the same procedure used by the explainer review group session and opportunities were given for participants to add to the information gleaned from the data provided by both explainer groups. On both occasions, the general perceptions developed by the explainers were supported, but several perceptions were discussed and refined.

Results

The results are organised in terms of the six general perceptions identified from the discussion in the two focus groups of explainers. Here the reactions of the two focus groups of visitors are reported.

Perception 1: Members of the visiting public have fun at the centre.

When the notion of fun being a component of visitors' experiences was put to the visitor discussion groups, spontaneous laughter erupted and a lively discussion ensued, indicating memories of an event that was clearly enjoyable. All members made definite statements that their visits had been a "fun" occasion for them. Two typical comments were:

> People have fun . . . playing with all the activities and being able to manipulate the environment they are in.

> It allows you to experience hands-on activities that are fun and teach you something at the same time.

Perception 2: Learning is not the main purpose of the visit.

Most members of both visitor review groups were in agreement that their prime motivation for attending the ISTC was to have fun. All but one saw the occasion as a family outing, where all members were able to enjoy the hands-on nature of the exhibits. One said, "I go to enjoy doing interesting things with my children." Any learning was regarded as incidental to the main purpose and if any occurred then it was regarding as "an added bonus." The one dissenting member stated her "main reason for visiting was to learn," although clearly fun was also a contributing factor as she added,

> I feel better about spending my money to come here than I do if I go to a fun fair because I have just as much fun here and I am also learning something.

Perception 3: The role of an explainer is to facilitate understanding of the exhibits, not to teach.

All members of both visitor review groups agreed with the notion that explainers should act only in a facilitating capacity when visitors are interacting with exhibits. One said,

> You can go at it at your own pace and just have someone there to help if needed.

One visitor was clear her preference was to be able to enjoy the exploratory nature of the exhibits.

> You get satisfaction out of exploring things for yourself, but occasionally some clarification is beneficial.

Another, who was a parent, claimed,

> If my kids were to come in here and have another school experience they wouldn't enjoy it.

It should be noted that the visitors indicated in their discussions that they would like to have more explainers available as they believed they had the potential to greatly enhance a visitor's experience. Further, some visitors believed explainers were particularly helpful when a visitor was interacting with difficult "technical" exhibits.

Perception 4: Learning occurs when visitors relate experiences at the centre to experiences in the outside world.

This perception was also supported by both visitor discussion groups. Three statements that typify both visitor discussion groups were:

> The activities and experiments allow people to expand their existing knowledge through discovery and personal experience.

> The exhibits explain the intricacies of phenomena that occur in normal circumstances.

> Some of the things we saw here were directly related to things we use at home and it was interesting to find out how they work.

Perception 5: Analogies facilitate understanding.

It was at this point it became clear that only a few (three out of 20) members of the visitor discussion groups had any contact with an explainer during their visit and none had experienced an analogy being used by an explainer. However, most of the members indicated their belief that the use of an analogy by an explainer would be an effective aid in grasping a concept being demonstrated by an exhibit. However, one person had reservations about the value of analogies as a tool for aiding explanations:

> To a point, analogies are interesting, but often under the circumstances of a visit, I really look for specific explanations.

Perception 6: Incidental learning, unrelated to the intention of an exhibit, often occurs.

All members of the visitor discussion groups concurred that unintended learning does occur at the ISTC. However, no one in the visitor discussion group was able to give a specific example as it "was six months since our visit." When pressed further whether they believed incidental learning had actually occurred the majority of members said, "Yes definitely," but only one example could be supplied.

> When data related to an exhibit are explained, it is often perceived in a context related to personal experience and then incidentally applied to other life experiences.

Discussion

The data from the visitor focus groups show considerable agreement with the findings from the explainers, confirming the proposed six general perceptions about the visitors' learning. As well, these general perceptions were confirmed by the second group of explainers after two months. In summary, the claims for validity have been reinforced by supportive reactions of two different groups of visitors, who concurred with all six perceptions. Although there is general agreement that visitors have fun and learn something on a range of levels, precisely what is learned is still uncertain and hence at this stage still unable to be measured. Consequently, these data feed into the development of PVQ which also derives from the outcomes of other interviews with the professional staff, described earlier and floor interviews with visitors, described in the next section.

On-floor Interviews

Rationale

These interviews were conducted prior to the visitor focus groups and aimed specifically at collecting data to be used in developing the PVQ. While data from interviews with staff proved useful their scope was narrow in focus and there was still a need to try to establish outcomes of visits from the perspective of voluntary visitors. The questions used in these interviews were therefore designed to cast a wide net to capture a broad spectrum of reactions.

Method

Subjects

The floor interviews were conducted with a total of 70 randomly selected adult voluntary visitors to *Scitech*. Although their ages were not requested, they were estimated to range from about 18 to 70 years.

Procedure

A series of 14 set interview questions was generated from a range of sources, including the responses of interviews with *Scitech* professionals, casual conversations during the immersion phase with visitors during their visit to *Scitech*, as well as some of the literature reporting previous research in ISTCs (Stevenson, 1991). Guidelines for conducting interviews and structuring questions were taken from Fowler and Mangione (1990) and Merriam (1988) . As a check on the appropriateness of the questions, they were given to a member of the *Scitech* education team and a science educator for critical comment. Neither person suggested any alteration.

Each interviewee was asked the same 14 questions. They were:

- Have you enjoyed your visit?
- Have you been to *Scitech* before?
- What made you decide to visit today?
- How long have you been looking at the exhibits today?
- Did you have an interest in science and technology before your visit?
- Can you tell me what you have learned today?
- What is your favourite exhibit?
- Which exhibit did you like the least?
- What do you think of science and technology after your experiences here?
- Do you think there is something you might do as a result of your visit to *Scitech*?
- Do you intend to visit again?
- Do you have any suggestions that might make *Scitech* a better place to visit?
- Is there anything you can think of that I haven't asked you about your visit?

In addition, those people who had previously visited *Scitech* were asked another question which was to recall their memories of that experience. When interviewees were hesitant or brief with their responses probing questions, such as "Could you tell me more about that?" and, "Why do you say that?" were asked.

Occasionally a prompt like "If there was a $40 000 prize for your answer" was put in a seemingly light-hearted tone in order to stimulate a more elaborate response. The same order of questions was followed in all interviews, except for the few instances where interviewees had already volunteered information that fully addressed the question to be asked.

Interviews were conducted with the 70 visitors in three phases. The first phase began by interviewing seven visitors to trial the suitability, and sequence, of the set questions used in the interview. It immediately became evident that people were generally a little cautious and tentative when giving their responses to questions at the beginning of the interview. In addition, people had appeared to be still a little distracted by their environment immediately prior to the interview, where they had been immersed in high levels of activity, noise, and crowded conditions. After the third interview, the sequence of questions was reviewed, and slightly amended by changing their order so that the opening two questions were low-key and welcoming in nature. The new opening questions "Have you enjoyed your visit?" and "Have you been to *Scitech* before?" were presented in a conversational manner. The change was effective in getting people to relax and allowed them time to settle and focus their attention on the more searching questions that followed.

While conducting this trial of seven initial interviews near the exit from the exhibit floor some difficulties were encountered. It was difficult for the interviewer to be heard because of the background noise from exhibits. As well, it was too noisy for clear reproduction of visitors' responses on a tape recorder. The problem was overcome by withdrawing with participants to a quiet, isolated laboratory adjacent to the exhibit floor and reasonably close to the exit. Seats were available and there was no opportunity for interruptions by curious onlookers.

After this trial, another 21 visitors were interviewed, giving a total of 28 interviews for the first phase which ran over five weeks commencing in the last two weeks of January, 1994 and continuing until late February, 1994. All these interviews were audio-taped with each respondent's prior consent and an assurance of anonymity given.

The second phase of interviews was conducted by a group of 15 trainee explainers who were undergoing an introductory training program under the direction of the *Scitech* Explainer Co-ordinator. Their interviews with the visiting public were used as part of that program at the instigation of the Explainer Co-ordinator. He believed it was a good opportunity for the trainee explainers to gain a valuable insight into visitor's reactions to experiences at *Scitech*. The explainer trainees conducted a total of 22 interviews immediately following a briefing by the researcher and the Explainer Co-ordinator. They were informed of the need and purpose of the overall study, the reason for the interviews, and the procedure to follow while conducting an interview. Time was allowed for any questions from the trainees. Each trainee was provided with a typed copy of the interview protocol. All the questions, and the recommended procedure, were discussed. They were instructed to select prospective interviewees by a random method of approaching the third person to pass an imaginary line between any two exhibits they chose. The second phase took place just after the end of the first phase – March 6, 1994.

About six months following the first phase, the third phase took place when another 20 people were interviewed during July, 1994. The third phase of interviews was conducted when a very different exhibition, "The Great Australian Treasure Hunt", was the main attraction. It featured more interactive exhibits than did the "Gargantuans of the Garden" exhibition that was running when the first and second phase interviews were conducted. All of the first and third phase interviews were conducted by the researcher, most of them on weekend afternoons with some on all days of the week during school holidays as this was the time when the target population of public visitors was most likely to be present. In the first phase, 10 of the interviews were conducted during school term weekdays, 2 on each day of the week. All the interviews completed by the trainee explainers in the second phase were completed on one Sunday afternoon and differed from the first and third phases in that they were conducted at any part of a visit. For the trainee explainer interviews, written notes were made to record visitor responses. Audio-taping was not considered because of the logistics involved in getting 15 audio-tape recorders and it would have been impossible to find 15 separate quiet locations where audio recording would have been effective.

The rationale for gathering data over an extended period of time and using data from interviews by people other than the researcher was a form of triangulation to minimise possible bias by casting a wide net for information (Guba & Lincoln, 1989) . The data were not intended to be used for comparing visitors' reactions at different times or to different exhibitions, but to provide a broad, inclusive data base covering as many possible visitor reactions that can be reasonably expected in a study of this nature.

After the initial trial with seven people, all potential interviewees in phase 1 and phase 3 were engaged immediately outside the withdrawal area. Approaching prospective interviewees near the exit was a deliberate strategy because it was likely people would have been at *Scitech* long enough to experience a number of exhibits. In order to eliminate subject selection bias, every fifth person who passed between two particular exhibits was approached. If the person was accompanied by a very young child demanding their attention, then the next person who passed was approached. In the event of person declining to be interviewed the next person who passed between those particular exhibits was then asked if they would consent to an interview. When a group of people passed the whole group was asked to volunteer. Sometimes a whole family participated and on other occasions part of the group would consent to an interview while the other members continued their visit. On four occasions, a whole family participated and on seven other occasions part of the group consented to an interview while the other members continued their visit. Thirty seven interviews in the first and third phases were with individuals, although most (31) of those people had visited as part of a group.

Visitors were approached by the researcher introducing himself, explaining the purpose of the project and asking them if they would spare ten minutes of their time to answer some questions. The explanation of the project was put in the following way:

> We are seeking the visiting public's assistance with our planning by trying to establish the outcomes of a visit by the public to *Scitech*. In order to do this I'm looking for volunteers to help by answering a few questions that will take about ten minutes of your time. Would you please be able to help?

All persons approached except two agreed to participate in the first phase and only one refused in the third phase, so a high participation rate ensured a robust random sample. No details of the response rate to the explainer trainees was obtained. The same sequence of questions was followed in all interviews and on some occasions additional probing questions were used in order to get the respondents to talk about their experiences at *Scitech*. All third phase interviews were audio-taped and subsequently transcribed with the permission of the respondents. A verbal guarantee of anonymity was given.

When conducting the trial of seven interviews initially, it seemed visitors' responses were brief and superficial perhaps due to their state of distraction. However, when the tapes were subsequently transcribed and the data reviewed it was evident people were quite willingly relating their experiences, and had provided quite a deal of lucid information concerning their perceptions. Two possible factors may contributed to the mistaken perception. First, people could have been refocussing their thoughts after being very actively engaged immediately prior to the interview. Second, a typical experience involves only a brief exposure to a large number of exhibits and hence recalling specific examples may have been difficult.

Results

This section reports an analysis of all of the visitors' responses to each question. In addition, samples of visitors' comments are given to illuminate the analysis and to provide grounding and support for any assertions and propositions that are made. The average duration for the 48 phase 1 and 2 interviews was 18 minutes, and ranged from 11 minutes minimum to a maximum of 27 minutes. No details of the length of the second phase interviews by the trainee explainers were recorded.

Have you enjoyed your visit?

Multiple sources, including personal observations, discussions with *Scitech* staff, and conversations with visitors, had indicated people have a lot of fun when visiting *Scitech*. This question was used as an opening to each interview and was put in the form of a casual inquiry concerning each person's enjoyment of their visit. Of the 70 people interviewed, 69 (98.6%) people replied in the affirmative and the emphatic note in many of their voices indicated that was a true indication of their belief, and not just polite responses. The one person who didn't enjoy her visit attributed a severe headache she was suffering to the "overpowering noise level" at *Scitech*. People were asked to explain why they were enjoying their visits and all provided a reason.

While a majority of respondents, 48 (68.6%), gave the hands-on nature of the exhibits and educational emphasis as reasons for their enjoyment, there was often a combination of reasons. Two examples were:

> Yes. The whole idea is good. You can get your hands on and see how and why they [the exhibits] work. One thing that impressed me was how much electricity I was using in fluoros [sic], bulbs and the heaters [see Figure 4.8]. It has very practical relevance. (Female)

> Yes. Terrific! Everything is really very interesting as it stimulates the mind. I know a lot about how it works and it's good to see it in action. (Male)

The following two quotes typify those who referred to the participatory nature of the exhibits and educational benefits of their experiences. One person who lived in a rural area during her school years appreciated the practical approach to learning in science and technology. She said,

> Science I didn't enjoy. It always started as a theory. I lived in the country where there were no museums. The hands-on experience has made a difference. The hurricane exhibit gave experience and explanation like [sic] the principles behind it all. It's great as a place to learn something and an attitude change.

The other said,

> [It] makes it enjoyable because of the hands-on experience. *Scitech* hands it to you on a platter. (Male)

Figure 4.8. The Domestic Electricity Consumption Exhibit.

Another 18 people (26%) mentioned an element of excitement as the reason, or one of the reasons, for enjoying their visit. Two statements were:

> Just met up with my husband and sister during the visit. We all agreed to spend all day here. It is terrific and we're having a great time. (Female)

> Yeah [sic]. We thought it may have been quiet. I'd enjoy it more without the ten-year-old. He gets so excited I can't read the details and I get pulled away. The insects [exhibits] are a bit crazy looking. Each time we come there's been new exhibits and you're allowed to touch them. That makes a difference. (Female)

Fifteen others (21%) voiced social reasons for as the source of their pleasure. Three of those comments were:

> Yes, sure have. It's probably the hands-on things that is [sic] good to share with grand children. We can have some fun with them, with things you can have some control over. (Female)

> Good. It is a chance to talk to your kids and say "Look. This is how it works". My little daughter was interested in pulleys. It gave her a chance to have a hands-on approach instead of standing and looking. (Male)

> I enjoyed explaining things about what I'd learnt at school – why things happened. (Male)

The last two comments provide examples of teaching taking place at the exhibits.

The remaining group of comments were more general in nature. For example:

> That's a hard question as the whole place is fantastic. Everything is great. It's got something for everyone. You've only got to look at people to see the pleasure it's giving them. (Female)

Repeat visitors and their memories

Forty seven visitors (67%) interviewed had previously visited *Scitech* with the median being four previous visits and a maximum of 12. When the return visitors were asked for their memories of their previous visits they were all able to describe at least one exhibit. These varied greatly from a basic description of an exhibit to more complex descriptions of their experiences while interacting with exhibits. Examples of basic descriptions were "Gas, hot air balloon, electricity, and lung things" and "Chickens, echo thing, parabolic mirror, water works, shadow wall." Some people volunteered reasons for their remembering particular exhibits. An example was:

> Yes, the lungs. I was starting my degree as a mature age student and I found it really helpful for the basic science. Things like Bernoulli's principle [see Figure 4.9]. All the basics. (Female)

It is possible some people may have had their memories refreshed if they revisited those exhibits during their current visit. However, there were examples of people remembering exhibits that were no longer present. A "Special Effects" exhibition, that had been on the floor about six months before the first interviews, consisted of a number of exhibits designed to make people aware of the some of the techniques used for creating illusions in movie film production. Some interviewees gave responses that revealed they still retained clear impressions of their experiences while visiting "Special Effects." One male respondent said,

> I saw how make-up was put on to get certain facial features. I also remember making videos of walking through volcanoes. I saw myself walking up the side of mountain and falling down a cliff. All of it was quite impressive.

Five people gave responses that indicated they were able to remember details of experiences and exhibits over a long period of time. One person was able to recall accurately details of an exhibit she had seen during their last visit which had been "five or six years previously". She remembered the

> . . . optical illusion exhibit [see Figure 4.10] that had a room with a sloping floor with black and white squares that made our children of different heights look to be the same [height].

Another person remembered the "exhibit on eyes and nose, the imitation hurricane and eggs hatching" from their last visit three years ago. Some people did not describe specific exhibits but were able to described memories of experiences with exhibits. For example one person said,

> The last time my hair stood on end. We sometimes forget the simple things in life are quite enjoyable. There were very good displays. (Female)

One visitor was a social worker and as part of her job she brought a group of teenagers from a refuge to an exhibition. She remembered the social consequences of that visit.

> Just by being here they [the teenagers] were experiencing a lot of things. They talked about the things they've done. I noticed they'd talked about things they'd seen a lot.

Figure 4.9. The Bernoulli Principle Exhibit.

Figure 4.10. The Distorted Room Exhibit.

Four did indicate they recalled their memories of school science being refreshed but they did not elaborate. For example one male respondent said, "It shows basic laws of science and refreshes your memory from school."

It should be noted that only one example, the optical illusion room, indicates return visitors remembered any scientific principle, or concept, that an exhibit was designed to demonstrate.

Length of visit

All interviewees were asked to estimate to the nearest half hour an approximate time they had been attending the exhibits. The average approximate time supplied was one and a half hours with a range of one hour to four hours per visitor. The strategy of choosing a point near the exit for initial contact with potential informants had proved to be successful in allowing visitors a reasonable time to experience exhibits prior to their interview. The average time of visits by the interviewees contacted by the trainee explainers was similar however the range was half an hour to five hours. As the people interviewed by the trainee explainers were enlisted at any part of the exhibit floor, it would be reasonable to expect a number of visitors would be at an early stage of their visit. However, when the time of the phase 2 interviews is considered (Sunday, 3:30 pm), people would mostly be in the latter stages of their visit as most Sunday afternoon visitors tend to arrive early in the afternoon in order to get better value for their money rather than commencing their visit mid-afternoon (V. Dodds, personal communication, March 7, 1994).

Studies have shown that the time visitors spend in a museum is approximately one and a half (Falk, 1991) to two hours (McManus, 1992) . The findings of Falk (1991) , reported in Chapter 2, were that during a visit the most intense engagement occurred in the early part of a visit and tapered off rapidly during the visit. Hence, most of the interviewees in this study proved to be suitable subjects as they had experienced the intense interaction stage and would most likely be well into the browsing stage.

Did you have an interest in science and technology before your visit?

Fifty three interviewees (76%) indicated a prior interest in science and technology. Their level of interest ranged from "just a general interest" to a professional level, with 15 stating their interest was work related. Two teachers (husband and wife) who previously had a moderate interest in science and technology found their work requirements had put them in a position where they needed to take more interest and found *Scitech* to be a source of resources. The male teacher said,

> I have a small interest in science and technology. Both of us are teachers and one of our school priorities this year is science and technology. Materials are all available

> here that aren't in the primary school which has limited equipment. We'll be coming here for a school visit this year from Lake Grace [Approximately 350 km away].

One person attributed her life long interest in science and technology to childhood experiences in the interactive gallery in the *London Science Museum*.

> I was fortunate as I went to a hands-on science museum in London that changed my views of science and museums. It shows science in a different way for children. I was about nine and literally spent hours there. I was actually allowed to touch things. That was the appeal. I remember being entertained for hours on end, so that made quite an impression on me. It did to my brother and sister as well and going into a museum became fun. Being able to touch things and being able to make things happen made science fun.

Seventeen respondents (24%) indicated no prior interest in science and technology. However, 12 (70%) of those said their visit to *Scitech* had increased their interest. Typical responses of those with little or no interest in science and technology were:

> Not to any great extent. Just a general interest like most people. (Female)

> I don't take a lot of interest. The shows in the theatre are good. I haven't got time in a busy schedule to keep up. (Male)

Can you tell me something you have learnt?

At the time of formulating the interview questions, consideration was given to possible reactions to this particular question because respondents may have felt they were being "grilled" to regurgitate facts and become defensive. There were a few occasions when that did happen. Those who were hesitant or defensive were quickly reassured it wasn't a test and were encouraged to try and recall anything, but no cues were given. Sixty two of the 70 people (89%) were able to give at least one example of something they believed they had learnt. Those examples of learning indicated varying levels of cognition ranging from a brief description of something new, through recalling previous learning experiences, to applying their new knowledge to their own life. The main exhibition at the time of the first and second phases of interviews was based on insects commonly found in urban gardens. Advertising and promotional activities by the marketing department in *Scitech* had been focused on that theme. The comments of 18 out of the 48 respondents in phases 1 and 2 of the interviews indicated they believed they had learnt something new about insects as a result of their experiences at those exhibits. Two comments were:

> I've seen European wasps for the first time. I didn't know what they looked like or realise they were in Perth or how many were in the East. There is a lot of bugs. I learnt something new. (Female)

> Insects. I'm not really into insects so that was quite interesting. I learnt about mosquitoes, red back spiders, funnel web, the dung beetle.

During the third phase of the interviews, when the feature exhibition was "The Great Australian Treasure Hunt," 13 people related instances where they had learnt something about geology or the mining industry. One of the exhibits was an earthquake house that gave visitors a simulation some of the effects of an earthquake (see Figure 4.11). The simulation was set to an intensity comparable to that of the Newcastle (a city in New South Wales) earthquake. One person remarked that,

> It brought back memories of an earth tremor when I was in Rabaul, PNG, a few years ago and also gave me an indication of what happened in Newcastle a few years ago. (Male)

while another said,

> It was beautifully set up and it was something we'd never experienced before. As well seeing it on the TV in the room at the same time really added to it. (Female)

One respondent found one exhibit that demonstrated the principles of multiplexing (telecommunications system) that related specifically to his work and assisted him to understand a current problem he was facing.

> [I] have a salesman selling me a program that is to do with multiplexing and blow me down if there isn't a display here that explains it in words of one syllable. It's an old program but I didn't know it before. So next time I'll be far more knowledgeable in my dealings with him.

Another response was interesting because initially an adult male declared he hadn't learn anything then went on to recount how he'd learnt about stir thickening liquids.

> Not anything! I think it's quite clever, the way they have shown arthropods. In the lecture on slime I learnt about stir-thickening fluids.

If that response is any indication of other responses that may be evoked, then care should be taken when developing any method to detect learning in order to allow for an initial reaction that is defensive, dismissive, or not thought through. Some people may need to be given a variety of opportunities, or prompts, to demonstrate they may have learnt something.

Figure 4.11. The Earthquake Room Exhibit.

Ten respondents related a view of their experiences at *Scitech* that indicated they saw it as a "refresher" course in basic science. Two examples were:

> Probably nothing that I hadn't learnt at school but it was good to recapture it. (Male)

> No. I don't think so. More a question of practising stuff you know about already with models of stuff like lungs and gear wheels with connecting rods and mechanics. It makes it all accessible. (Male)

Two people indicated they had learnt something which they intended putting to practical use by making things for use in their own home life. Two examples were:

> The chicken drinker had an inverted coke bottle. I will use that for my hens. (Male)

> I'm now going home to build some fly traps. There are a lot of insects in Brunei where we live. I'll be able to catch them without chemicals and that will be safer for our child. (Male)

One person was able to link the information from an exhibit to a medical condition he had and to gain a better understanding of his anatomy.

> I found out where a pace maker goes. The ear, I've been having trouble with my ear and now I know where all the little bits are (Male).

Another person found an exhibit assisted with a new hobby she was pursuing. She stated,

> I am beginning to learn about sailing into the wind and the exhibit that modelled sail adjustment and wind direction helped me understand more (see Figure 4.12).

One person was effusive when describing her experiences and her response identified some additional points, other than learning, about outcomes of visits. She described her perceptions of what she had learnt with the following statement.

> Lungs. I enjoyed that. It's a funny sensation going through all that. I pointed out to my husband he shouldn't be smoking. It was just seeing everything working that was tremendous. The part where you put your name, age, and weight and I've just been told I'm slightly underweight. That's just me. Insect part was good as we could get close up and the size of various things showed a lot of details. The insects we've imported seem strange, for example the dung beetles. I think it'll be good for school kids. I'll be going home and telling my two girls (about 18) to go to *Scitech*. My sister-in-law and husband are taking their time. It's a thing for everybody and shows what women can do. It is good that girls can see they are able to participate.

Figure 4.12. The Sailing Against the Wind Exhibit.

Her statement is revealing in that it gives an overarching view of the complexities of a visit experience and reveals that learning in an informal environment could not readily be assessed by the traditional means of post experience testing in the cognitive domain. Her statement clearly indicates that sensory impressions given by an exhibit add an extra dimension to a visitor's learning. She commented on the strangeness and
the enlargement of some of the insect exhibits and referred to the sensation of walking through a working model of a lung. Her reference to the inclusiveness of the exhibits would give support to a notion that ISTCs address an issue of access and equity for all people to have an opportunity to participate in science and technology. Further, she provided more evidence that people personalise their experiences by relating those experiences to something in their lives. In this instance it was her husband's smoking, and her weight. Her statement also reveals an intention to recommend to others they visit and it also implies it would be beneficial because the experiences offered are not threatening and are inclusive.

Which exhibit did you like the best?

This question was asked in order to establish what people could remember about specific exhibits and to seek to identify any intrinsic or extrinsic features of an exhibit prompted those memories. All 70 respondents were able to identify at least one exhibit they favoured although some were unable to select any particular one. A considerable number of respondents, 17 (24%) felt it was difficult to single one out above the others as all they had seen were good. Two typical comments were:

> That's a hard question as the whole place is fantastic. Everything is great. It's got something for everyone. (Female)

> [I'm] fascinated by them all. And the shows that are going on. I always go back and see them again. (Male)

Forty three people (61%) described more than one exhibit. For example, two responses were:

> I liked the electrical ones with sparks. The voltage show was absolutely fantastic. Light was fantastic, a lot of the others [were] too. The chickens was a good exhibit. They are living as it's happening and you see the development. (Female)

> Chickens hatching, hearing one. It wasn't recent technology. It was using something that exists. I liked the crystal, the way in which it was melting down and reforming. My niece and nephew liked playing couriers and the drawing board. (Female)

Ten people (15%) gave replies indicating their reason for a favourable memory of an exhibit was due to personalising of their experience. Two responses were:

> Lung one. When we were smoking, the first few times we visited we refused to go in. We always play on the reaction machine. The boys try to beat Mum. (Female)

> The operation of the heart and ears and relating it to my own body. Just seeing it how it as it really is. (Male)

One person gave an answer "Waterworks near the door – simple complexity" which appears paradoxical or perhaps convoluted. However, if it is regarded in the oral context of the interviews it indicated an appreciation of an exhibit, which on first impression can appear to be complicated system for producing sound using water but actually utilises a series of basic mechanical devices.

Which exhibit did you like the least?

Fifty two visitors (74%) did not identify any particular exhibit that was unfavourable to them. Some typical comments by these people were: "No, all interesting" (Female), "All fascinating" (Female), and

> All good. I hope they never cut the funding for a place like this as kids are able to understand things. (Male)

In seven instances (10%) maintenance faults with some of the exhibits were more a source of frustration rather than dislike. Two examples by males were: "The Woodside video [an exhibit about oil drilling] didn't have sound" and "[There were] a few out of commission."

Only nine (13%) of visitors specified a least liked exhibit. Not being able to successfully manage their experiences while interacting with an exhibit was the main reason people gave. Two examples were:

> [The] sound dishes [exhibit is a] bit hard to figure if it's working due to distractions. Unless it's obvious kids lose interest. (Male)

> The radar gun. Our ten-year-old couldn't get the minimum speed for it to register so they he got frustrated. (Male)

One person wasn't sure whether she disliked any exhibit. She said:

> The touch screens didn't hold me for long. I'm not attracted to them [computers] so I don't know if I like them or not.

What do you think of science and technology after your experiences here?

One of the underpinning goals of *Scitech* is to impart a positive science and technology message on the public of Western Australia. Thirty seven respondents (53%) indicated their views on science and technology had changed favourably as a result of their visit. There were no reported instances of people having changed their views to a less favourable status. Fifteen people (21%) referred to their prior experiences at school as having limited, or even been detrimental to, their views of science and technology. They claimed their experiences during their visit to *Scitech* had altered their perceptions of science and technology. The following examples typify those claims:

> I have definitely changed my views and I wish when I was at school it had been presented in such an interesting way. Maybe it was and I wasn't interested. Now I find when I go to the shows I'm listening and trying to remember things about it. (Female)

> You can present basic principles in ways people understand or don't understand. It can be inclusive or exclusive, and inclusive is not how science is taught in schools. My experience in schools is that teachers do not explain well. Here they have presented complicated concepts in a simpler way. It puts science in inclusive ways and makes complex concepts simpler as opposed to schools. Seeing is believing and having it explained to you while it is happening makes it realistic. (Female)

> I liked physics at school but it wasn't taught well, so here is a chance to put it right. (Male)

Eleven people answered the question by indicating that they may be stimulated to do something as a result of their visit to *Scitech*. There was a range of possible actions, both in the work-place and in domestic situations. One statement, by a primary school principal, relating to her workplace, also raised the issue of the image of science and stereotyping of scientists. She said,

> I'll probably ask more questions and I may understand more processes. I saw some ideas for the primary classroom. I think science is poorly looked on by Australian society, for example, the 'mad professor' image. *Scitech* helps overcome that image.

Another person, who was a manager of a company, was prompted to develop a submission to gain approval for investing an additional eight thousand dollars in upgrading computer equipment. He stated,

> I don't think that I'll do anything different. I'll certainly be able to understand a few things better. Now I know I'll have to prepare a case to put to the board for $12000 instead of the $ 4000 the committee had set aside in its budget. I'll make decisions based on knowledge picked up here today.

One person indicated he intended to replicate an exhibit for his own use. He said,

> Well I'm in the building game and the organ near the door you could build it yourself. It's not my own idea but I could build it myself.

Five people indicated a heightened interest in science and technology had resulted from their visit. One person claimed,

> It's bound to change. Being able to play with hands on materials makes you feel more familiar with science. I'm [now interested] in knowing more. (Female]

while another said,

> It made me more interested. I never bothered with science at school. This [visit] has made it easy to look at simpler explanations. (Female)

One person reported an increased awareness of science and technology when she stated,

> A visit makes us more aware of science. You see things from day to day and this reminds you of how they work.

Nine people said their views of science and technology would change, but they either did not know how, or they were unable to articulate specifically how that would happen. "I guess it would although I'm not sure how" (Male) was a typically vague comment. Prompting for additional information by asking them to elaborate did not evoke any clarification.

Do you think there may be something you will do as a result of your visit to Scitech?

This question was asked to try to identify what people may intend do if they had been motivated by their experiences. Twenty three people (33%) said they intended to do something, with 11 of those saying they would watch more TV shows particularly documentaries that were about science and technology. One person said,

> Maybe watch more science and technology shows. I've always watched "Beyond 2000." I'll probably watch some others now. (Male)

while another stated,

> I like to watch general TV shows like "Beyond 2000" and "The Bush Tucker Man." The visit here will make me interested in watching more shows like that. (Male)

Two people indicated some things they had seen could be translated into their workplace. One, a primary school teacher, said he would "Use some ideas in the classroom as it [the visit] gave me some ideas." The other was the manager who stated he would be upgrading some computer equipment.

Five primary school teachers said they intended to bring their classes to *Scitech*, and the principal of a small rural primary school said he intended to organise for a whole school visit.

Four people indicated they intended to do some reading that was science related. One said he would "probably start reading more about science." Another said she found that an increased interest may stimulate an intention to do some research.

> I'm more interested in the heart, ears and lungs – especially the ears. I'll look that up.

Seven people indicated they would buy something at the science shop on their way out, while nine said they would recommend a visit to other people. One person said he would "breed some chickens for my children to watch." One person said he would join Scitrekkers – a special *Scitech* club that offers significant discounts for visits and special science related activities. One said she would be more careful with her domestic energy use as she was now "more conscious of electricity consumption." Two people indicated that, although they mightn't actually do anything, they had a heightened interest in science and technology. One said,

> [The visit] has made me more interested. I never bothered with science at school. This has made it easy. Just look at the simpler explanations. While there is nothing specific I think I'll do I'm sure there are things I'll subconsciously remember that will help me later. (Male)

Do you intend to return to Scitech?

The reason for asking this question was to get some indication of whether people were satisfied with their visit and if they had been stimulated enough by their experiences to spend more of their leisure dollars on revisiting *Scitech*. It was hoped it would give people an opportunity to provide further comments about their general perceptions of their visit.

All except one of the visitors residing in Western Australia indicated they would probably return to *Scitech*. The person who was the exception said, "Yes. I might if I had time, but I'd prefer to go shopping." There were five tourists, two from interstate and three from overseas and all these said they would visit an ISTC again when they had an opportunity. One said, "Yes, I'd go to the one in Adelaide, my home town. There is so much to see and so much to learn." The responses indicated almost all regarded their visit as being a worthwhile experience. Some were quite emphatic:

> Yes without a doubt. Why? I can't see it all today. I'll bring the grandchildren to really enjoy themselves. (Male)

> No doubt! As kids get older they get different experiences that suit them at that age. (Female)

> Definitely! Both kids and myself. Our two-year-old enjoys the sounds. (Male)

Others interviewees were less emphatic but did make it clear they intended to return. Two examples were:

> [It's a] wee bit expensive. Every six months or so. (Male)

> Probably, but not regularly. I'd come again to bring someone else to show them. (Male)

The answers fifteen people (21%) gave do suggest that some people's agenda for a return visit would now include learning. Two examples of explicit learning intent were, "Yes, to learn something we didn't know before" and "Yes, to learn something new." One answer, which implied learning would be an important part of the reason for revisiting was

> Different things to see and do. Like to be able to look at things in depth. (Female)

Another interviewee made it clear that learning would be on his return visit agenda and in order to accomplish that he would leave his children at home so he could be freer to interact with exhibits of his own choice. His response was;

> Yes, its stimulating – gets you thinking. I would come back without the children as they are young and kept demanding my attention.

There were also twelve people (14%) who gave benefits for children exclusively as a reason for their revisiting. Two examples were "Good for kids because they can touch the exhibits" and "I'd encourage my two daughters to come along". Five other people (7%) gave comments that made it clear parents felt the enjoyment factor was beneficial to their children and would help with their attitude towards science and technology. Two of the comments were: "The hands-on approach helps kids' attitudes" and

> Yes. It's something different and we will come back every six months because the boy enjoys it. (Female)

A total of six primary school teachers had been visiting individually to assess whether bringing their school classes to visit would be worthwhile. They all indicated they would be bringing their classes. One of these also indicated she would return because of social benefits for her family. She responded,

> Yes, because I've incorporated it as part of my job and I will also bring my grandsons at another time. [It's] a great social outing and I like the experiences.

Suggestions for improvement

To commence closure of the interview, people were asked for any suggestions that might make *Scitech* a better place to visit. The purpose of this question was to provide *Scitech* staff with some feedback and get additional information about visitor satisfaction to use as confirming or disconfirming evidence when cross referenced with other statements. As 45 people (64%) said they didn't have any suggestions, this would indicate a high level of visitor satisfaction. Two examples were:

> As it is *Scitech* makes science and technology more accessible. It gives a chance for my children to have access to it. I think it's excellent. The guides are excellent. Some of the things I read I need help with so more guides would help. Two years ago they had a mother daughter thing. Everyone I spoke to found it great. For both parent and child it's accessible hands on. (Female)

> Not really. It's got a bit of everything. It caters for all ages, right from babies to older people. I'm converted. (Female)

Alleviating the excessive noise level on the floor attracted the largest number (13) of suggestions for improvement. One person made clear his view of the level of noise when he said, " [The] noise is annoying. [I] have to talk at force 10."

There was one other main area the public suggested should be improved and that was to control the number of people trying to access exhibits so people got equal opportunity to use. One male interviewee described it as a "feel of chaos with a lot of people" and suggested there should be a "means by which people can have their turn at exhibits." Although 11 people identified this as being a problem, seven of those added a proviso to their statement which indicated they believed that it still was a good place to visit. No one was able to suggest any method for more orderly access to the exhibits.

It would seem that for five people their visits would be "better without kids" and with one of them even suggesting an improvement would be to "ban kids." While both the comments may appear facetious there was an element of frustration in the adults' demeanour that would indicate they would have appreciated a visit without having to contend with either their own children, or those of others.

The three areas of suggestions by the public were passed on to the management staff at *Scitech*. They were aware of the noise factor being a problem and were considering ways of dealing with it. A low ceiling in the building made solutions difficult and expensive. Any attempt at controlling access to exhibits would run counter to *Scitech's* basic philosophy of an open floor plan with people being free to wander in any direction and choose any exhibit to interact with. With regard to the suggestions that kids be banned, the feasibility of advertising "a couple of kid-free days so adults can be free to experience a visit as they wish" was to be discussed by *Scitech* management (V. Dodds, personal communication, December 12, 1994).

The closure of the interview was to ask people if they could think of any other question the researcher could have asked them that would enable them to disclose any further information about their visit. Not one of the interviewees made any further suggestion and it was concluded that the existing questions encompassed all possible avenues for gathering information in a one to one interview.

Summary of the Results of the Interviews

The purpose of interviewing a sample of visitors was to identify their perspectives of their visit. The information supplied by those visitors was used to establish a list of general outcomes of visits as seen by those visitors. In addition, a data bank of visitors' statements about their visit, using visitors' language, was developed. These statements were for future use in final questionnaires and for immediate use in developing a post visit questionnaire. A summary of categories of outcomes, developed from visitors' responses, is provided. These outcomes were identified by widely varying numbers of people and do not necessarily apply to every visitor. At this stage of the study the outcomes were regarded as possible broad outcomes, the extent of which is to be explored later. They were: enjoyment, social experience, learning, applications, motivation, attitude shift and change of views.

The most frequently supplied outcome was the enjoyment people experience while visiting. They believed that science is presented in a manner that is exciting and interesting and for some this changes the image of science. Some mentioned that the social experiences for families enhanced their enjoyment.

It was also clear that some people believe they do learn something new and that the learning does occur on different levels. It is also clear that for people who have visited before, memories of experiences and exhibits remain and some are able to cite evidence of long term memories. Others indicated a raised level of awareness of science and technology, particularly in relation to themselves and their everyday lives.

Some people indicated what they saw and experienced had a practical value and provided them with ideas for future use in their work, hobbies and studies. These applications included building items based on scientific principles they had experienced, purchasing computer software and using information in school projects. Some also said they intended purchasing a microscope from the *Scitech* science shop.

A number of visitors indicated an increased interest in science and would now be motivated to read more about science and watch science related TV programs. There were also indications people believed they would think about science and technology more often. Almost all said they would revisit *Scitech*.

There were clear indications of a shift in attitudes as some people stated they were more favourably inclined towards science and technology. None said they were less favourably disposed. This was particularly the case when people had previously been "turned off" science as a result of adverse experiences at school. They saw the experiences provided by *Scitech* as addressing the issue of access and equity in science and technology.

Collectively, the informants for the interviews proved to be a rich source of information. The information they generated showed a wide variety of experiences and anticipated outcomes. People readily volunteered for interviews and were quite willing to provide whatever information they could. By using a large number of subjects from the visiting public and many of staff of *Scitech* who dealt directly with the public, trends were able to be identified and checked. As well, the strategy of using focus groups allowed the congruence of views of different groups associated with a visit experience to be tested.

These broad outcomes developed provide the framework for developing a questionnaire to be administered after people had time to assimilate their visit experiences. The third stage of this study, which concerns the PVQ; its development, its field testing, and the analysis of data it provided, is reported in the following chapter.

CHAPTER 5

STAGE 3: THE POST VISIT QUESTIONNAIRE

Overview

In this chapter, the steps involved in developing the Post Visit Questionnaire (PVQ) are outlined, followed by the procedures used for collecting the data. The analysis of the data collected about each of the items is then reported together with a discussion about the results.

Background

Considering the large body of research concerning ISTCs, it is surprising that so little has involved visitors after they leave the premises. In the research that has been conducted, the techniques for data collection have been instances of interviewing by phone calls after visits (White, 1990; Schibeci, 1992) , some interviews (Stevenson, 1993) , written responses in essay format (McManus, 1993a) and structured questionnaires (Johnston, 1995; Stevenson, 1993) . These were reported in detail in Chapter 2.

The model adopted for this stage of the study was the approach employed by Stevenson (1991) who used an instrument consisting of seven items intended to prompt written statements about people's post-visit memories. The intention of the PVQ was to provide written responses from visitors which could be used to develop the final two instruments, the PVII designed to be administered at the point of exit, and the PVOI designed to be administered some time after the visit. The kind of instrument used by Stevenson was considered to be the most effective for gathering data to be used for developing instruments based on written prompts.

Construction of the Pilot PVQ

Development of the Items

Written data from voluntary visitors were required for developing items for the final two survey instruments for two reasons. First, written comments on the visit outcomes needed to be from the visitors' perspective (Aikenhead, 1988) . Second, the language and style of the items needed to be those of the visitor and not those of the researcher (Lederman & O'Malley, 1990) .

The PVQ was designed to catch a wide range of written comments so an open-ended format was used for most items. For some items, a mixture of closed and open-ended formats was appropriate. Any closed items were followed by a related open-ended item so that respondents were encouraged to elaborate on their responses. Most of the items were sourced from the interview data and reflected the broad outcomes that were identified after it was analysed. They were: enjoyment, social experiences, learning, applications, motivation, attitude shift and change of views. All the items on the PVQ were developed by the researcher and given to colleagues for critical comment. The purpose of each item is explained in the results section reported later in this chapter.

Once the items were selected, they were presented in a format that allowed plenty of space for writing to encourage multiple and lengthy responses. The 11 items on the pilot PVQ were:

Item 1. Please write **three words** that you think best describe your own experiences at *Scitech*. Please give your reason for writing each word.

Item 2. Did your visit help you **understand** something that has helped you with:

a) your work or study?

b) your general thinking about everyday events?

c) your leisure/entertainment/hobby?

d) an issue to do with science and technology?

Item 3. Can you give me an example of something you are now **doing** (or have done) that was a result of your trip to *Scitech*?

Item 4. Which exhibit did you like **best**? Please explain what you liked about it.

Item 5. Which exhibit did you like the **least**? Please explain what you did not like about it.

Item 6. Would you please indicate your level of **interest** in science and modern technology before and after your visit to *Scitech*?

Item 7. Would you please indicate your level of **awareness** of science and modern technology before and after your visit to *Scitech*?

Item 8. If there has been a change of your **ideas** about science and modern technology as a result of your visit to *Scitech* please describe how they have changed.

Item 9. Do you think your visit to *Scitech* was **worthwhile**? Please give your reasons.

Item 10. What other **comment** can you make about your visit to *Scitech*?

Item 11. Would you please provide us with some **details about yourself** to assist in this study.

There were mixed response formats used with most items requiring open-ended responses. Some items used part open and part closed formats. For instance, when responding to Item 2, visitors were required to indicate a "Yes" or "No" to each of a, b, c and d. If they indicated "Yes" they were then requested to provide additional written information. Two items sought closed responses only. Items 6 and

7 were placed into a grid where respondents indicated their position on a five point scale. Item 11, placed last on all the PVQs, sought the following characterises of respondents: sex, age group, occupation, level of education in science, and whether English was their first language. The pilot PVQ was given to two experienced educational researchers and the Manager of Education at *Scitech* for critical comment. No suggestions for change were made. The pilot PVQ instrument is shown in Appendix 5-A.

Pilot PVQ Field-test

Method

Subjects

The pilot PVQ field-test was conducted with a group of specially targeted visitors to *Scitech*. They came from the group of visitors who were the 28 participants in the first phase of interviews and from some of the people who had accompanied them on their visit. At the time of the end of the interviews, each person was invited to participate further in the study and all agreed. They were also asked if there was anyone accompanying them who would also be willing to participate. This method identified 50 potential respondents of whom 36 returned the pilot PVQ, a response rate of 72%. A demographic breakdown of their sex, ages and background in science (see Table 5.1) revealed similar characteristics to the randomly selected participants in the main field-test reported later. Their occupations proved too diverse to classify and all spoke English as a first language.

Procedure

All volunteers were asked to assist by answering a questionnaire that would be posted to them about 3 weeks after the visit. No clear indications of the content of the questionnaire were given in an effort to avoid cuing respondents. The only comment made by the researcher was that it was a project to help *Scitech* in serving its visitors. Only after the volunteers had agreed to participate, were they offered an incentive of a free pass to *Scitech* for completing the pilot PVQ. Details of their names, addresses and contact telephone numbers were recorded for the purpose of future contact and an assurance of confidentiality about their personal details was given (see Appendix 5-B). A pilot PVQ, a covering letter (see Appendix 5-C) and a reply paid envelope were posted in time to reach each volunteer during the third week following a visit. Once the completed pilot PVQs were returned, a free pass to *Scitech* was posted to the respondents. Later in the study, the group of 36 who responded were approached to further assist by participating in two focus groups, one of which contained some follow-up investigation about the effectiveness of the PVQ.

Table 5.1
Demographic Characteristics of Respondents to the PVQ

Demographic	Pilot Field-test		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male	17	47	43	37	60	39
Female	19	53	74	63	93	61
Total	36	100	117	100	153	100
Age (years)						
11 - 12	4	11	6	5	10	7
13 - 17	3	8	7	6	10	7
18 - 25	2	6	9	8	11	7
26 - 35	4	11	12	10	16	10
36 - 45	9	25	34	29	43	28
46 - 55	10	28	35	30	45	29
56 +	4	12	14	12	18	12
Total	36	100	117	100	153	100
Education level						
Pre-secondary	10	27	16	14	26	17
Secondary	10	28	65	56	75	49
TAFE	5	14	15	13	20	13
University	11	31	21	18	32	21
Total	36	100	117	100	153	100

When the demographic data for the pilot field-test respondents were analysed, an unintended group of participants emerged. This group comprised school-aged children, who had been part of some the visiting groups and had returned completed pilot PVQs. Seven (17%) of the respondents in the pilot field-test were aged between 11 to 17 years of age. The data they provided were useful as they gave an insight into the outcomes of voluntary visits for school children and provided an extra dimension to the scope of the study. For instance, some remarked that the visit had increased their motivation in school science. Consequently, the 11 to 17 years age range was included in the sample populations for the following investigative stages of this study.

A pattern in the timing of the returns of the pilot PVQs began to emerge. Almost all returns were received on a Monday or a Tuesday indicating people were most probably completing their questionnaires on a weekend and posting them either on a Sunday or Monday. This pattern held for both the first and second weekend after the PVQs had been mailed out. The pattern had implications for the timing of future mailing of questionnaires to potential respondents so they would be completed at a time preferred by the researcher. If, for example, this researcher wanted a questionnaire completed two to three weeks following a weekend visit then it would be best posted to reach a potential respondent at least two days before the second weekend following a visit. That way, it was hoped the potential respondent, given the advance warning, would organise for some time to be available for completing the questionnaire during their leisure time on a weekend. That strategy for the timing of mailing out survey instruments was followed throughout the study and the pattern of returns proved to be consistent.

Results

Most of the items yielded rich data, so the pilot PVQ was capable of achieving its objective in obtaining written data reflecting visitors' reactions. However, the two items about the best and least liked exhibits did not prove fruitful and they were dropped from the PVQs for the main field-test. The data generated by the remaining items in the pilot field-test were pooled with the data from the main field-test (description to follow) and the results from the analysis of data supplied by all versions of the PVQ are reported in the main field-test section.

Participant Review of the Pilot PVQ

One of the reasons for conducting the first visitor focus group was to review the effectiveness of the pilot PVQ following its field-test. Full details of the structure and procedure for conducting this focus group were given in the previous chapter and will not be repeated here. The first two questions put to the first visitor focus group were pertinent to the PVQ and they were asked before the questions relating to the explainers' perceptions. They were: "Is there anything you have thought of since that you didn't include on the PVQ?", "Did the PVQ allow you express the experiences of your visit?" Once discussion began, open-ended questions were asked to elicit extra details. "Can you tell us more about that?" and "Why do you say that?" and "Would you have liked to have one (an explainer) to help?" are some examples. During this focus group it quickly became evident people could still remember details of their visit. Initially, they all indicated they had provided all the information about their visit on the PVQ and they could not add to it.

One participant remarked that two of the items (one about ideas and the other about issues) seemed to be asking for the same information but added that it was probably satisfactory to keep it that way as it made her think again about what she had written. Two of the others agreed it did seem repetitive but they did not regard it as a problem. At that point, all agreed that items on the instrument allowed them to express all they wished about their visit. However, further discussion revealed some additional useful information.

As the session progressed, some of the participants mentioned how they discussed their visit. One participant, a school-aged female stated how "they had talked about the visit all the way home in the car." Another couple (mother and school-aged son) related how they disagreed with the information provided by the graphics accompanying the exhibit. After discussing the matter at the exhibit and on the way home, they had searched a data base using their own computer to check on the information and the son revealed that, "*Scitech* had been right." During the session the subject of explainers and their perceptions of visitor learning was raised. It was immediately evident none of this focus group had experienced any contact with the explainers. Consequently, items relating to visitors' discussions both during and after their visit and about contact with explainers were developed for the PVQ used in the main field-test.

Main Field-test

Method

Subjects

There were 117 voluntary visitors to *Scitech* who participated in the main field-test of the PVQ and their characteristics of sex, age and education in science were generally similar to those of the participants in the pilot PVQ field-test (see Table 5.1). Again their occupations were very diverse and there were no categories to indicate whether respondents' worked in science-related fields. That item in the demographic data was subsequently discarded. Although there was only one respondent who did not have English as a first language, the item was retained for the PVII when data were collected from ISTCs other than *Scitech*.

Procedure

The main field-test of the PVQ was conducted about four months after the pilot field-test. Some modifications were made to the PVQ as a consequence of the pilot field-test and the first visitor focus group. The two items about best and least liked exhibits had been discarded as a result of the pilot field-test and four further items were added. The four items were:

Item 12: Did you discuss any of the exhibits with anyone else **during** your visit? If yes please describe your discussion.

Item 13: Did you discuss your visit experiences with anyone else **after** leaving *Scitech*? If yes please describe your discussion.

Item 14: Please list the three things you **remember** most clearly about your visit to *Scitech*. Please explain why you remember these.

Item 15: Did you have contact with a **Sciguide** (an Explainer) while looking at the exhibits during your visit. If yes, please describe the nature of that contact.

The first and second additional items sought information about visitors' discussions during and following a visit respectively. The third additional item prompted visitors to identify and describe three memories of a visit. This item arose out of the literature about memories of visits to ISTCs (Falk, 1988; McManus, 1993; Stevenson, 1991) . Originally it was not included in the pilot PVQ, because of criticism of contamination of data by cuing respondents for their memories of visits (McManus, 1993a) . As the first item on the pilot PVQ had prompted respondents for the first three words that best described their experiences while visiting, a subsequent item about memories may have confused respondents and perhaps contaminated the data about memories by cuing. The item requesting three memories was placed at the beginning of 70 copies of the main field-test PVQ, where it would be most likely to generate uncontaminated data. The item about the three words that best describe a visit was not included on those 70 copies. The fourth additional item sought information about visitors' contact with explainers. All the other items were retained.

Altogether in the main field-test, 140 copies of the PVQ were distributed. In an attempt to shorten the PVQ, as the pilot PVQ was several pages long, two shorter versions were prepared. All of the items, except two, were split between the two versions of the PVQ with each version being sent to 70 potential respondents. The exceptions were Item 6 and Item 7 from the pilot PVQ about interest and awareness in science and technology where quantitative data were required for statistical analysis. These items were common to both versions of the PVQ that were distributed for the main field-test. The two versions of the PVQ, labelled A and B, are given in Appendix 5-D and 5-E.

The strategy of lessening the number of items on the PVQ was adopted in a bid to increase the amount of data prompted from each respondent because it was hoped they would spend extra time in attending to each item. However, a visual scan of the responses on the returned copies revealed this strategy did not work. It seems more likely that it is the nature of the item itself that determines the quantity of data. For example, the reasons given for the three things people remembered most clearly about their visit tended to be lengthy and rich in information while the reasons visitors suppled for choosing the first three words to describe their experiences usually invoked only short phrases.

All subjects in the main field-test were randomly selected by the researcher on the exhibit floor following the same procedure used for the interviews with visitors. Most wanted to know what was involved. It was then explained that it would probably require about 20 minutes of their time to complete a questionnaire to be posted to them about two to three weeks after their visit. Most agreed (9 out of 149 declined) and they were then asked to complete the same form as the respondents to the Pilot PVQ (see Appendix 5-B) providing their contact details. The form contained a written assurance of confidentiality of their contact details. It was only after they provided their contact details that an offer of an incentive of a free pass to *Scitech* for returning a completed form was made. They were also asked if there was anyone else visiting with them and whether those people may be willing to assist by completing a PVQ. The pilot field-test had indicated there would be sufficient school-aged respondents generated by this procedure. The recruitment process was repeated until a total of 140 potential respondents were identified. This figure was based on the response rate of 72 percent for the pilot field-test which, if maintained, should yield approximately 100 responses. Hence, 50 sets of data for each of the items on the two different PVQs used in the main field-test and 100 sets of data for the item about interest and awareness of science and technology were anticipated. The procedure for posting of the PVQs and the free pass was the same as in the pilot field-test. However, in the main field-test – unlike the pilot field-test – follow-up letters (see Appendix 5-F) were sent to 47 people who hadn't responded after one month following the posting of the PVQ. The follow-up letters produced another 14 completed PVQs giving total of 117 responses for the main field-test of the PVQ – a final response rate of 83%.

Data Analysis

Data from each administration of the PVQ are combined for each item. Results are reported on an item by item basis, beginning with the item's purpose, then a summary of the results is provided followed by a discussion. The number given to items varies across the versions of the PVQ, of course, so the wording is included to identify each item. Demographic details of the respondents to individual items are given in Appendix 5-G. A code is used to identify the demographic details of the respondents who supplied statements that are cited when reporting the results of the PVQ. For sex it is male (M) and female (F). Ages groups in years are 11-12, 13-17, 18-25, 26-35, 36-45, 46-55, and 56^{+}. The categories in science education were based on levels of education in science. They were pre-secondary (P), secondary (S), technical and further education or polytechnic (T) and university (U).

Item 1: The Best Three Words Describing Visit Experiences

Purpose

This item required people to list three words that best described their own experiences at *Scitech* and then to provide the reason for giving each word. It was designed to elicit adjectives describing visitors' perceptions about their visit to *Scitech* to provide the data base from which items could be developed for the semantic differential format used in the PVII. By requesting respondents to provide a reason for each word it was hoped to clarify meanings different people may ascribe to individual words. Those meanings could then be used as a basis for grouping words into intuitive domains. In addition, the reasons people supplied for giving each word would provide extra statements for possible use in the PVOI.

Results and discussion

Data were collected from 98 respondents, all of whom supplied three words giving a total 294 responses resulting in a bank of 64 different words. However, not all respondents supplied reasons for choosing each word. Twenty two words were given more than once and accounted for 85.7% of the responses. These are shown in Table 5.2 with each of the 22 words ranked by frequency of choice. The remaining words that were supplied once only are shown in Appendix 5-H.

The written statements were almost invariably short, with an emphasis on description rather than indications of reflective mental processing of visitors' experiences. Some examples of reasons given with the most frequently supplied words are provided later in this section. It was possible however, to intuitively assign all of the words supplied to three broad categories. The first category includes words that can be related to enjoyment (for example, fun, interesting, exciting); the second includes those related to mental activity (for example, educational, informative, understandable); and the third includes those related to the physical environment of their visit (for example, busy, active, colourful, noisy). The first two categories were not mutually exclusive as some supporting statements indicated a strong link between the cognitive and affective domains. A typical response was:

> It allows you to experience hands-on activities that are fun and teach you something at the same time. A brilliant way of making education more fun. (F, 36-45, T)

This finding provides evidence in support of McManus (1993b) and Wellington (1990) who asserted that visitor affect and cognition are "firmly integrated" (McManus, 1993b, p. 108) in the context of museum communication.

It is worth noting that although fun was the word most frequently given overall, it was not the most popular first choice. Interesting (19, 19.4%) was clearly the most frequent first choice, followed by educational (12, 12.2%), informative (10, 10.2%), exciting (7, 7.1%) and stimulating (6, 6.1%), all ranking ahead of fun (5, 5.1%).

Table 5.2
Frequency of Words Used to Best Describe a Visit to *Scitech*

Word Used	Total Citations		First Choice		Second Choice		Third Choice	
	n	%	*n*	%	*n*	%	*n*	%
Fun	38	12.9	5	5.1	18	18.4	15	15.3
Interesting	35	11.9	19	19.4	9	9.2	7	7.1
Educational	34	11.6	12	12.2	15	15.3	7	7.1
Informative	24	8.2	10	10.2	5	5.1	9	9.2
Stimulating	18	6.1	6	6.1	7	7.1	5	5.1
Enjoyable	16	5.4	3	3.1	7	7.1	6	6.1
Exciting	15	5.1	7	7.1	4	4.1	4	4.1
Fascinating	10	3.4	4	4.1	4	4.1	2	2.0
Busy	9	3.1	3	3.1	2	2.0	4	4.1
Inspiring	9	3.1	3	3.1	4	4.1	2	2.0
Worthwhile	6	2.0	3	3.1	3	3.1	0	0.0
Noisy	6	2.0	3	3.1	2	2.0	1	1.0
Experimental	5	1.7	2	2.0	1	1.0	2	2.0
Intellectual	4	1.4	2	2.0	1	1.0	1	1.0
Variety	4	1.4	1	1.0	2	2.0	1	1.0
Colourful	4	1.4	1	1.0	1	1.0	2	2.0
Active	3	1.0	2	2.0	1	1.0	0	0.0
Superficial	3	1.0	1	1.0	2	2.0	0	0.0
Knowledgeable	3	1.0	1	1.0	0	0.0	2	2.0
Understandable	2	0.7	2	2.0	0	0.0	0	0.0
Attractive	2	0.7	1	1.0	1	1.0	0	0.0
Learning	2	0.7	1	1.0	1	1.0	0	0.0
One citation	42	14.3	6	6.1	8	8.2	28	28.6
Total	294	100.0	98	100.0	98	100.0	98	100.0

The three most frequently supplied words are analysed in some detail to give a sample of the reasons people provided for supplying them. There is a natural cut-off in frequency between educational and informative (see Table 5.2), so the first three words were chosen to provide a general illustration of the responses this item generated. Those three words provide sufficient accompanying information to indicate the type of data gathered by this item. They also provide evidence that it is difficult to establish the exact meanings people ascribe to each word. However, there is enough evidence to suggest general meanings of words and to establish some common links between words. A sample of the reasons people gave for choosing the remaining 19 words given more than once are provided in Appendix 5-I. Those details are provided as a reference as all 22 words were used as a basis for the development of the PVII described in the next chapter.

Fun:

The most common reason given for having fun was the opportunity to interact with the exhibits.

> People have fun at *Scitech* by playing with all the activities and being able to manipulate the environment they are in. (M, 26-35, U)

Learning was seen as an integral part of the enjoyment and was directly attributable to the interactive nature of their experiences.

> It allows you to experience hands-on activities that are fun and teach you something at the same time. (M, 13-17, S)

The freedom to choose from a wide variety exhibits was seen by some other people to be factors that contributed to their visit being a fun event.

> It's a hands-on exhibition and you can look, smell, touch. Our children enjoy the freedom of playing and learning. (F, 26-35, U)

One person (F, 26-35, U) believed the novel opportunities made it "fun trying new things out," while another in the oldest age bracket (M, 56^{+}, P) was philosophical about the fun he had during his visit stating, "There's not enough of this in life."

Interesting:

Most of the reasons people gave for choosing interesting were quite descriptive and proved to be of little use for categorising the word. Only two statements gave any indication of learning on any level.

> There were lots of activities which took some patience to do. (M, 18-25, S)

There was no evidence to distinguish whether the interest was because of the fun element or the learning experience because comments tended to be general and related to the nature and variety of the exhibits.

> I found that every display held my interest in comparison with other places I have been offering a wide range of displays, often only a handful of things are of interest to me. (F, 26-35, U)

A typical descriptive statement that revealed little information useful to this study was:

> Immediately you entered the room the first exhibit made you very interested and I thought it continued right throughout *Scitech*. (M, 36-45, S)

Educational:

The reasons people regarded their experiences as educational were diverse and ranged across the interactive nature of the exhibits, the personalising of their experiences, simplifying scientific principles and modern technology, a new awareness, and changing the school curriculum. The most common reason was the interactive nature of the exhibits which was given by thirteen respondents. They indicated the interactive mode of involvement enabled learning to take place.

> Activities and experiments allow people to expand their existing knowledge through discovery and personal experience. (F, 26-35, U)

The variety and nature of presentation of information, as well as simplifying the scientific principles behind modern technology, proved to be an educational experience for five others.

> Because of all the different things and the explanation of the physics and workings of communications and different things we take for granted. (F, 26-35, S)

One person alluded to broadening her knowledge about herself and part of her everyday environment.

> Use of electricity by different appliances. Anatomy of lung and effect of smoking. (F, 46-55, U)

Two others believed learning could be achieved by people of all ages.

> Learning is achieved by adults and children when they visit *Scitech*. (M, 26-35, U)

One person felt the changing exhibits enhanced her learning experience.

> I always discover something new. For example, I didn't realise how big funnel web spiders are. (M, 36-45, U)

Another advocated changes to the primary school curriculum so that a visit to *Scitech* would be experienced by all children.

> This program should be compulsory for every primary school child to promote physics and science as possible career paths. (M, 46-55, U)

Item 2: Understanding of Science in Visitors' Everyday Lives

Purpose

This item was, "Did your visit help you **understand** something that has helped you with: your work or study; your general thinking about everyday events; your leisure / entertainment / hobby; and an issue to do with science and technology?" Each of the four areas of understanding were placed in a grid for people to indicate their responses (see Appendix 5-A Item 2). This item sought to build on the interview question that asked visitors what they had learned during a visit. The researcher had a feeling that some people may have been uncomfortable when asked what they had learned possibly because they felt they should have been able to remember precise details. Consequently, a decision was made to use the word understand instead of learn on the PVQ because understanding seemed to be a more subtle way to evoke responses about learning. The purpose of this item was to determine whether learning has been transferred from experiences at *Scitech* to the respondent's own personal environment.

Results and discussion

The results for each of the four different contexts of understanding are reported individually. There were 97 responses to the item on understanding.

(a) Your work or study

Thirty three (34%) of the respondents were able to identify at least one instance where their visit to *Scitech* helped them understand something to do with their work or study. A wide range of work could be established from their responses and included the following areas: teaching, management, medical, secretarial and public relations. The largest occupational group was the primary school teachers. Their statements indicated a visit had helped them to better understand scientific principles and concepts, made them aware of the value of a trip to *Scitech* for their class, and they found new ideas and strategies they could use for their teaching.

> As a primary school teacher it gave ideas and inspiration towards future science activities. (F, 26-35, U)

A company manager reported having a communications system, the functioning of which was explained by an exhibit at the centre. He found "it a big help to see it demonstrated at *Scitech*" (M, 36-45, T). Another person, who worked in the medical field, found that provision of information about issues concerning patients' health was useful.

> The computer quizzes on health issues I found interactive and user friendly. As a medical receptionist I could see that these issues could increase clients' awareness of their problems. (F, 26-35, T)

A number of school students, particularly primary school students, wrote that their visit had helped them with their science at school.

> At school we are now doing a project/assignment on rocks and minerals and the displays helped a lot. (M, 11-12, P)

Secondary school students also indicated benefits.

> Easier to understand school work when you actually see the exhibit in detail and with explanation. (F, 13-17, S)

There were 11 respondents who did not supply reasons why their visit had helped them to understand something about their work or study.

(b) Your general thinking about everyday events

Fifty nine people (61%) in this sample reported an instance where their visit had helped them understand something in their everyday lives. The way in which people reported those examples varied. Twelve visitors gave examples that directly linked an experience at *Scitech* to an experience in their everyday world and were able demonstrate how that experience aided their understanding. An example was:

> I have been interested in road safety so I liked the area of the reaction timer. Whilst we were there, all our family members had a try on each machine. I was fascinated to see the various times of each age member of our family. I related that back to the road safety centre here when I have been involved with similar tests. (M, 36-45, T)

A number of exhibits on the floor were related to domestic and workplace environments. For example, there was a telephone exhibit and an exhibit that gave an indication of relative amounts of power consumed by electrical appliances commonly found in a household. Eight people specifically mentioned these exhibits as assisting them understand more about their domestic environment.

> I am more aware of how complex our telephone system is and how technologically involved new developments are. (M, 46-55, S)

> . . . I also received a greater appreciation of the power required to work household appliances and am now even more conservative with electricity. (M, 36-45, T)

> How colour affects heat in cars, wood, metal, etc. (F, 26-35, S)

Five others indicated an understanding but their statements were more an indication of a increased awareness of an area of science.

> I find that each time I visit *Scitech*, I broaden my knowledge of science in general and particularly in the area of the physical sciences. My last visit gave me a broader knowledge and understanding of the world of insects. (F, 36-45, S)

Six indicated they were now more likely to seek explanations for events and occurrences that they had previously accepted without needing an explanation.

> Things just don't happen. Something makes them happen and now I possibly have more of an interest in finding out how, why, and what! (F, 36-45, S)

(c) Your leisure/entertainment/hobby

Twenty three respondents (24%) reported that their visit had enhanced the leisure/hobby/entertainment dimension of their lives. Nine related it to physical exercise.

> Exercise and keeping fit are my areas of leisure and hobby, I guess, so the area on the body and how it functions was most interesting and informative, e.g. heart, lungs. (F, 36-45, S)

Four people regarded the visit itself as a form of leisure activity that provided a bonus of education for their children.

> Being able to take children to *Scitech* for a recreational activity has provided me with a resource that children enjoy and learn from. (M, 36-45, U)

Three people made specific reference to a hobby that had been enhanced by their visit.

> I understand more about electrical currents and how they work in my crystal radio. (M, 11-12, P)

(d) An issue to do with science and technology

Although thirty five respondents (36%) indicated their visit had assisted them with their understanding of an issue to do with science and technology, their responses indicated the term issue was not clearly understood. It seems the concept of an issue had different meanings for some people. One person referred to "issues like conduction, sound waves, how gears and pulleys work, etc." (M, 36-45, T) Some referred to understanding scientific phenomena, for example " absorbing heat, speed and electrical currents" (F, 46-55, S) while others gave statements that were clearly instances of knowledge acquisition.

> The optic nerve fibre and laser displays were very informative and helped strengthen the course notes that our work has just started to develop on the communication areas. (F, 18-25, U)

As there is a varied interpretation of the term "issue" it was not included in any items on further instruments. The term issue had been used to elicit statements that may have given some insight into civic scientific literacy. Eventually three other approaches were adopted to try to generate items to gauge scientific literacy. The first was to look for comments to develop into items that imply applied scientific literacy in the vein of Wellington's (1990) knowledge *that*. The second was to devote a section on the second instrument, the PVOI, to items that sought participants' views about science and technology. The third was to include some items that could indicate attitudes towards science, which was one of the three dimensions Ucko (1985) states is used to measure scientific literacy. Specific items about scientific literacy will be discussed in the chapter about the PVOI.

Item 3: Actions Attributed to a Visit

Purpose

This item was, "Can you give an **example** of something you are now **doing** (or have done) that was a result of your visit to *Scitech.*" It was developed from the interviews where 33% percent claimed they intended to do something as a result of their visit to *Scitech*. The intention of the item was to provide data about the variety of things people are motivated to do following a visit.

Results and discussion

Of the 120 copies of the PVQ that were distributed with this item, 86 were returned, a response rate of 72%. There were 81 responses to this item, with 59 respondents (73%) providing examples of behaviours and actions they directly attributed to their visit to *Scitech*. However, almost all of these provided only one example. It is probable that the wording of the item prompted respondents to provide only one example when they may actually have done more. Only three respondents provided more than one example.

Twenty two respondents (27%) indicated they could attribute no action or behaviour to their visit, however, five of those indicated they intended some form of future action. The sample group of visitors reported a wide range of activities that are listed later in this section.

Some of the changes people made were quite far reaching. Eleven people indicated they had made significant lifestyle changes concerning their health as a result of interacting with exhibits at *Scitech*. The exhibits that prompted their actions are large models of the lung and heart where visitors are able to walk through the former and view a triple by-pass on the later. At the heart, people are able to place their finger on an electrode and hear a magnified sound representing their pulse and view a small cathode ray tube screen trace of their pulse. One visitor stated she was "now attending aerobic classes," (F, 18-25, U) while another wrote that

> I am even more conscious of keeping my body fit and healthy with exercise and diet having read more information on it at *Scitech*. (F, 26-35, U)

One respondent revealed she had successfully "given up smoking after the lung!" (F, 26-35, T)

Five people indicated their visit had prompted them to read scientific articles.

> Read a short article on gyroscopes furthering my understanding of how they work (M, 36-45, T)

Another person indicated a heightened interest in science and technology items that are presented in newspapers and television. He was also one of three respondents who indicated their intention to conduct some project that was based on their experiences at *Scitech*.

> I now have more interest in scientific and technology topics, in the media and on television. Also when time permits I would like to attempt building a small electrical generator for garden lights. (M, 26-35, S)

The two others indicated they both planned to build a model based on an exhibit they had experienced.

> With having two small children they were fascinated with the suspended board and stationary marker which drew lovely patterns. I'm thinking at the present of possibly constructing a smaller version (time permitting). (F, 26-35, U)

Five people reported buying pieces of scientific apparatus, scientific kits or toys. The main exhibition at the time of their visit was "Gargantuans of the Garden" and featured huge moving models of insects many of which can be easily found in urban and rural areas.

> Bought my son a microscope so he can look at plants and insects, those around home, with greater interest than before. (F, 36-45, U)

Seven people tried experimenting to replicate principles they saw at exhibits or demonstrations.

> Made goop [sic] from cornflour – liquid that flows when still (from show in theatre). (M, 13-17, S)

The company manager, who had said at the time of the interviews his experience with the multiplexing exhibit enabled him to make a more informed decision, revealed that he had upgraded his communications system. The manager was enthusiastic about his experience as following his visit he was now "promoting *Scitech* to friends and acquaintances." (M, 46-55, U)

A permanent exhibit that allows people to discover the relative costs of different electrical appliances commonly used in the home impacted on some visitors. After their experience with the exhibit five visitors reported changing some of their domestic habits.

> I conserve more power now that I've seen how much energy it takes to run certain appliances. (M, 36-45, S)

Four parents indicated they now tried to link explanations for scientific phenomena and concepts to "real world" examples when explaining events to their children.

> Try to add a scientific touch to things I do with my children. I am taking more time to explain to my children the workings of various things that they come in contact with in daily life. (M, 26-35, U)

There were some comments on a lighter note. One respondent reported the only action that could be attributed to her visit was that she now was

> Resisting the children's demands to return every week. (F, 36-45, U)

The remaining action reported was talking about the visit to people who were not part of the visiting group. These included other family members, friends and work colleagues. Of those who indicated they hadn't done anything as a result of their visit, one added a caveat that it was possible she may be able to use something she had experienced by interacting with her children at a later date.

> There is a possibility that as my children grow I might be able to put something I picked up into practice with them. (F, 26-35, S)

A summary of things people reported doing as a result of their visit is listed. They were:

- Bought a piece of scientific apparatus or kit (5).
- Read a scientific article (5).
- Changed domestic habits (5).
- Thought more about everyday events more (6).
- Benefited studies (6).
- Used information in a hobby (5).
- Changed lifestyle (11).
- Watched more science related TV programs (4).
- Conducted an experiment (7).
- Constructed something (4).
- Explained some things to children in a scientific way (4).
- Showed children how some things work (4).
- Influenced decisions at work (1).
- Talked about visit to people other than those who visited with them (9).

- Recommended to others they visit (6).
- Resisted children's demands to return every week (1).

Item 4 and Item 5: Best and Least Liked Exhibits

Purpose

The items were, "Which exhibit did you like **best**?" and "Which exhibit did you like **least**?" Respondents were then asked to supply reasons why they gave their answers. The items were asked to prompt memories that may have provided evidence of learning and were taken from Stevenson's (1991) study.

Results and discussion

There were 23 (64%) of the 36 responses about the best liked exhibit, however, seven did not specify a certain exhibit. They provided comments such as "liked them all" (F, 26-35, S) and "cannot choose one from the many exhibits" (M, 36-45, U). When the respondents did name a particular exhibit there they tended to supply a reason that was descriptive rather than revealing any information about learning.

> The "city building" computer program was very interesting – if a little over simplified. The video exhibit showing pixels, tones, freeze, memory, etc., was another excellent exhibit. I could go on and on. (M, 46-55, U)

Only seven of the comments did imply some learning had taken place.

> Probably the "lung" because it is easier to understand things (about your body) when they are in life size models. My daughter has asthma and this is another reason. (F, 36-45, T)

Eleven (31%) identified a least liked exhibit with only seven giving a reason. The comments typically reflected some form of frustration at either the level of explanation accompanying an exhibit, the failure of an exhibit to function, or lack of organisation.

> In the past I have found some of the more advanced electronic circuit type of exhibits impossible to figure out as the instructions were not adequate for someone who knows nothing of this field. (F, 36-45, S)

> The train – disorganised, lacked direction, lacked supervision and explanation. Potential assistance was required, but not always available. (F, 36-45, U)

> I do resent paying money for my family to visit and then find some exhibits not working. It shouldn't be too hard to check if exhibits are working! (M, 36-45, U)

Both items were discarded after the pilot field-test as they were not successful in eliciting much useful information. In the main field-test they were replaced by an item that explicitly sought the memories of visitors.

Item 6 and Item 7: Visitors' Interest and Awareness Concerning Science and Modern Technology

Purpose

During the visitor interviews, a number stated they had changed their views about science and modern technology after their experiences at *Scitech*. Some of those claimed a heightened interest while others said their level of awareness had increased. At that time the management of *Scitech* was developing a corporate plan that included a mission statement, part of which was to increase the Western Australian public's of awareness of, and interest in, science and technology. In the final plan the mission has been altered slightly to read " . . . increase the interest and participation by Western Australians in science and modern technology" (Scitech Discovery Centre, 1995) .

It should be noted that during the initial phase of the study when casual conversations were held with approximately 30 visitors from a wide variety of backgrounds, one of the questions asked of each visitor was, "Do you think there is any difference between science and modern technology?" It quickly became evident that those visitors did make a distinction. Some were very clear while the remainder were able to explain in terms that reasonably identified each.

Results and discussion

A specific item on visitor interest and awareness about science and modern technology both before and after a visit was included on all the PVQs to generate some quantitative data. The item was presented in a grid format (see Appendix 5-A Item 6). Respondents were asked to indicate their levels of interest and awareness about science and modern technology on a five point scale that ranged through none, low, moderate, high to very high. The responses were scored by allocating a 1 for no interest or awareness through to 5 for a very high level. The responses were hand coded and checked for accuracy. Data were analysed using Statistical Package for the Social Sciences (SPSSx) software.

The data provide a basis for comparing visitors' reflections about their experiences three weeks after their visit. The results show that for this group of 153 visitors, there were statistically significant increases ($p < .001$) in their interest and awareness concerning science and modern technology as a consequence of their experiences while visiting *Scitech* (see Table 5.3). Table 5.3 also shows there are large effect sizes, particularly for awareness of science and awareness of modern technology where the effect sizes are almost one standard deviation. Cohen (1969) suggests that 0.8 represents a large effect, so these values indicate a substantial change. This group of visitors apparently believes their experiences while visiting *Scitech* have increased their interest in science and modern technology, and raised their level of awareness of science and modern technology.

It is acknowledged that conclusions reached from these data would be more persuasive if subjects were randomly selected prior to entry and the same items administered on pre-visit and post-visit basis. However, that would have involved engaging another substantial cohort of subjects. It is also acknowledged that the results could be influenced by factors other than their experiences at *Scitech*. For example, respondents may have been wanting to please the ISTC staff or give an answer they thought was expected of them by the researcher. It is also possible their enjoyment of the visit influenced their responses. All, or any combination of these reasons, could have inflated the scores of the post-visit responses. Nevertheless, these findings are consistent with the statements of the visitors who had been interviewed and who gave no indication they were trying to please. In the item described next, many people have given substantial arguments why they believe their interest and awareness changed, even though the focus of the question was broader than this.

Table 5.3

Means, Standard Deviations, Dependent t-test and Effect Size Results of Pre-visit and Post-visit Scores for all Respondents

	Pre-visit		Post-visit				
	M	*SD*	*M*	*SD*	*t*	*p*	Effect size
Interest in Science	3.36	.77	3.91	.72	9.88	.000	.71
Interest in Modern Technology	3.42	.72	3.92	.70	9.89	.000	.69
Awareness of Science	3.29	.74	4.01	.59	11.63	.000	.97
Awareness of Modern Technology	3.27	.71	3.99	.64	13.44	.000	.99

Note. *n*=153
Effect size = (Difference in means) / SD of pre-visit scores

Item 8: Ideas on Science and Technology

Purpose

The item was, "If there has been a change of your **ideas** about science and modern technology as a result of your visit to *Scitech* please describe how they have changed." Its purpose was to elicit people's thoughts about any shift in the way they viewed science and technology. As well, it was hoped it would stimulate comments about their attitudes to science and technology.

Results and discussion

Quite a lot of people did not respond to this item and a large proportion (42%) of those that did indicated their ideas had not changed. The item did, however, elicit some information that was quite revealing, particularly in relation to people's previous experiences of science at school.

> There was a clear distinction between science as it is presented at *Scitech* and the way people remembered it at school. I always found science and technology a confusing subject, best left to the scientist, but after visiting *Scitech* I realise that it doesn't have to be that way. If you sit back and analyse something and break it down look at things in a "smaller" way you can get enjoyment as well as an understanding out of why something works, or how, etc. (F, 36-45, S)

The item also revealed that the manner of presentation at *Scitech* has made science more enjoyable and meaningful than that which they had previously experienced.

> Science is made more alive through *Scitech*. The hands-on approach is wonderful for kids' understanding. I might have been more interested in science if I had access to *Scitech* as a child. It's a wonderfully challenging, stimulating and educational experience for children. (F, 46-55, S)

Other comments revealed that for some visitors science was made easier to understand and more accessible, interest in science was renewed, and the role of science and technology in everyday life was appreciated more.

> I used to find science boring and difficult to understand but hands-on science is so much fun. It brings it back to earth and not in the realm of professors and physicists. (F, 36-45, S)

> Although I don't feel that my ideas have changed, I do think my visit actually rekindled an interest in science. (F, 36-45, S)

> [I] have a better appreciation of the laws of nature, the universe, the world and many things we take for granted each day. (F, 26-35, T)

There was a positive response from some school children.

> My ideas have changed from thinking science was [a] boring dull thing to loving every minute of my 3 science sessions a week. (M, 11-12, P)

Item 9: Whether a Visit to Scitech *Was Worthwhile*

Purpose

This item arose out of the interviews when many people indicated they thought their visit was worthwhile and was designed to gather further information about their reasons.

Results and discussion

There were 89 responses to this item, a rate of 74 %. There was almost complete consensus that the visit was worthwhile. Only two visitors wrote that it was not worthwhile.

> . . . after all I had heard about *Scitech,* I was disappointed. (M, 46-55, U)

> We left quickly because we couldn't find anything that interested us. (F, 36-45, T)

Many of the comments tended to reinforce information people had already supplied in response to the previous items. For example, 29 of the comments highlighted the value of learning.

> It was a fun way to learn about many varied and interesting topics. Far more I think is learnt that way than if you were just given a whole lot of books or pamphlets to read on various topics. Hands-on is instant and therefore more memorable in my opinion. (M, 36-45, U)

There were two areas of comments that are worth highlighting however. The first was made by 13 parents who indicated their pleasure came from the benefit for their children.

> For me <u>the</u> most important aspect of the *Scitech* display is the fun my children derive from it. If they're happy so am I. Children can be very critical of things they do not enjoy and I can truthfully say that whenever I have taken them to *Scitech* the reaction has always been positive. (F, 36-45, U)

The second concerned social benefits which were seen as important with 22 people who indicated it was of value for a family to share and enjoy a learning experience.

> The kids thought that it was great. My wife and I used the opportunity to discuss many of the concepts during and after with the children. We saw it as a worthwhile and enjoyable learning experience for the children. (M, 26-35, T)

Item 10: Additional Comments

Purpose

The purpose of this item was to give people a chance to add any comments in an area that may not have been foreseen when the contents of the PVQ were determined. It was the last item on all of the PVQs and invoked many responses that summarised people's views on their visit.

Results and discussion

The responses to this item tended to be lengthier and more detailed than those for the other items, but generally, respondents tended to reiterate points they had already made. Many respondents also used this item to make complaints and, in some instances, to make suggestions for improvements. The main areas of complaint were: noise (12), access to exhibits (8), cost of entry (7) and exhibits that malfunctioned or were not working at all (5).

Item 11: Would you please provide us with some details about yourself to assist in this study

This item collected data about respondents' sex, ages and levels of education in science. A summary of that data was reported previously in Table 5.1. The item also collected data about respondents' occupations and whether English was their first language. The occupations proved too diverse to classify and all except one respondent spoke English as a first language.

Item 12 and Item 13: Visitors' Discussions During and After a Visit

Purpose

These two items were, "Did you discuss any of the exhibits with anyone else **during** your visit?" and "Did you discuss your visit experiences with anyone else **after leaving** *Scitech*?" The items arose from the visitor focus group sessions and from the research literature (Borun, 1989a; Borun et al., 1996; Diamond, 1986; Dierking & Falk, 1994; McManus, 1989, 1994) . Previous research on visitors' conversations had been conducted while visitors are interacting with exhibits and used the content of those conversations to determine whether any learning takes place. This item sought to establish the extent of visitors talking to one another both during the visit and following a visit. No other research has been found about discussions following visits to ISTCs.

The items also requested people to recall the nature of discussions that took place up to three to four weeks previously. In some cases it would have been longer before people completed the PVQ, therefore, it would not be reasonable to expect fine detail of any discussion, nor was that the intention of the item. The item was used mainly to generate more statements about people's experiences.

Results and discussion

The 70 copies of the PVQ in the main field-test that contained these two items did not include the item about actions following a visit. This strategy was used to avoid cuing on the item about actions and probably accounts for the much lower level of reported conversations on that item. Both the discussion items generated 49 responses, a response rate of 70%. Of these, 42 (86%) indicated that during their visit they had discussed the exhibits while 43 (88%) indicated they engaged in post-visit discussions about their experiences. Three people indicated they did not talk about their experiences either during or after the visit, which means 46 (94%) of this sample group of 49 engaged in some form of discussion about the exhibits.

People mostly gave brief, general responses about the content of their discussions. For example, one wrote that during her visit the discussion "was with the children about many things at *Scitech*" (F, 26-35, S). However, some did provide more elaborate details of their discussions. One person wrote that:

> Things like, look at this! My reactions are faster than yours! How did they do that? Does it always do that? Let's try it this way. Brief interactions (because of the noise) some of which were experimental ideas, others just comments on new things learnt or experiences. Perhaps discussion is not really the word for this. (F, 36-45, U)

Respondents' statements about conversations during their visit were analysed in an attempt to gain some insight into the levels of cognitive activity of visitors. They were categorised into three broad groups – explanation/analysis, reflective or general impressions, and descriptive – which reflect different levels of cognition. The explanation/analysis category is where some higher level of cognitive activity relating to understanding of an exhibit can be assumed to have taken place. It is not possible to determine the exact nature of the cognitive activity that actually did occur, but there is clear evidence people did believe they were engaging in higher levels of mental processing. One person reported "being 'challenged' both mentally and physically by exhibits" (M, 26-35, T), while another wrote she "exchanged ideas with other people who were interacting with exhibits (including members of my family)" (F, 26-35, S).

The second group of comments was generally more reflective in nature and tended to sum up a visitor's general impressions of their experiences. For example, "My sister and I were commenting on what a great exhibit the digger was and how the kids loved it" (F, 36-45, U). Comments in the third group were purely descriptive and similar in nature to those that both Stevenson (1991) and McManus (1993) categorised as descriptive in their memory studies. These comments are regarded as indicators of a low level of cognitive activity. Some examples were: "Thinking the TV would fall off the table in the earthquake house" (M, 26-35, U), "Oh, look and see how such and such happens" (F, 56+, S) and "The theatre – the kids love the shows" (F, 36-45, S).

The levels of cognition indicated by the explanations varied, as did the nature of the interactions between the people sharing the experiences. There were reports of discussions between adults, as well as parents explaining exhibits to children.

> I discussed the exhibits with my friend who had accompanied me (29 years old) and with my five-year-old daughter. We discussed how things worked and I would explain this to my daughter, hoping to provoke interest and understanding rather than just moving between exhibits. (F, 26-35, S)

Some children even claimed they explained how exhibits worked to their parents.

> I asked Mum to look at the rock displays. We listened to the songs. I showed her how it worked when you chose the correct type of rock e.g. igneous. (M, 13-17, S)

Some people related how they had discussed and explained exhibits with people other than their family or group.

> Showed other people how to use displays. Asked other people how to use displays. Had a conversation in earthquake display about Darwin's cyclone. (F, 46-55, T)

A breakdown of the 43 written comments about conversations during a visit provided 22 examples of statements indicating explanation/analysis, 12 examples of general impressions and 9 examples of description.

There were far fewer written comments (27) about the nature of post-visit conversations, and the substance of those conversations was generally quite different to those held during the visit. The post-visit discussions tended to focus on general impressions of the visit and were of a descriptive conversational nature. Consequently, numbers in the different levels of cognitive activity were quite different, with five classified as explanation/analysis, three general impressions and 19 descriptions. Typical post-visit descriptions focussed on the value of a visit in both monetary and experiential contexts.

> I discussed the cost of a visit for a family which I think is expensive. Also, [I discussed] the displays which were most popular. The earth mover and train were well organised with *Scitech* staff on hand so that each child was able to have a turn. (M, 36-45, S)

It is clear visitors' dialogue about their experiences does not finish at the exit. People reported talking about their visit on their way home in their car, and after that, discussing exhibits with other people including friends, relatives and work colleagues.

> I spoke of our visit to *Scitech* with my workmates. They were very interested to find out about the whole set up. I impressed upon them that, there would be something that would interest the whole family. (M, 26-35, T)

The content of the post-visit dialogue also included relating memories of the visit, descriptions of exhibits, planning future visits, comparing experiences with others who had visited and further explanations of concepts and principles demonstrated by exhibits.

There were also some adverse comments about experiences reported in the post-visit discussions.

> Mainly about the amount of people there – too many to appreciate every exhibit. And I couldn't get a go on the backhoe! (M, 36-45, U)

> We discussed the hologram (clear glass) because I couldn't understand how it worked! No wires etc, and there was no explanation to read! I still don't know. (M, 36-45, U)

Item 14: Memories of a Visit to Scitech

Purpose

Respondents were asked to list the first three things they remembered about their visit and were also asked to supply the reason for their memory. Visitors' memories have provided valuable information about learning in museums (McManus 1993; Stevenson, 1993; Falk, 1988). However, possible cuing of memories is a problem (McManus, 1993a) and to minimise contamination of responses care was taken to ensure respondents had no previous indication of what items the PVQ would contain. As well, this item was placed at the beginning of 70 copies of the main field-test PVQ to avoid possible cuing from other items.

Results and discussion

Fifty four respondents, a response rate of 77%, replied to this item and in all except two instances, respondents gave reasons for each memory. The results are reported in 14 categories of memories with a sample statement for each category. Most respondents either named or described an exhibit while the remainder gave a memory that described the environment or "Gestalt" of their visit. The categories of with frequencies of 20 or more statements are listed next and the remainder are shown in Appendix 5-J.

Novel (44)

> Two sound reflecting parabolas (across noisy room). I found this exhibit fascinating because there was so much noise in the room, yet I was able to hear Melanie talking as clearly as if she were standing right next to me. (F, 36-45, S)

Inter-activity (34)

> There are so many things to do hands-on. The children would race from one exhibit to the next to touch everything, to make it work. They loved being able to <u>do</u> things. (F, 36-45, S)

Sensory (29)

> Probably the sound dishes. Very hard to pick. There's the sheer size of the musical contraption, the claustrophobia of the lung, the video phones, the gas spectrometer, the bubble machine – Once you begin to remember a visit to *Scitech* lots of images <u>come crowding in.</u> (F, 36-45, U)

Gestalt (22)

> That a lot of 'love' had been used in arranging the exhibits. Colour, humour, subtle education was used extensively. It was a celebration of mankind's achievements. Scientists had gone out of their way to showcase their wares. (F, 36-45, T)

Children's enjoyment (21)

> The rolling of balls down tubes to demonstrate different velocities. My children played for at least 1/2 hour competing for the balls and trying different ways of bouncing the balls to return them down the tube. (M, 26-35, U)

Everyday relevance (20)

> TV health questions on food. Children don't always want to listen to their parents so I thought this would teach them about food and what they should eat in a fun way. (F, 36-45, U)

The findings support other research that indicate visitors can recall in quite some detail memories of their experiences. In this current study the memories are considered to be a medium term of less than one month as compared to the time of some memories in the recollection studies by Falk (1988), McManus (1993a) and Stevenson (1991) . It is worth pointing out that the only respondent who didn't provide memories had reported a negative experience when visiting, which clearly was a memory.

Item 15: Contact With Explainers

Purpose

During both the visitor focus group sessions it became evident that few of the people in the groups had any contact with the explainers. Some of those in the focus groups mentioned they would have appreciated assistance from the explainers while visiting. Although this item did not link directly with this study, it was included in 70 PVQ's during the main field-test to provide data for the *Scitech.*

Results and discussion

There were 54 responses to the item and 45 of those indicated the respondents did not have any contact. For three of the nine that did have contact it wasn't just limited to facilitating of learning.

> I lost my 6-year-old and they helped me find him. Someone ordered the children to avoid fighting at the digging machine. (F, 26-35, S)

The six others did find the information explainers were able to pass on to be quite useful.

> When I first saw the satellite dish I had no idea how it worked so I asked a guy with the *Scitech* vest on and he was very helpful. (F, 26-35, U)

The results of this item were passed on to the Explainer Coordinator.

Summary

The PVQs proved to be a fertile means of eliciting written comments from visitors and provided an adequate data base of statements to develop items for the two instruments to measure visit outcomes. The first instrument, the PVII, was developed using data solely from the item about the three words that best describe a visit. The second instrument, the PVOI, was based mainly on data from the remaining items (except the item about explainers) with some data from the interviews. The development and validation of the PVII and the PVOI are reported in the next two chapters.

CHAPTER 6

STAGE 4: THE PERCEPTIONS OF VISIT IMPACT INSTRUMENT

Overview

This chapter describes the development of an instrument, the Perceptions of Visit Impact Instrument (PVII), suitable for administration to the public at the conclusion of a visit to an ISTC. First, a rationale is given for having an instrument that provides a reliable quantitative measure of the immediate impact of a visit on the public. Second, the selection of the type of instrument used as a model is justified, and the construction of the draft instrument is described. Third, a detailed account is given of its subsequent testing and refinement using a synthesis of statistical procedures and qualitative methods. Fourth, testing of the PVII for sensitivity to respondent variables of sex, age and level of education in science as well as difference between ISTCs is reported. Finally, comments about the instrument from the participating centres are discussed.

Rationale for the PVII

Need for Quantitative Data

During the initial stages of this study discussions with section managers and administrators at *Scitech* revealed they had already formed an opinion that, generally, the public who visited *Scitech* reacted very favourably to the experience. That impression was based mainly on anecdotal evidence accumulated from informal feedback in the form of comments made by the visiting public to visitor services staff. Comments made by friends and acquaintances of *Scitech* staff following visits provided supplementary anecdotal evidence.

To date, two studies have been commissioned by *Scitech* to collect quantitative data about visits by the visiting public. The studies, by Johnston (1995) and Schibeci (1992) , were described in some detail in Chapter 2. Both studies attempted to determine whether there was some form of specific impact on both voluntary visitors and school groups. While each study had a different focus, neither provided any empirical evidence to support or refute the general notion of favourable reactions by the public to a visit held by the *Scitech* administrators and section managers. The PVII was developed to obtain some empirical evidence of people's perspectives.

Style of Instrument

While conducting the interviews with visitors in the initial stages of this study, it became clear that by the end of a visit people had formed definite opinions about their experiences, and, in their own mind, they were able to evaluate their visit. It seemed that the point of exit could be an appropriate time to administer an instrument to collect information about their views. However, it was also apparent that some people were showing signs of exhaustion towards the end of a visit, and tiredness was mentioned by some interviewees as a reason for making their decision to conclude the visit. Furthermore, an adult female participant in one of the discussion groups pointed out that it took quite a deal of effort gathering her family together so they could leave. She also stated that answering any lengthy questionnaire at the point of exit could be an imposition on a respondent and some responses "may be brief and hastily thought through." Therefore, while it seemed people would be capable of providing information at the point of exit, any instrument for effective data collection would need to be concise.

Historically, three styles of instruments have been used to collect data about people's reactions toward events and attitude objects. The first was developed by Thurstone and involved ranking a series of statements along an 11 point continuum by making comparative judgements (Gable & Wolf, 1993) . Shrigley and Koballa (1984) , while discussing desirable characteristics of attitude scales, cite Hovland and Sherif (1952) as having described Thurstone's method for developing an instrument as a "time-consuming and questionable judging process" (p. 113). Hadden and Johnstone (1982) , when reporting on a study involving reliability of semantic differential instruments, referred to the "more cumbersome Thurstone method" (p. 406). Therefore, Thurstone's method was not considered to be an appropriate model for designing an instrument for administration at the point of exit, mainly because of the time it would take to develop.

The second style of instrument is based on a Likert scale, where respondents are able to indicate their responses to statements on a five point scale ranging from strongly agree to strongly disagree. It has been used frequently for research in psychology and education and is considered to be reliable (Gable & Wolf, 1993) . As well, it has been used in the area of formal science and technology education research as a basis for instruments developed specifically for measuring attitudes (see, for example, Rennie & Treagust, 1989; Fraser, 1974) . Likert scale instruments typically contain a number of items which require time to read before responses can be made. Consequently, an instrument based on Likert scales would also take some time to complete, and hence would not be particularly suited for collecting data from visitors to an ISTC at the time of their departure.

A third style of instrument is the semantic differential. Similarly to the Likert scale, it is regarded as a reliable technique (McCallon & Brown, 1971) . It is also easy to develop (Schibeci, 1982) and takes little time to administer (Gable & Wolf, 1993) . The feasibility of developing an instrument based on the semantic differential technique was investigated further.

Suitability of a Semantic Differential Instrument

The semantic differential instrument was originally developed as a tool for the "measurement of meaning" (Osgood, Suce & Tannenbaum, 1957, p. 20) in a psychological context. It consists of a series of semantic scales each consisting of bipolar adjectives that are separated by a line, usually divided into seven equal intervals, representing a continuum of semantic space (Gay, 1992) . The bipolar adjectives represent the two extreme positions a respondent can take about a particular feeling, attitude, or reaction. The series of scales represents a "multi-dimensional space" (Osgood et al., 1957, p. 71) .

Osgood et al. (1957) developed a standardised bank of items and scales for constructing semantic differentials. They are based on three dimensions labelled evaluative, activity, and potency. However, Osgood et al. (1957) state "that it is a highly generalisable technique of measurement which must be adapted to the requirements of each research problem to which it is applied" (p. 76).

Mindak (1969) described how he adapted the technique when developing a semantic differential to provide quantitative data to solve a marketing problem. The problem arose because only highly subjective responses were available for analysing public reactions to images of brands, products and companies. He developed items from his own sources using word association tests with customers, individual and group interviews, and the advertising by his company and their competitors.

There are instances when a semantic differential technique for attitude measurement has been used for research in formal science education settings. For example, two separate studies that relied on the bank of items developed by Osgood et al. (1957) as a source were conducted by Johnston (1991) and Postle (1985) . In both studies semantic differential instruments were developed to measure changes in attitudes of primary school age children towards science as a result of controlled interventions.

No studies that used a semantic differential instrument in informal science education settings have been sighted, and hence no semantic differential items pertaining to visits to ISTCs were available. As in the study conducted by Mindak (1969), new items were needed to construct a semantic differential instrument appropriate to an ISTC setting.

The Draft PVII

Development of the Draft PVII

Development of a Bank of Items

Roid and Haladyna (1981) stress that it is preferable to use the language of the target population, rather than that of the researcher, when developing any test items, as it will better satisfy the criterion of construct validity. The first step was to generate a bank of items using a representative sample of the visiting public as a source. A starting point for the item bank was the adjectives people used to describe their reactions to a visit to *Scitech*. These were obtained from responses to a question on the PVQ, which had asked participants to give the first three words that came to their mind when they thought about their recent visit to *Scitech*. They were also asked to give their reason for supplying each word. That request was made to provide clarification for the meanings different people may have attributed to each word. The full analyses were provided in Chapter 5.

There were 64 different words included in the 294 given by 98 respondents, and the 22 given more than once were used as the basis for constructing the pilot instrument. Some of the words originally given as nouns were altered to their adjectival form for use as bipolar adjectives. The 22 words used for the pilot instrument are shown in Table 6.1, together with their frequency and percentage of the total number of words given by respondents. (The remaining words supplied are shown in Appendix 5-G.)

In order to form bipolar pairs, the antonyms needed for each of the 22 adjectives were obtained from two sources. The first was a dictionary of antonyms (Manser, 1990) , however, some problems arose. In most instances the dictionary gave multiple antonyms for each word, but in the case of the word *experimental*, none was given, while the word *understandable* was not listed. The dictionary supplied some antonyms which were the same for different words. For example, dull and boring were antonyms listed for both *interesting* and *exciting*. In addition, it was possible the meaning of some of the antonyms supplied by the dictionary may have been unclear to some members of the visiting public.

These problems were addressed by using a group of five female and three male adult volunteers, from an amateur public speaking club, as a second source of possible antonyms. The eight volunteers were from diverse occupational and educational backgrounds, their ages ranged from about 20 to about 50 years, and none had previously visited *Scitech*. Each volunteer was supplied with a list of the 22 adjectives (see Appendix 6-A), and asked to provide antonyms for each of the adjectives without referring to a dictionary. The task was carried out without supervision and at their convenience.

Table 6.1
Frequencies and Percentages of the Words Given More Than Once to Describe a Visit to *Scitech*

Word	f	%	Word	f	%
Fun	38	12.9	Noisy	6	2.0
Interesting	35	11.9	Experimental	5	1.7
Educational	34	11.6	Intellectual	4	1.4
Informative	24	8.2	Variety	4	1.4
Stimulating	18	6.1	Colourful	4	1.4
Enjoyable	16	5.4	Active	3	1.0
Exciting	15	5.1	Superficial	3	1.0
Fascinating	10	3.4	Knowledgeable	3	1.0
Busy	9	3.1	Understandable	2	0.7
Inspiring	9	3.1	Attractive	2	0.7
Worthwhile	6	2.0	Learning	2	0.7

Note. *N*=294.

The criteria used for selecting which antonyms to use to form bipolar adjectives were decided upon prior to analysing the group's responses. They were:

- when a majority of the group gave an antonym the same as the dictionary, the antonym would be retained,
- when a majority of the group gave the same antonym that was different to the antonyms in the dictionary, the group version would be adopted,
- if there was no consensus by a majority of the group about an antonym supplied by the dictionary, the item would be discarded,
- when no antonym had been given by the dictionary a consensus of a minimum of three members of the group about a suitable antonym was needed before the antonym was considered for inclusion,
- if there was support by at least three of the group for more than one antonym supplied by the dictionary, the decision about which of the multiple antonyms to use would be made by the researcher while considering the context of a visit to an ISTC, and finally,

- in the event of the same antonym being supplied for different words by both the dictionary and the group, a subjective decision about antonym selection would be made by the researcher.

When the list of 22 bipolar adjective pairs was finalised, a copy was given to each of six *Scitech* education team members, a teacher and two adult members of the public, for critical appraisal. No changes were suggested, and the list became the basis for preparing the draft instrument.

Construction of the Draft PVII

The next step involved the construction of the draft instrument. Each pair of bipolar adjectives was positioned on opposite sides of the page and separated by seven equal intervals represented by boxes. Care was taken to allocate positive adjectives to either end of the scale in a random way so that participants needed to think about their responses, rather than falling into a pattern of quickly ticking straight down one side of the instrument (Henerson, Morris & Fitzgibbon, 1987) . A set of directions for completing the instrument was placed at the top of the page preceding the items. A final section requested respondents' demographic details based on their age, sex, level of education in science, occupation and whether English was their first language. The Draft PVII is shown in Appendix 6-B.

Just prior to commencing the pilot field-test, other ISTCs were sought to participate in the study. As an inducement, an undertaking had been given to analyse the data they collected, and to provide each centre with an individual confidential report. The education team at *Scitech* had also indicated that if categories of items could be developed, then results would have more meaning to ISTCs than results based solely on individual items.

The first approach to develop categories useful to ISTCs involved five members of the education section at *Scitech*. Each was given a sheet of paper with a list of the 22 positive adjectives (from each item pair) with a request to sort them into categories. The attempt was not successful, as no consensus was reached with the number of suggested categories ranging from three to six.

For the next attempt, all words were written on individual slips of paper and intuitively sorted into piles by the researcher. Four piles evolved, three of which contained intuitively meaningful clusters of words. One of the clusters consisted of words associated with some form of mental activity, while another contained words relating to enjoyment. The third group were words that indicated a sensory response. However the remaining words in the fourth group, *inspiring*, *superficial*, and *variety*, didn't seem to fit any category.

The reasons visitors gave for supplying the words were then examined. (A full analysis of those reasons was given in Chapter 5.) However, this was of little use in developing categories at this stage as occasionally similar reasons were given for supplying some of the words in both the mental activity and enjoyment groups. Following that approach would have meant merging two potential categories into one.

Finally, three notional categories were used based on the groups determined by the researcher. One consisted of the group of words implying mental activity while another group was associated with enjoyment. They were titled "cognitive" and "affective" respectively. The third, titled "physical environs," consisted of words that were more loosely associated. They all implied a reference to the physical environment inside an ISTC.

As a further check on the three categories, they were put through two scrutinising processes. First, the words were listed in the three groups and given to the Principal of a technology primary school and a former university science educator for critical comment. Both believed the categories were appropriate. Second, the groups of words were given to all seven members of the *Scitech* education section for their consideration. However, on this occasion two of the words were deliberately placed in categories different to the ones to which they were originally allocated. *Interesting* and *stimulating* were listed in the cognitive category. They were the only words questioned with *interesting* attracting five queries and *stimulating* seven. All recommended the words be placed in the affective category. They also indicated the three groups of words were appropriate categories in an ISTC context.

The final categories and their words were:

- <u>Cognitive</u> (*educational, intellectual, informative, experimental, learning, understandable, knowledgeable*),
- <u>Affective</u> (*fun, enjoyable, worthwhile, inspiring, exciting, interesting, stimulating, fascinating)*, and
- <u>Physical Environs</u> (*active, colourful, quiet, busy, superficial, variety, attractive*).

The items were arranged in three separate groups on the Draft PVII to reflect the different notional categories.

Review of the Draft PVII

The draft instrument was given to two members of the *Scitech* education section and two science educators, to review the clarity of instructions, readability, and ease of use. They were also asked to determine whether it allowed sufficient scope for expressing views about a visit. All reviewers rated it satisfactory on each of these criteria. As well, the review process established face validity of the draft instrument.

Pre-test of the Draft PVII

Further preliminary data were obtained when the draft instrument was pre-tested using the ten members of the first visitor discussion group as subjects. The pre-test was conducted to trial the administration of the instrument and to seek feedback about it from voluntary visitors who had visited *Scitech*. The group were informed about the purpose of the instrument, and were then asked to complete it. They were timed for future reference, the longest taking almost six minutes with the quickest taking approximately two and a half minutes. Critical comments were requested and recorded in writing after they had all finished.

There was some discussion about the Draft PVII. All participants agreed that the instrument allowed ample scope to express their views. One adult male believed seven divisions on the semantic scale forced him to make a distinction that was too fine. He stated he would have been more comfortable with five divisions. All of the others were untroubled by the seven divisions. An adult female believed a true-false format would be more efficient from her point of view as a tired mother at the end of a visit whose main priority was getting all her children together and leaving the premises. Both an adult female and a school-aged female suggested some bipolar adjectives could subsume others. All participants agreed the instructions were clear and all the bipolar adjectives were comprehensible. They also all agreed the request for personal details for demographic data was not intrusive.

All of the comments were considered. The suggestion of a true-false format for an instrument to be administered at the point of exit was not adopted for two reasons. First, it did not suit the style of instrument being developed as it would require a series of statements, rather than the set of bipolar adjectives, to which people could respond. Second, the reason given for suggesting the true-false format was to enable quick completion of the instrument. As the pre-test group was able to complete the pilot instrument in about five minutes, time would not be an imposition on respondents. Although the suggestion of subsuming some bipolar pairs with others that had close meanings had some merit, there seemed little point in omitting any of the pairs at this stage as there were only 22 items. Consequently, no changes were made to the draft instrument before its pilot field-test.

Validating the PVII

Overview

There were three steps involved in validating the Final PVII. The first step, the pilot field-test, involved using data collected from a random sample of visitors at the end of a visit to *Scitech*. The data were used to conduct factor analyses and compute reliabilities, determine inter-item correlations, and to provide descriptive statistics of items and factors for scrutiny. Following the pilot field-test, the Draft PVII was slightly modified. The second step, the stability field-test, was also conducted at *Scitech* and involved data using a random sample from a different cohort of visitors. Data, collected at the point of exit and again approximately three weeks after the visit, were analysed to determine the stability of the Pilot Field-test PVII. In the third step, the main field-test, the instrument was unchanged before being administered to a random sample of visitors from five different sites including *Scitech*. The data analysis procedure was similar to the pilot field-test.

In all, 1152 respondents yielded sets of useable data. There were 177 respondents in the pilot field-test, 172 in the stability field-test and 803 in the main field-test. Percentages and numbers of respondents for the three field-tests based on the demographic criteria of sex, age, and education level in science are shown in Table 6.2. The demographic characteristics of the samples in all three field-tests are generally consistent, and hence, it can reasonably be assumed that samples are representative of the population who visit the ISTCs involved in the field-tests. Selection procedures for respondents in the three field-tests are described separately in each section because they were different.

The Pilot PVII Field-test

Method

The data were collected immediately outside the exit doors of *Scitech* where the people leaving had to pass. A table and four chairs were set up so that people would be comfortable while completing the questionnaire. Every third individual or group of people who passed the site were approached and asked if they would be willing to answer a brief questionnaire about their visit. When anyone refused the next group, or person, exiting was approached. Five people declined, and all of them offered a reason. One explained she had "no time to spare" and the four others were only temporarily exiting as they were taking children to nearby public facilities.

Gable and Wolf (1993) stress that any sample should be representative of the target population, so in addition to random sampling, data were collected on eight days over a period of a month in September and October, 1994.

It became clear, after the first two days, that there was an optimum time for soliciting volunteers from visitors at the point of exit. As opening time was 10:00 am, relatively few people left until approximately 12:30 pm when a constant flow exited until 3:00 pm. After that time relatively small numbers left at sporadic intervals. Subsequently the time slot for data collection was limited to the period between 12:30 pm and 3:00 pm.

Table 6.2.
Respondent Demographic Data for All Field-tests of the PVII

Demographic Group	Pilot Field-test		Stability Field-test		Main Field-test		Total All Tests	
	n	%	*n*	%	*n*	%	*N*	%
Sex								
Male	83	47	75	44	320	40	478	41
Female	94	53	97	56	483	60	674	59
Total	177	100	172	100	803	100	1152	100
Age (years)								
8 to 12	30	17	32	19	109	14	171	15
13 to 17	16	9	19	11	86	11	121	11
18 to 25	22	12	21	12	99	12	142	12
26 to 35	59	33	41	24	184	23	284	25
36 to 45	29	16	38	22	228	28	295	26
46 plus	21	12	21	12	97	12	139	12
Total	177	100	172	100	803	100	1152	100
Education level								
Pre-secondary	39	22	44	26	118	15	201	17
Secondary	78	44	74	43	400	50	552	48
TAFE / Polytechnic	8	5	9	5	66	8	83	7
University	52	29	45	26	219	27	316	27
Total	177	100	172	100	803	100	1152	100

Some exceptions to the subject selection procedure occurred when departing visitors walked over to the table, where others were completing the instrument, and expressed curiosity about what was happening. They were then asked to participate. Nine subjects were engaged in this manner. Their inclusion does leave a question about the complete random nature of the sample used in the pilot field-test. However, it seemed at the time, that a refusal on the grounds of contamination of data, would have been inappropriate given that the project depended on the good will of the public.

Prior to beginning the pilot field-test, advice had been sought from both the *Scitech* education manager and the principal of a primary school about minimum age limits for subject selection, based on appropriate reading age and language comprehension levels. Acting on their advice, a lower limit of 10 years was initially set for data collection, however, two subsequent events led to lowering the limit to eight years. First, during the pre-testing of the draft instrument with the first visitor discussion group, one child aged eight was keen to try completing the instrument. She was able to do so without any apparent difficulty. Second, during the pilot field-test some eight and nine-year-old children, who were part of randomly selected groups, made it clear they wanted to participate. Again, no obvious difficulties could be detected. Some, who were younger than eight years, quickly gave up trying to complete the instrument. A tentative lower age limit of eight years was then set.

People took varying times to complete the instrument but most were estimated to have finished within five minutes. Two respondents ticked straight down the page and their responses were discarded later. One adult male, who couldn't read, wanted to participate. The written details of the instrument were read to him, and he was able to complete the instrument without any additional cuing.

Analysis of Data

The random sample of 179 visitors yielded 177 sets of useable data which falls within the parameters given by Gable and Wolf (1993) , who recommended that the number of subjects in the sample for a pilot field-test should be 6-10 times the number of items on a pilot semantic differential instrument.

Items were manually scored by allocating seven for the most positive through to one for the most negative response, and the data analysed to determine whether the number of items could be reduced and subscales could be formed. In both the text and the tables of this report, the adjective pairs are written, and reported, with the positive adjective on the left hand side. However, all versions of the PVII had randomly assigned positive-negative and negative-positive items and the actual forms are shown in the Appendices.

The means and standard deviations for each item are shown in Table 6.3, while the percentage frequencies of response for each item are shown in Appendix 6-C. One feature of the results is that the means of all items, except one, are clustered at the positive end of the adjective pair continuum. The exception is the *quiet-noisy* item which has the lowest mean score of 2.31. The means for all other items ranged from 6.54 for *fun-boring* to 5.15 for *intellectual-trivial*. Standard deviations ranged from 1.63 for *intellectual-trivial* to 0.61 for *fun-boring*. There is a consistent pattern of items with highest means having smallest standard deviations suggesting a ceiling effect and items with lowest means having largest standard deviations. However, as even the highest means are almost one standard deviation below the maximum score, no item was discarded at this stage because of a ceiling effect. It is possible that on some administrations there might be a ceiling effect and this point is taken up later. The number of divisions on the scale was retained at seven, as a decrease to five could have accentuated a ceiling effect for some items.

There is a consistent pattern of item response frequency distributions showing a clustering at one end of an item (see Appendix 6-C) and, consequently, there are high means and small standard deviations. The only exception is the *trivial-intellectual* item which has a small cluster (15%) of responses on the *trivial* side and a large cluster (72%) on the other. A response pattern of this nature does have implications for a semantic differential item developed to measure attitudes.

Table 6.3.
<u>Means and Standard Deviations of Items for Pilot PVII Field-test</u>

Item	Bipolar Adjectives		*M*	*SD*
1	Educational	Non-educational	6.62	.71
<u>2</u>	Intellectual	Trivial	5.15	1.63
3	Informative	Uninformative	6.49	.78
4	Experimental	Non-experimental	6.21	1.04
5	Learning	Bewildering	6.31	.99
<u>6</u>	Understandable	Confusing	5.73	1.14
<u>7</u>	Ignorant	Knowledgeable	6.27	.72
8	Fun	Boring	6.64	.61
<u>9</u>	Enjoyable	Unpleasant	6.59	.63
<u>10</u>	Worthwhile	Worthless	6.40	.72
11	Inspiring	Uninspiring	5.95	1.10
12	Exciting	Dull	6.19	.92
13	Interesting	Uninteresting	6.54	.84
<u>14</u>	Stimulating	Discouraging	6.32	.98
<u>15</u>	Fascinating	Monotonous	5.88	1.27
16	Active	Passive	6.24	.85
17	Colourful	Bland	6.31	.86
<u>18</u>	Quiet	Noisy	2.31	1.29
<u>19</u>	Busy	Idle	5.93	1.26
<u>20</u>	Detailed	Superficial	5.97	1.17
21	Variety	Uniformity	6.26	.82
22	Attractive	Unattractive	6.54	.66

<u>Note.</u> Items with their number codes underlined were stated in a negative format.

According to Shrigley and Koballa (1984) good Likert scale items reflect "emotional intensity" (p. 111) and have response patterns that characteristically exhibit clustering on both sides. As semantic differential items are also usually constructed to measure respondents' emotional reaction to an attitude object (Osgood et al., 1957), clustering on both sides would be expected. Here it is a different situation as the items refer to perceptions rather than emotional reactions. The responses to the items on this scale indicate the degree of agreement with a general view rather than providing a measure of a position taken on a contentious issue.

Shrigley and Koballa (1984) , when discussing the suitability of Likert scale items, recommended that consideration should be given to discarding any items that invoke a neutral response rate of 25% or more. They suggest a neutral response rate of that magnitude may indicate that an item is not invoking enough emotive reaction in respondents. If the same criterion is applied to the suitability of items for a semantic differential scale, then all of the items fall well within that limit. Only two items, *quiet-noisy* (17%) and *trivial-intellectual* (12%), attracted a neutral response rate of 10% or greater (see Appendix 6-C).

Inter-item correlation coefficients were calculated to see whether scales might be formed in order to reduce data. They are reported in Appendix 6-D. Only 45 individual correlations out of 231 were not significantly different from zero ($p <$ .05). The most frequent items amongst those correlations were: *quiet-noisy*, which did not correlate significantly with 11 other items, *superficial-detailed* (9), *confusing-understandable* (8) and *learning-bewildering* (6). The significant correlations ranged from the highest correlation of .67 between *worthwhile-worthless* and *fun-boring* to the lowest correlation of .15 for *exciting-dull* and *learning-bewildering*, *busy-idle* and *informative-uninformative*, and, *detailed-superficial* and *educational-non-educational*.

As a preliminary check on the three notional categories (cognitive, affective and physical environs), a factor analysis using data from the pilot field study was attempted. However, the factor analysis did not provide any clear factors. A series of exploratory principal components analyses was conducted with solutions of five, four, three and two components, using a varimax rotation. In these solutions it was common for some items to load across more than one factor, suggesting that at this stage the categories had some overlap and that some items were redundant.

Discussion

At the end of the pilot field-test three items were discarded and another adopted reducing the number of items to 20. There were two reasons for discarding the items *confusing-understandable* and *learning-bewildering*. First, they were among the items with lowest levels of significant inter-item correlations. Second, they were considered to be repetitive, and so were merged to form a new item, *understandable-bewildering* for further trialing. The third item *attractive-unattractive* was discarded because it consistently split over the other factors.

The item *quiet-noisy* could have been rejected after the analysis, but it was retained on subjective grounds. *Noise* had been the most commonly used word of complaint and was a source of annoyance to a number of visitors. Its retention would provide *Scitech* with further quantitative data about a possible problem, and it would also determine whether noise was also a characteristic of any of the other four sites involved in the main field-test.

The instrument was then modified for the stability field-test. The 20 remaining bipolar adjective pairs were kept in the three notional categories and space was allocated on the back of the instrument for respondents to supply written comments about their visit. The modified instrument was used in the stability field-test and is shown in Appendix 6-E.

Stability Field-test

Method

Data for the stability field-test were collected from visitors to *Scitech* using the amended Pilot Field-test PVII of 20 items. Data were collected from a random sample of 250 visitors leaving *Scitech,* who were selected using the same procedure as the pilot field-test, over four consecutive weekends in November and early December, 1994. An explanation of the nature of the study was given to all prospective respondents. They were then asked if they were willing to participate by completing two questionnaires, one immediately, and another that would be posted to them in approximately three weeks. Those that agreed were then invited to complete the first questionnaire and supply their contact details. Only when they had completed the first questionnaire were they offered a free pass to *Scitech* as an incentive to complete the second questionnaire. They were not informed that the second questionnaire was identical to the first.

Administration of the second questionnaire was conducted by posting out a questionnaire, and an accompanying letter (see Appendix 6-F), timed so they should have received them approximately two weeks after their visit. One hundred and thirty eight were completed and returned within two weeks of posting. After that time a follow-up letter requesting assistance was sent to the subjects who had not returned a completed questionnaire (see Appendix 6-G). This achieved an additional 39 responses, giving a total 172 of the 250 potential responses, at an overall response rate of 69%.

Analysis of results

The procedure for scoring the data was the same as that used in the pilot field-test, and correlations between the responses at the point of exit and the responses after approximately three weeks were calculated. The test-retest correlation coefficients for items within the nominal categories are shown in Appendix 6-H. The correlation coefficients ranged from a high of .89 for *Interesting-Uninteresting* (Item No. 12) to .37 for *Knowledgeable-Ignorant* (6). Fourteen of the items correlated most highly with themselves than they did with each of the other items within each of their notional categories for both scale administrations. The six that did not were *Educational-Noneducational* (1), *Informative-Uninformative* (3), *Knowledgeable-Ignorant* (6), *Enjoyable-Unpleasant* (8) *Inspiring-Uninspiring* (10) and *Variety-Uniformity* (20). All were retained for the main field-test however, because the differences generally were not consistent between administrations.

Main Field-test

Method

In the main field-test five ISTCs were used as sources of data. At *Scitech,* one explainer conducted the random selection of respondents and administration of the questionnaire at the point of exit. This procedure was adopted for three reasons. First, by excluding the researcher it would make data collection more independent. Second, it matched the procedures at the other centres where the researcher was unable to collect data. Third, it tested the ease of administration of the PVII. The explainer was briefed on the procedure to follow and provided with a written set of directions as a reference if required. Both the method for randomly selecting subjects and the arrangements for data collection were the same as the pilot field-test. Data were collected on weekends at varying times over a period of approximately six weeks during January and February 1995 when the explainer was on duty.

A set of 200 copies of the instrument (unchanged from the stability field-test instrument and for the main field-test will be referred to the Main Field-test PVII) was posted to a contact person in each of the other four centres in early January, 1995. Each contact person was supplied with the detailed description of the procedure used at *Scitech* in an attempt to ensure that consistent data collection procedures would be followed at all sites (see Appendix 6-I). The need for the sample of visitors to be selected randomly was stressed. Completed instruments were returned from March 1995 to April 1995. The number of returns from each centre varied probably due to the different resources available at each of the centres for administering the instrument. Informal contact with some of the centres indicated busy schedules and lack of time to deploy a designated person hampered their efforts to collect data. Any instruments that did not have responses for all items, or had ticks straight down the page, were discarded and not included in the data analysis.

The demographic characteristics of respondents at each of the ISTCs are consistent. Full details of the number of participants at each centre and their demographic characteristics are shown in Table 6.4. Because of small numbers in the

8-10 and 11-12 years age groups, the groups are combined to a 8-12 years group. Similarly, the small numbers of respondents aged 56$^+$ years were combined with the 46-55 years group to form a single group, age 46$^+$ years.

Table 6.4.
Respondent Demographic Data for Main PVII Field-test

Demographic Group	*Total*		*Centre A*		*Centre B*		*Centre C*		*Centre D*		*Centre E*	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Sex												
Male	320	40	55	30	80	41	43	39	79	45	63	45
Female	483	60	131	70	115	59	66	61	95	55	76	55
Age (years)												
8 to 12	109	14	14	8	27	14	35	32	23	13	10	7
13 to 17	86	11	18	10	18	9	14	13	21	12	15	11
18 to 25	99	12	20	11	27	14	7	6	31	18	14	10
26 to 35	184	23	50	27	49	25	15	14	36	21	34	24
36 to 45	228	28	67	36	48	25	30	28	41	24	42	30
46 $^+$	97	12	17	9	26	13	8	7	22	13	24	17
Education level												
Pre-secondary	118	15	16	9	33	17	35	32	21	12	13	9
Secondary	400	50	106	57	97	50	55	50	72	41	70	50
TAFE/Polytechnic	66	8	18	10	13	7	4	4	20	11	11	8
University	219	27	46	25	52	27	15	14	61	35	45	32
Total	803	100	186	100	195	100	109	100	174	100	139	100

Data Analysis

Data collected from the five sites were subjected to the same analytical procedures as in the pilot field-test. The means and standard deviations of the combined responses across all the centres, shown in Table 6.5, reveal a similar pattern of results to the pilot field-test. The means for all items, except *quiet-noisy*, were again at the positive end of the scale and ranged from 6.54 to 5.07. Standard deviations ranged from 0.89 to 1.63, with items recording the highest means again having smallest standard deviations. Conversely, items with the lowest means had the largest standard deviations. Generally, means of the same items in both the pilot field-test and main field-test were similar. As items with highest means were approximately one standard deviation below the maximum score, no items were eliminated because of a ceiling factor.

Table 6.5
Main Field-test Items, Means and Standard Deviations

Item No.	Adjective Pair		*M*	*SD*
1	Educational	Non-educational	6.39	.89
2	Intellectual	Trivial	5.07	1.68
3	Informative	Uninformative	6.33	.98
4	Experimental	Non-experimental	6.22	1.08
5	Understandable	Bewildering	5.84	1.30
6	Knowledgeable	Ignorant	5.92	1.25
7	Fun	Boring	6.54	.89
8	Enjoyable	Unpleasant	6.49	.95
9	Worthwhile	Worthless	6.40	1.03
10	Inspiring	Uninspiring	5.75	1.27
11	Exciting	Dull	5.98	1.12
12	Interesting	Uninteresting	6.44	.90
13	Stimulating	Discouraging	6.04	1.17
14	Fascinating	Monotonous	5.91	1.23
15	Active	Passive	6.26	1.12
16	Colourful	Bland	6.22	1.13
17	Quiet	Noisy	2.95	1.63
18	Busy	Idle	5.84	1.39
19	Detailed	Superficial	5.60	1.42
20	Variety	Uniformity	6.07	1.24

Note. Item numbers that are underlined were stated in a negative format.

The results of an inter-item correlation analysis are shown in Appendix 6-J. It shows that 19 of the 20 items correlated significantly (p<.05) with each other. The exception was *quiet-noisy* (Item 17) which correlated (p<.05) with only eight of the 19 other items. Four of those eight were negative correlations. The item *quiet-noisy* was then discarded.

Bearing in mind the advice from the education team at *Scitech* that a small number of results would be interpreted more easily than data for all items individually, the remaining 19 items were subjected to a principal components analysis which resulted in the extraction of three components with eigenvalues greater than unity accounting for 49.3% of the variance. The three components were rotated using a varimax rotation, but the rotated factors were not clean because five items loaded across more than one factor with loading values of more than 0.4. Three factors confirmed the intuitive structure of the three categories, and in fact further analysis using four and two component extractions were used to check this but neither yielded any more interpretable factor structure. This indicated that the exclusion of items which split across factors would remove items containing some redundancy resulting in cleaner factors and the desirable feature of reducing the number of items to make the scale more easily used. Subsequently, five items *experimental-nonexperimental, understandable-bewildering, worthwhile-worthless, fascinating-monotonous,* and *busy-idle* were discarded.

Using the remaining 14 items, a principal components analysis revealed three components with eigenvalues greater than one. They contributed 54.7% of the variance (see Table 6.6). The results of a varimax rotation of the three factors are presented in Table 6.7 which shows no items split across any factors with a loading of 0.4 or greater. The means, standard deviations and Cronbach alpha coefficients as a measure of internal consistency for each of the three factors are shown in Table 6.8.

Table 6.6

Eigenvalues, Percentage of Variance and Cumulative Percentage for Three Factor Solution of the Main Field-test

Unrotated Factor	Eigenvalue	Percentage of Variance	Cumulative Percentage
I	5.26	37.6	37.6
II	1.37	9.8	47.4
III	1.03	7.3	54.7

Note. Only factors with Eigenvalues greater than one are shown.

Discussion

Following the item analysis and factor analysis that reduced the number of items in the main field-test instrument from 20 to 14, the factor analysis of the remaining 14 items indicates there is a possibility of an instrument of 14 items split into three scales. However, Gable and Wolf (1993) warn that even though a factor analysis may reveal distinct groups of items, they do not necessarily form logical factors when considering the conceptual underpinning of the overall context in which they are to be used. In this trial, the groups of words loading onto each factor, shown in Table 6.7, fit into three sound intuitive categories based on the meanings of the

Table 6.7

Factor Loadings for Three Factor Solution of the Main Field-test (Varimax Rotation)

Item No.	Adjective Pair		Factor I	Factor II	Factor III
11	Exciting	Dull	.74		
12	Interesting	Uninteresting	.72		
7	Fun	Boring	.70		
8	Enjoyable	Unpleasant	.65		
13	Stimulating	Discouraging	.62		
10	Inspiring	Uninspiring	.58		
16	Colourful	Bland		.81	
15	Active	Passive		.75	
20	Variety	Uniformity		.63	
6	Knowledgeable	Ignorant			.70
2	Intellectual	Trivial			.68
19	Detailed	Superficial			.58
3	Informative	Uninformative			.53
1	Educational	Non-educational			.52

Note. Item numbers that are underlined were stated in a negative format.

words in a conceptual framework of reactions to a visit to an ISTC. The three groups have been termed Affective (six items), Cognitive (five items), and Sensory (three items). An analysis of the three scales shows the means of the Affect and Sensory scales are high, but both are approximately one standard deviation below the maximum score (see Table 6.8). It is noted that the high means of the scales is a function of the high item means. The issue of a possible ceiling effect is taken up later. When considering the internal consistency of each of the three scales, the Affective and Sensory scales are well within an acceptable level, while the Cognitive scale is marginal (Gable & Wolf, 1993) . The means and standard deviations for each of the 14 items of the Final PVII are shown in Appendix 6-K. Corrected item-scale correlations shown in Table 6.9 indicate that all items tend to contribute to their scale. The only exception is *variety*, which adds little to the scale but was retained because its performance in the principal components analysis was satisfactory and dropping it would reduce the Sensory scale to only two items. The Cognitive scale has the lowest alpha coefficient at .66, but the items contribute to the internal consistency fairly equally.

Table 6.8

Means, Standard Deviations and Internal Consistencies for the Three Scales

Factor	Scale	No. of Items	*M*	*SD*	Alpha
I	Affective	6	6.21	.77	.82
II	Sensory	3	6.18	.94	.73
III	Cognitive	5	5.86	.83	.66

Note. Means are reported as the mean item score.

Table 6.9

Item-scale Correlations for the Three Scales

Item No.	Adjective Pair		Corrected Item-scale Correlation	Alpha if Item Deleted
		Affective		
11	Exciting	Dull	.65	.79
12	Interesting	Uninteresting	.53	.81
7	Fun	Boring	.57	.81
8	Enjoyable	Unpleasant	.68	.77
13	Stimulating	Discouraging	.66	.78
10	Inspiring	Uninspiring	.52	.81
		Sensory		
16	Colourful	Bland	.57	.61
15	Active	Passive	.61	.56
20	Variety	Uniformity	.47	.74
		Cognitive		
6	Knowledgeable	Ignorant	.43	.62
2	Intellectual	Trivial	.40	.64
19	Detailed	Superficial	.45	.61
3	Informative	Uninformative	.44	.60
1	Educational	Non-educational	.45	.59

Note. Item numbers that are underlined were stated in a negative format.

Test-retest correlation coefficients for an instrument based on the three scales using those 14 items are given in Table 6.10. The test-retest reliability coefficient for each scale is above the lower limit of acceptability recommended by Mitchell and Jolley (1996). Two scales – Affective and Cognitive – have the lowest test-retest reliability coefficient of .74 which means that for both of these 26% of the variation in their scores is due to random error. Therefore, each of the scales exhibits acceptable stability.

Table 6.10
Stability Reliability Correlation Coefficients Matrix for the Three Scales

Test	Retest		
Scale	Affective	Sensory	Cognitive
Affective	**.74****	.54**	.48**
Sensory	.58**	**.81****	.60**
Cognitive	.43**	.34**	**.74****

Notes. $^{**}p < .01$. Correlations of each scale with itself are bolded.

There is a good degree of commonality between the three scales derived from the factor analysis and the three notional categories that were derived intuitively. The composition of the Affective and Cognitive scales based on the factor analysis is comparable to the Affective and Cognitive notional categories. Almost all the items (one exception) in the Cognitive scale were in the Cognitive notional categories, while all items in the Affective scale were in the Affective notional category. The common items for the both the Cognitive scale and Cognitive notional category contained the words *educational, intellectual, informative* and *knowledgeable* and items containing the words *fun, enjoyable, inspiring, exciting, interesting* and *stimulating* were common to the both the Affective scale and Affective notional category. The different item on the Cognitive scale was *detailed-superficial* and had previously been included in the Physical Environs notional category. All three items on the Sensory scale were included in the Physical Environs notional category. The Final PVII is shown in Appendix 6-L.

Sensitivity of the PVII

Discussions with the education team at *Scitech* had revealed there was an interest in investigating whether there were any differences in visitors' perceptions based on their ages, sex, and level of education in science. The education team was also keen to compare the results of the centres in the study so centre became the fourth variable to be investigated. So that anonymity was preserved, results identifying any centre remained confidential to the researcher alone. There were no preconceived ideas about differences on any of the variables, and, as indicated earlier, no research was found concerning differences in the perceptions of visitors at the point of exit. Consequently, it was not possible to predict whether differences between the scores on these subgroups would be found and, if they were, what might be the direction of these differences. The term sensitivity has been adopted in this study to describe the potential of an instrument to register differences between the variables of sex, age, level of education in science and centre.

All analyses for the sensitivity of the PVII used the data collected during the main field-test. The number of respondents, means and standard deviations for each of the four variables on each of the three scales are reported in Table 6.11. Mean scores for each of the groups are high indicating a strong, positive experience when visiting. The mean scale scores ranged from a high of 6.40 (*SD* = .68) for the 8-12 year age group on the Affective scale[3] to a low of 5.40 (*SD* = .81) for the 13-17 year age group on the Cognitive scale. Overall, the scores on the Cognitive scale tended to be lower than those on the Affective and Sensory scales, but no consistent trends appeared across scales, except that females' perceptions are always more positive than males'.

A multivariate analysis of variance (MANOVA) was used to test jointly the effects of age, centre and sex on the Affective, Cognitive and Sensory scales of the PVII. These visitor variables are independent, but age and level of education in science are not independent because, for example, school-age children could not have had a tertiary education. Thus education was omitted from this analysis. Table 6.12 shows the non-orthogonal relationship between age and level of education in science. To maintain a reasonable number of respondents in each cell of the three-way matrix, respondents were collapsed into three age groups: school-age (8-17 years), young adult (19-35 years) and older adult (36^{+} years). The number of visitors in each three way cell are shown in Table 6.13. Detailed results of the means and standard deviations for groupings based on sex, the three age groups and each centre on the Affective, Cognitive and Sensory scales are presented in Table 6.14.

The results of the MANOVA shown in Table 6.15 indicate a statistically significant ($p < .01$) two-way interaction between age and centre and a statistically significant main effect for each of the three variables ($p < .001$). Table 6.15 reports

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[3] Respondents with no education in science did have higher means of 6.56 (*SD* = .58) on the Sensory scale and 6.50 (*SD* = .55) on the Affective scale but as there was a comparatively low number of respondents (9) it may not be an accurate indicator for this group of visitors.

Table 6.11

Number of Respondents, Means and Standard Deviations on Each Scale of the PVII for the Main Field-test

Variable		Scale					
		Affective		Cognitive		Sensory	
	n	*M*	*SD*	*M*	*SD*	*M*	*SD*
Sex							
Male	320	6.05	.85	5.72	.88	6.01	.99
Female	483	6.32	.70	5.96	.79	6.30	.89
Age Group (years)							
8-12	109	6.40	.68	5.74	.85	6.37	.69
13-17	86	6.06	.75	5.40	.81	6.02	1.08
18-25	99	5.97	.78	5.59	.78	6.14	.94
26-35	184	6.26	.76	6.02	.78	6.17	.98
36-45	228	6.21	.77	5.97	.81	6.15	.95
46^{+}	97	6.30	.81	6.12	.80	6.28	.90
Education level							
None	9	6.50	.55	6.24	.66	6.56	.58
Primary	109	6.39	.71	5.80	.83	6.33	.88
Secondary	400	6.22	.76	5.87	.85	6.18	.95
TAFE/Polytechnic	66	6.26	.65	6.01	.76	6.20	.86
University	219	6.09	.84	5.82	.83	6.10	.98
Centre							
Centre A	186	6.16	.78	5.71	.83	6.04	1.06
Centre B	195	6.32	.74	6.00	.78	6.38	.86
Centre C	109	6.19	.82	5.89	.83	6.07	.93
Centre D	174	6.11	.86	5.83	.91	6.21	.90
Centre E	139	6.29	.62	5.88	.78	6.17	.89
Total	803	6.22	.77	5.86	.83	6.19	.94

Note. Means are reported as the item scale score.

Table 6.12

Numbers of Respondents in the Cross Breakdown of Demographic Subgroups

Age group (years)	Education Level in Science			
	Pre-secondary	Secondary	TAFE / Polytechnic	University
Males				
8-12	40	2		
13-17	2	37		
18-25		13	8	19
26-35	2	24	7	30
36-45	1	42	12	36
46^{+}	3	22	2	18
Females				
8-12	57	10		
13-17	1	45	1	
18-25	1	29	4	25
26-35	4	73	11	33
36-45	1	74	17	45
46^{+}	6	29	4	13

Table 6.13

Number of Respondents in each Age x Sex x Centre Grouping

	School-age		Young Adult		Older Adult	
Centre	Male	Female	Male	Female	Male	Female
A	6	26	14	56	35	49
B	23	22	27	49	30	44
C	21	28	8	14	14	24
D	16	28	33	34	30	33
E	15	10	21	27	27	39

Table 6.14

Means and Standard Deviations for Age x Sex x Centre Groupings

		Age Group					
		School-age		Young Adult		Older Adult	
Sex	Centre	*M*	*SD*	*M*	*SD*	*M*	*SD*
				Affective			
Male	A	6.03	.55	5.57	.96	6.10	.84
	B	6.26	1.03	6.04	.68	6.27	.87
	C	6.28	.62	6.04	.43	5.58	1.30
	D	5.91	.99	5.87	.85	6.11	.90
	E	6.03	.56	6.18	.82	6.07	.64
Female	A	6.29	.68	6.20	.75	6.27	.73
	B	6.40	.70	6.40	.63	6.41	.62
	C	6.26	.68	6.58	.39	6.22	.91
	D	6.36	.69	5.96	.97	6.41	.69
	E	6.40	.47	6.48	.63	6.43	.48
				Cognitive			
Male	A	4.33	.85	5.26	.91	5.90	.79
	B	5.82	.83	5.91	.76	5.97	.91
	C	5.86	.66	5.63	1.10	5.67	1.00
	D	5.06	.98	5.64	.82	6.05	.89
	E	5.35	.61	5.83	.76	5.64	.88
Female	A	5.54	.72	5.78	.84	5.87	.70
	B	5.59	.67	6.19	.68	6.19	.76
	C	5.94	.82	5.99	.84	6.02	.82
	D	5.56	.91	5.93	.78	6.33	.74
	E	5.68	.87	6.05	.68	6.22	.66
				Sensory			
Male	A	5.61	1.00	5.55	1.51	6.06	.95
	B	6.25	1.29	6.14	.62	6.18	.97
	C	6.10	.75	5.88	.40	5.50	1.47
	D	5.75	1.17	6.07	.82	6.16	.76
	E	6.00	.86	6.08	.86	5.89	1.17
Female	A	6.32	1.03	5.98	1.10	6.12	.92
	B	6.42	.52	6.54	.96	6.53	.59
	C	6.25	.75	6.33	.86	6.10	.97
	D	6.38	.73	6.31	.91	6.39	1.03
	E	6.57	.45	6.17	.93	6.38	.68

the univariate tests for the age x centre interaction, and reveals that interaction is on the Cognitive scale. Table 6.16 (and later tables) also report eta-squared as a measure of effect size interpreted as a proportion of variance explained. It can be seen that the interaction accounts for 2.85% of the variance in the Cognitive results. Figures 6.1, 6.2 and 6.3 were drawn from the means reported in Table 6.14, and comparison shows that in contrast to the graphs for the Affective and Sensory scales (Figures 6.1 and 6.3, respectively), Figure 6.2 shows a considerable variation, particularly for the school age visitors at *Centres A*, *D* and *E*.

Table 6.17 reports the univariate results for main effects for sex, centre and age. (Appendices 6-M, 6-N and 6-O show the full details of the ANOVAs for each of the three scales.) It shows that there is a statistically significant effect ($p < .001$) for sex on all three scales. The results in Table 6.11 and Figures 6.1, 6.2 and 6.3 show that it is the females who are responding more favourably on all scales. However, these differences are only small as shown by the eta-squared values in Table 6.17 – the largest being .0317 for the Affective scale. There are statistically significant effects for centre on the Cognitive scale ($p < .001$) and on the Sensory scale ($p < .01$) with eta-squared values of .0305 and .0180 respectively. Age has a statistically significant effect on the Cognitive scale ($p < .001$) and an eta-squared value of .0479, the largest effect size.

Examination of Figure 6.1 for the Affective scale suggests little difference, on average, between centres when the variance for the age and sex subgroups are ignored. This is reflected in the mean scores reported by centre in Table 6.11, and is consistent with the small effect size of eta-squared .0110 reported in Table 6.17. *Centre B* has the highest mean overall on the Affective scale and *Centre D* and *Centre A* the lowest. The most obvious differences between centres are on the Cognitive scale where the largest effect size (3.05% of variance explained) is found. The means in Table 6.11 show that *Centre B* has the highest mean, *Centre A* the lowest and the other Centres in between. It is noticeable in Figure 6.2 that the low mean for *Centre A* is attributable to low scores for school age and young adult males, partly responsible for the interaction effect noticed earlier. *Centre B* has the highest mean on the Sensory scale, and *Centres A* and *C* the lowest (see Table 6.11) and although these differences are statistically significant at the .01 level, they account for less than 2% of the variance.

The largest effect reported in Table 6.17 is for age on the Cognitive scale, with nearly 5% of the variance accounted for. The variation between age groups in Figure 6.2 has already received comment, however, examination of the means in Table 6.11 reveals no consistent increase over the six age groups with age, although the highest means are for those 26 years and over.

Table 6.15

Multivariate Analysis of Variance Results for Age x Sex x Centre

Effect	*df*	*F*	*p*
Age x Sex x Centre	24	1.24	.197
Sex x Centre	12	.67	.779
Sex x Age	6	.60	.729
Age x Centre	24	1.87**	.006
Sex	3	13.08***	.000
Centre	12	3.48***	.000
Age	6	11.39***	.000

Note. ** $p < .01$ *** $p < .001$

Table 6.16

Univariate Analysis of Variance Results for Age x Centre Interaction Effects

Scale	*SS*	Error *SS*	*F*	Eta^2
Affective	8.39	443.00	1.83	.0176
Cognitive	15.85	485.54	3.15**	.0285
Sensory	7.00	661.59	1.02	.0099

Note. ** $p < .01$

Table 6.17

Univariate Analysis of Variance Results for Centre, Sex and Age Main Effects

Scale	Sex		Centre		Age	
	F	Eta^2	*F*	Eta^2	*F*	Eta^2
Affective	26.44***	.0317	2.30	.0110	.64	.0002
Cognitive	26.49***	.0299	6.75***	.0305	21.19***	.0479
Sensory	24.95***	.0302	3.71**	.0180	.18	.0004

Note. **$p < .01$ *** $p < .001$

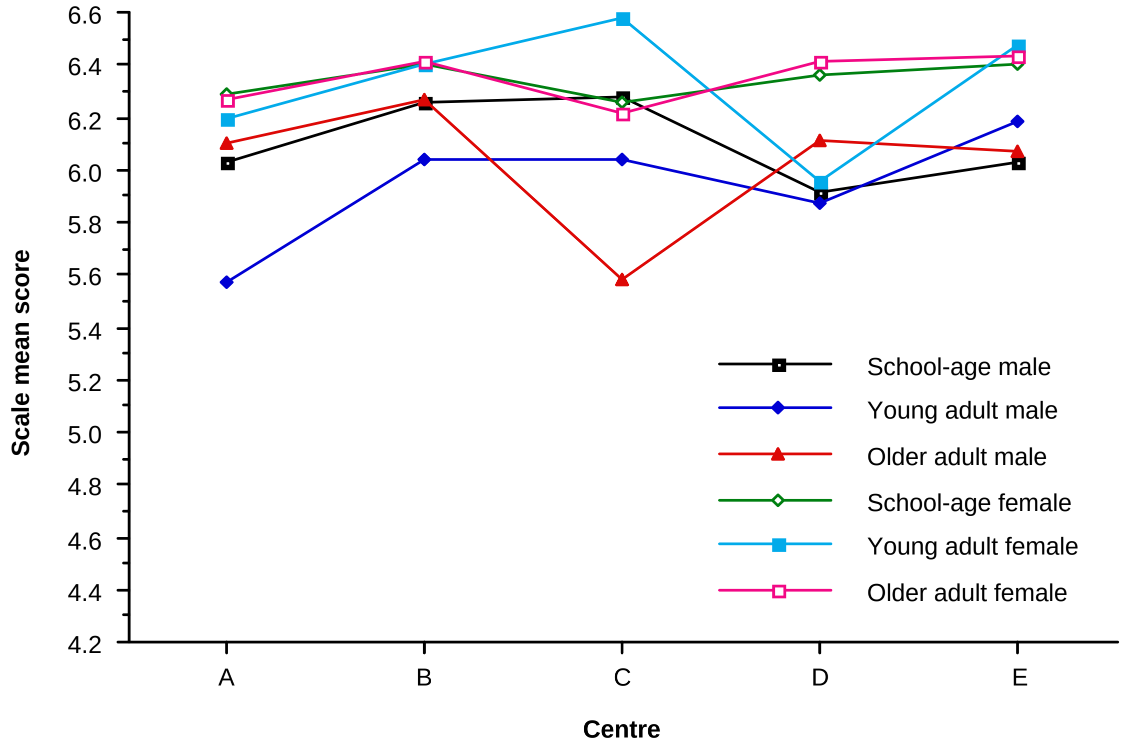

Figure 6.1. Mean scores for sex and age by centre on the Affective scale of the PVII.[4]

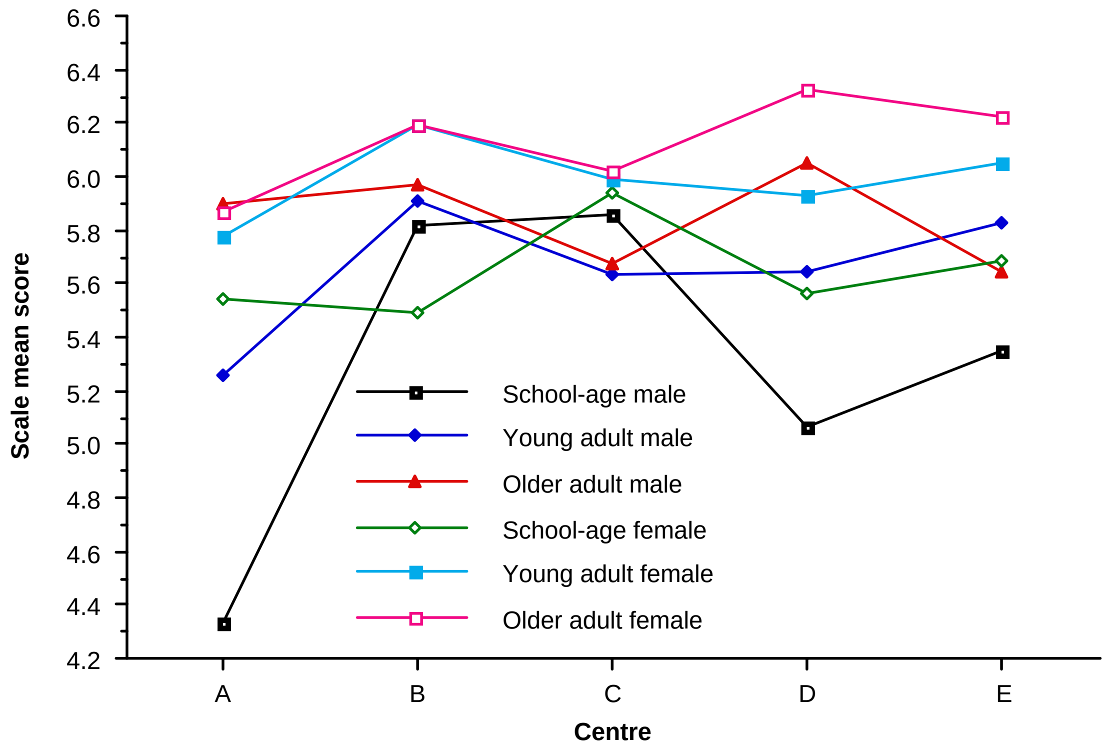

Figure 6.2. Mean scores for sex and age by centre on the Cognitive scale of the PVII.

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[4] It is noted that the points on all three graphs are joined for ease of visual inspection and do not imply any relationship between the centres.

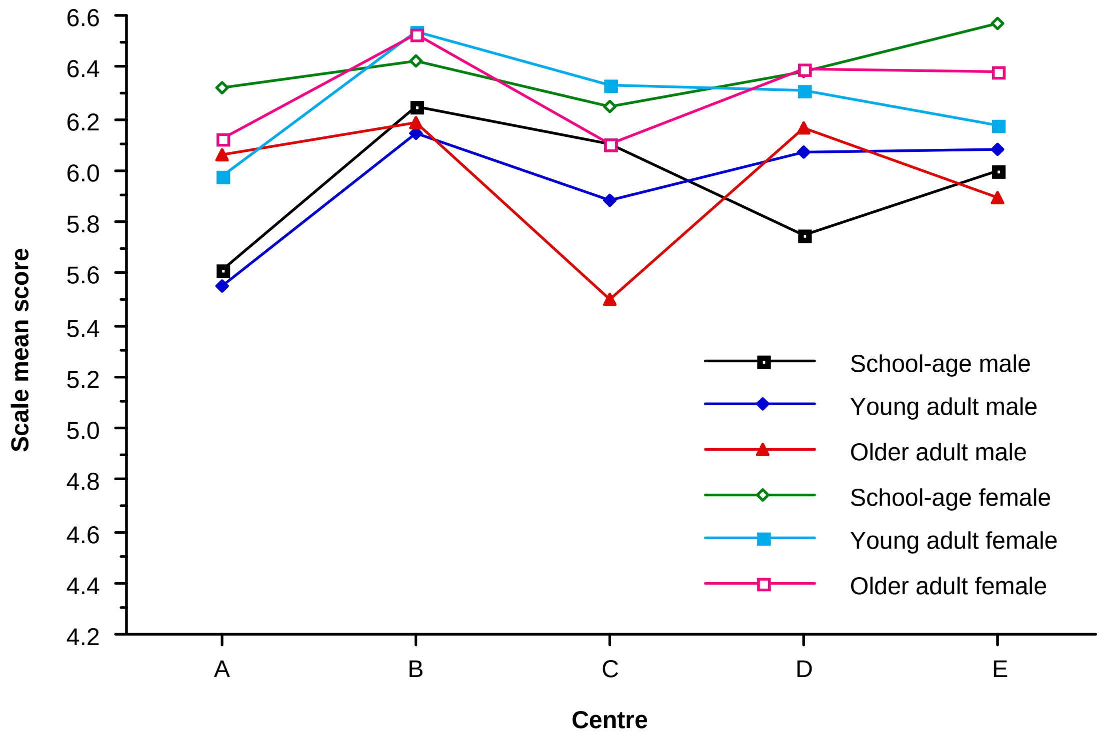

Figure 6.3. Mean scores for sex and age by centre on the Sensory scale of the PVII.

The overall results show the PVII is able to detect statistically significant differences between different subgroups of this sample of visitors on each of its three scales, particularly the differences between males and females. It is also able to detect differences between centres, some of which are statistically significant although the effect sizes are small. It seems, too, that different centres may have different appeal to different age groups. The statistically significant differences between centres were registered on the Cognitive and Sensory scales. It is difficult to give a specific reason for the differences on the Cognitive scale. *Centre B* has many more exhibits than *Centre E* and there were several major thematic exhibitions at *Centre B* which was not the case at *Centre D* and *Centre E*. It is possible that one, or both, of these differences may be reasons for the higher mean at *Centre B*.

There is a likely reason for the statistically significant difference on the Sensory scale. Immediately upon entering *Centre B*, a visitor is immersed into a sea of busy engagement with exhibits and colourful surroundings. The impact is accentuated because all the exhibits are displayed in a single, large floor area. The "buzz" of activity gets quite intense on weekends and school holidays when most of these data were collected. At both *Centre D* and *Centre E* the intensity is not as great nor is there the same immediate impact. *Centre E* is much smaller and has two separate galleries. *Centre D* has more exhibits but they are in many separate galleries.

For completeness, one way analyses of variance for the four levels of education in science (the very small group of nine with no education in science were omitted) with the three scales were carried out and the results are reported in Table 6.18. Only one result is statistically significant, an effect on the Affective scale. The results in Table 6.11 suggest higher means for those with a lower level in education, but the effect was trivial, accounting for less than 1% of variance in the scores on the Affective scale.

Table 6.18

Analysis of Variance Results for Education on the Three Scales

Scale	*SS*	*F*	Eta^2
Affective	6.96	3.92**	.0082
Cognitive	2.33	1.12	.0002
Sensory	4.15	1.57	.0022

Note. ** $p < .01$

Use of the PVII in a Different Kind of Centre

In a later opportunity to test the PVII in another forum, it was administered to 218 people immediately following their visit to a static, gallery-type exhibition of 15 technology exhibits. The exhibits were developed as their final year projects by engineering students in a technical and vocational training institution and the best of these exhibits were selected for public display. Each exhibit was accompanied by a brief written explanation of its function, quite similar in physical presentation to the graphics that usually accompany ISTC exhibits, but different in the style and content of the text. The text provided information only and did not present questions or prompts for any action by the reader. Only one exhibit, a data-base accessed by an available computer terminal, was in any way interactive. All the exhibits feature modern technology and were designed to commercially acceptable standards. Hence, their appearance is that of a professional product.

Three examples that typify the nature of the exhibits are a wheel chair; a robotic, human arm mobiliser; and a door bell for the deaf. The wheel chair has a seat that can be raised or lowered by an electric motor to assist a disabled person to reach different levels. The robotic mobiliser is a mechanical arm that gently raises and lowers the arm of a person who has had that limb immobilised for some time. It is used to perform repetitive movements over a period of time as a part of a physiotherapy rehabilitation program. The door bell for the deaf is an electronic device worn like a wrist watch. When door bell is rung, the device on the wrist notifies the deaf person by vibrating.

The exhibition is located in a permanent gallery at the institution next to an information centre for visitors, and is changed annually when projects from the next cohort of engineering students are evaluated. It is usual for visitors to the institution to call at the information centre when making enquiries about course or to use it as a place to wait while contact is being made with anyone with whom they have an appointment. The staff at the information centre counter usually invite visitors to view the gallery. At the entrance to the gallery, information is presented about the institution (vision and mission statements, history) in graphics on wall hangings and in a promotional video on a large screen at eye-level. Once a visitor passes into the gallery, the 15 technology exhibits can be viewed. The gallery is set in a modern building, it has high ceilings, and is well appointed with sufficient space for small groups of people to view the exhibits in comfort. The ambience is more like a traditional science and technology museum than an ISTC because it is quiet and visitors are engaged by reading and observing only.

Respondents in this study were 218 volunteers from a group of visitors who visited during the annual "open house" period. Open house is a three-day event held through the week where many activities and displays about courses available at the institution are conducted by staff and students in a carnival atmosphere. For example, two of the Engineering School's attractions enticed visitors to play soccer with robots and participate in an egg-collection competition using robots. The many interest clubs (e.g., rock climbing, adventure, drama) and student support clubs (e.g., campus care, student association) supplement the activities of the different disciplines. It is during this time that many prospective students (mostly future school leavers) visit the institution often accompanied by family members and friends. Many do not visit the gallery as the main attractions are located in more obvious sites. Attention was drawn to the exhibition by advertising it in newspapers and on television, and having it opened with a special ceremony by the Minister for Science and Technology. A sign was placed outside the visitor information centre inviting people to enter and view the technology exhibits. Therefore, people viewing the exhibits did so by choice, similarly to those who visit an ISTC as part of a leisure activity. There was no admission fee.

To get sufficient numbers for this study, each person who visited the gallery during the morning of the three days was approached by the visitor services attendant as they exited and asked to complete the PVII. Consequently, the sample is not random but it is representative of the visitors to the gallery. Most people agreed to participate. According to the attendant, there were 19 refusals and most of those said they did not have enough time to complete a questionnaire. Demographic data for the different groups for respondents to the PVII administered at the technology exhibits and in the main field-test are shown in Table 6.19.

Table 6.19

Number of Respondents by Sex, Age and Education Level Visiting the Technology Exhibits Compared with the Main Field-test

Demographic Subgroup	Technology Exhibits *n*	Technology Exhibits %	Main Field-test n	Main Field-test %
Sex				
Male	114	52	320	40
Female	104	48	483	60
Age Group (years)				
8-12	7	3	109	14
13-17	44	20	86	11
18-25	27	12	99	12
26-35	68	32	184	23
36-45	56	26	228	28
46^{+}	16	7	97	12
Education level				
None	0	0	9	1
Primary	10	4	109	14
Secondary	108	50	400	50
TAFE/Polytechnic	56	26	66	8
University	44	20	219	27
Total	218	100	803	100

While there are some differences in the percentages of the demographic subgroups of the respondents in the main field-test and at the technology exhibits they are mostly similar. The biggest difference is for the TAFE / Polytechnic level of education in science where there was a much larger proportion at the technology exhibits. Possible reasons for the differences in the percentages for the 8-12 and 13-17 year-old groups is that it was during a school week and the target for open house was 16-17 year olds.

Table 6.20 reports the means, standard deviations and Cronbach's Alpha for each scale calculated from data gathered by the PVII at the technology exhibits and during the main-field test (see Table 6.8). The reliabilities for each scale are very similar for the two sets of data. There are large mean differences for each of the three scales with the mean for the technology exhibits being lower on all three. This difference is accentuated by the high t-values also shown in Table 6.20 and large effect sizes for the differences between the means. Recalling that Cohen (1969) suggested 0.8 represented a large effect, effect sizes greater than two standard deviations are large indeed. As might be expected, the difference is smallest on the Cognitive scale and larger on the Affective and Sensory scales, consistent with the more stimulating environment of the ISTCs. Clearly, the PVII has distinguished between these two kinds of centres. It is not surprising this is the case as the ISTCs are much more similar among themselves than any of them is to a static display of modern technological exhibits. Further, these results suggest that the possible ceiling effect found in the data from the ISTCs in the main field-test is not relevant if the PVII is to be used more widely in a variety of environments.

Table 6.20

Means, Standard Deviations, *t*-scores and Effect Size for Main Field-test and Technology Exhibits

	Technology Exhibits			Main Field-test ISTCs				
Scale	*M*	*SD*	Alpha	*M*	*SD*	Alpha	*t*	Effect size
Affective	4.66	.73	.87	6.21	.77	.82	26.77***	2.04
Sensory	3.78	1.05	.77	6.18	.94	.73	32.67***	2.49
Cognitive	5.19	.49	.62	5.86	.83	.66	11.42***	.87

Notes. Means are reported as the mean item score.
Effect size is calculated as difference between means divided by the within-group standard deviation.
*** $p < .001$

Reports to Participating ISTCs

Each of the participating ISTCs was provided with a comprehensive report of their respective results. The report was in two sections with the first providing an executive summary that gave the purpose of the PVII followed by a brief description of the overall results. Both the CEO and Manager of Education at *Scitech* had mentioned they would be interested in having an indication how different age groups were reacting to a visit. Therefore, a second section was provided that gave a comprehensive analysis of the results including means for each of the three notional categories (Affective, Cognitive, Physical Environs) across a breakdown of groups by age. An example, typical of the reports, is shown in Appendix 6-P. The reports were accompanied by a letter which thanked each CEO and the staff who were involved for their support in making the study possible.

Approximately three weeks after sending the reports, a letter and short questionnaire seeking feedback about the PVII were sent to the five contact people at the ISTCs (see Appendix 6-Q and Appendix 6-R). Four responded and enquiries revealed that the contact person who administered the PVII at the remaining centre had left. The responses to the ISTC feedback questionnaire indicated the ISTCs were very positive about the PVII and it was regarded as being effective because it provided useful information. All four ISTCs stated the survey was valuable to them. One commented:

> This survey has been of great value in providing more specific feedback on our visitors' impressions of the centre other than indicating their degree of satisfaction.

All four reported they had used or intended to use the results of the study. One stated:

> It will be discussed with trust members by way of validating the work being done here, from a neutral standpoint.

Three reported they would use the instrument again, while the other reported they would "need to design their own with local considerations." One commented that it was easy to administer, easy to score and compile results. Suggestions for improving the instrument were concerned with the random negative-positive orientation of bi-polar adjectives. The comment was:

> I wasn't sure if the method of mixing the orientation of the scale i.e. sometimes, good - bad and sometimes, bad - good was confusing for visitors who answered quickly. I would have kept the negative positive orientation the same in each question.

No changes were made because of this suggestion. Some respondents may be in a hurry at the point of exit but the data might be contaminated by having a format that facilitated selections to be given with little thought.

Another criticism concerned the level of language and the number of options. The comment was:

> The language was a little hard for some of the younger groups we'd like to work with, and perhaps there were a few too many options.

The second part of that comment is interesting because it supports the decision to reduce the number of items on the Final PVII to 14 from the 20 that were on the Main Field-test PVII.

Summary

This part of the study led to the development of a validated instrument that enables data to be collected at the end of a visit to an ISTC. The PVII is structured so that the Affective, Cognitive and Sensory scales provide three pieces of information about visitors' immediate reactions to their experiences. As well, there is an open-ended item which allows for visitors to supply written comments. The PVII is easily administered and the data it gathers can be scored quickly. It also shows potential for wider use where the bi-polar adjectives are appropriate. Importantly, the four centres that replied gave positive feedback about its worth.

CHAPTER 7

STAGE 5: THE PROFILE OF VISIT OUTCOMES INSTRUMENT

Overview

In this chapter, the Profile of Visit Outcomes Instrument (PVOI) is described followed by an account of the evolution of its style. Details of developing a bank of items for use in the PVOI, and its first review, are then provided. The steps involved in collecting and analysing the data to test the items used in the PVOI are described, and finally, suggestions for using the PVOI are made.

Introduction to the PVOI

The PVOI was developed to gather data from voluntary visitors to an ISTC three to four weeks following their visit. During that period, visitors would have time to reflect on their visit experiences and possibly do something as a result of it. The PVOI was designed to collect data about a wide range of possible outcomes of a visit and, in doing so, give a broad picture of what visitors take away following a visit. An ISTC can administer it to a random sample of visitors to develop a profile of outcomes of a visit to their centre by extrapolating the results of those data to all their visiting population.

There are nine sections in the final PVOI with a total of 82 items. A summary of the structure of the PVOI is shown in Table 7.1. Most of the items relate to the affective domain of learning while some imply that cognitive learning has taken place. Discussion about exhibits following a visit, for instance, implies some level of cognitive activity but does not specify on what level it is occurring. The PVOI does, however, measure the extent to which that discussion (and cognition) about exhibits is taking place among a sample of the visiting population. When the items are considered collectively, a profile of visit outcomes is available for an ISTC to have an indication of its effectiveness from visitors' perspectives.

The PVOI was developed through a series of steps, the first being to examine statements from the PVQ and interviews to develop a bank of items. These were then sorted into categories which became eight of the sections of the instrument. The draft instrument was previewed by a targeted expert group and individuals as a check for face validity and some changes were made. It then underwent a pilot field-test with a small group of visitors who did not suggest any further changes. Following that, a main field-test was conducted, and alterations made, before a final review by some respondents in the main field-test. Before describing all the steps, the evolution of the style of instrument and the reasons for including the different formats for the items will be outlined.

Table 7.1
Structure of the Final PVOI

Section	Title	No. of Items
A	Your overall impression of your visit.	6
B	Your own learning and understanding as a result of your visit.	11
C	Your thoughts and feelings as a result of your visit.	9
D	Your views about science and technology as a consequence of your visit.	8
E	What you did as a result of your visit.	16
F	For parents in a family group.	13
G	For school students.	9
H	For primary school teachers.	9
I	Are there any other comments you would like to make about your visit to the centre?	1

Evolution of the Style of Instrument

During the literature review, only a few studies using instruments for research in informal science education were sighted. None of them was appropriate for use in this study where the target population is "free-ranging" voluntary visitors, mostly in pursuit of leisure, all with different backgrounds and agendas, likely to attend to many different exhibits. Schibeci (1992), for example, used an instrument that was developed to measure knowledge gain by visitors interacting with a specified set of exhibits. Another example was in the MIES study (Anderson, 1993a, 1993b, 1993c) where instruments were designed to measure outcomes after interaction with only one exhibit.

A search of the literature was conducted for a different type of instrument and one which had been developed recently, the Views On Science Technology and Society (VOSTS) instrument, seemed to be particularly suitable. The VOSTS instrument is unique because it is a qualitative multiple-choice instrument and given the open environment of a voluntary visit to an ISTC, was considered to be worth investigating. It was initially used as a model both for the developmental process of the PVOI and for the format of items.

When reporting its development, Aikenhead (1988) described it as an instrument that has an "empirically derived multiple-choice response mode" (p. 625). A typical VOSTS item consists of a stem, usually a statement on an issue, followed by a list of alternatives of which only one can be selected. There is no one correct answer to a VOSTS item, as all the alternatives in an item are different perspectives about the issue stated in the stem. It is also unique because there is an alternative which gives respondents the opportunity to indicate if they didn't understand the item. These alternatives were developed from data collected from a quantity of essays and short answers written by students about an issue and checked using follow-up interviews with students.

Accordingly, the first step in developing the PVOI was to develop items from all the PVQ and interview data and sort the items into categories. Seven categories emerged that suited a VOSTS-style instrument and these were used as a stems. They were: overall impression of a visit; learning and understanding from a visit; thoughts and feelings about the visit; views about science and technology after a visit; parents' perspectives of their family visit; school students; and school teachers.

A variety of statements from each category were selected as the alternatives to the stem. The following example was an attempt at developing an item based on the VOSTS model and shows the stem and alternatives based on the PVQ and interview data.

My visit was stimulating because:

- There was lots to do.
- There was a wide range of exhibits.
- I liked being challenged.
- I now look about me in a more inquisitive manner.
- I am now curious about things I hadn't given a great deal of thought to previously.
- I was exposed to many different things and how they work.
- I liked being exposed to many different things and how they work.

The following two alternatives would also be included in a typical VOSTS item:

- None of the above apply to me.
- I do not understand the question.

After developing VOSTS-type items using seven of the eight categories that were suited, two major problems were apparent. First, it was possible that items forming alternative responses to a stem could all be valid for any one respondent, whereas in a VOSTS format the respondent is limited to one alternative. Second, a visitor could indicate they agreed with a particular alternative but a VOSTS format does not allow for an expression of the degree of agreement. For example, when using a VOSTS format to respond to the PVOI item "I intend to return", a visitor could select it to indicate their intention to return but that alone would not provide an indication of the strength of that intent. For these reasons the plan to develop an instrument based on a VOSTS format was abandoned.

A simple solution to the problem was to adapt the response alternatives of the seven existing VOSTS-style items to a Likert format. The Likert scale proved to be more appropriate because it gave visitors an opportunity to indicate their extent of agreement or disagreement with each of the items. As well, all of the alternatives in each item were available for individual reactions, and consequently, a wider range of data was available to develop a more comprehensive profile of visit outcomes.

When discussing different styles of instruments for measuring the affective domain, Gable and Wolf (1993) suggest Likert scales are popular because they are "relatively easy to construct, can be highly reliable, and have been successfully adapted to measure many types of affective characteristics" (p. 50). Two other advantages of using a Likert format are that respondents would probably be familiar with the format and the data are easily scored.

Some items were not suited to a Likert response format, however, and eventually three different response formats were used. These were: Likert, checked box and open-ended. There is a section in the PVOI about different things people have done as a result of their visit and 14 of those items require a direct response only. Either respondents have done something or they have not, so a box is provided for them to indicate their response. As well, in this section and two of the others that use Likert scale items, there are open-ended items soliciting extra information. A section at the end of the PVOI contains one open-ended item to allow for any additional comments respondents may wish to make about their visit. On the final PVOI there are 61 items using a Likert response format; 14 items where respondents can check a box; and 7 open-ended items. The mixed format of the items on the PVOI allows a variety of data to be collected.

Construction of the PVOI

Development of a Bank of Items

The source of items was the data provided by voluntary visitors, mainly in response to items on the PVQ but also from some statements made during the interviews. By using a large number of randomly selected visitors' statements as a source, the criterion of construct validity is met (Mitchell & Jolley, 1996) . An inductive constant comparison method (Lincoln & Guba, 1985) was used to develop categories. Initially, all the transcribed oral and written responses supplied in the interviews, discussion groups and on the PVQs were keyed into a word processor. These were visually scanned for common elements and then cut and pasted into groups of similar statements. This proved to be a lengthy trial and error process during which some categories were tried and later discarded.

New categories were developed by setting aside a statement or phrase that did not suit an existing category until similar phrases or statements were found and pooled with it. As the pool grew, an appropriate generic name for that pool of phrases or statements became evident. All phrases were included until enough categories emerged to include all of them. Altogether eight broad categories emerged and their generic names became the titles for the first eight sections of the PVOI shown in Table 7.1.

The next step was to develop the items in each section. That was achieved by reducing the number of statements and phrases by selecting those that best encompassed the meaning of other similar phrases. No attempt was made to change the wording of the original phrases at this stage as the visitors' wording needed to be retained. Most statements and phrases were allocated easily to the categories, however, it was difficult with some as they could be placed in more than one category. In such cases, McManus had recommended any researcher faced with that dilemma has to make an intuitive decision about in which category to place those phrases (personal communication, February 14, 1995). Her recommendation was followed.

Three typical items on the PVOI and the visitor statements or phrases from which they were derived are:

A4 Children are free to explore without being told "don't touch"

- "Freedom for children to experiment whereas in other places they may have been told 'don't touch'."
- ". . . no restrictions allowed my children engage in activities of their own choosing."
- "I like the idea that my children can choose activities for themselves."

B11 I learned something new about the world around me.

- "I learned something new about the world around me."
- "The mining exhibit let me experience things I would otherwise never get the chance to see."
- "The insects we've imported seem strange, for example the dung beetles."

F7 We talk as a family about what we did on our family visit.

- "We talked about our visit all the way home in the car."
- "My children talk constantly about the things they have seen and that gives us a chance to talk about things and share experiences."
- "It was a source of educational entertainment that could be shared by the whole family . . . discussed on many occasions since the visit."

Full details of all the items and the statements from which they were derived are provided in Appendix 7-A.

Once all the statements had been categorised, and redundant phrases and statements identified and eliminated, a copy of the categories and statements were given to three colleagues. Two of these colleagues were experienced informal science education researchers and the third was a university lecturer whose only previous experience with ISTCs was as a casual visitor. They were each asked to identify any statement that was inappropriately categorised. Although a query was made about the similarity of two items in different categories, no changes of wording were suggested. The items were subsequently scrutinised by different groups throughout both the field testing and a review process, and will be reported at appropriate points in this chapter.

Before the draft PVOI was trailed, a factor to be considered was the timing of the administration of the PVOI. During both of the visitor discussion group sessions people had been asked when they thought would be an optimum time. Most favoured a period that was reasonably close to a visit with a maximum period of one month time lapse. One respondent had stated, "otherwise we'll forget." Seven other people, who had all visited *Scitech,* concurred with the discussion groups. The general consensus was that about three to four weeks after a visit would be an appropriate time to complete the PVOI. They believed adequate time would have elapsed for someone to have actually done something as a consequence of their visit. A time of two to three weeks following a visit for posting of the PVOI was settled upon.

Draft PVOI Construction

The physical construction of a draft PVOI for a trial field-test was the next step in the process. Each statement was listed under its respective category and for seven of those categories a Likert-scale format was used. Initially, a five-point scale Likert scale was adopted with options of Strongly Agree, Agree, Disagree and Strongly Disagree and No Opinion being used to direct visitors' responses. Because almost all of the statements collected from visitors were positive the items were constructed to reflect that bias. Negative statements about a visit were accommodated using two strategies. First, some would be captured by respondents disagreeing with a positively worded statement. For example, the visitor who wrote, "Science still seems like a lot of mumbo-jumbo to me" would be able to express his view by disagreeing with the item "I no longer think science and technology are beyond my grasp." Second, a section titled "Any other comment" was placed after all the Likert scale items and towards the end of the draft PVOI. Any respondents who wished to register their dissent could do so in this section. During the main field-test, some did.

A cover page was developed consisting of four sections: the title of the instrument at the top of the page followed by a brief explanation of its purpose, instructions about which sections respondents should complete and an example item, along with a respondent's possible answer to illustrate the process of completing the Likert scale items.

The draft instrument consisted of 83 items (excluding respondent details) presented in three response formats: Likert scale, check box, and open-ended. There were seven sections using Likert scales. Four were for all respondents and were designed to measure overall impressions, learning and understanding, thoughts and feelings, and views about science and technology. The remaining three targeted specific categories of voluntary visitors: parents in a family group, school students and teachers.

Another set of items referred to possible actions of people following a visit and people were required to indicate whether they had done one or more of 15 possible actions by checking a box labelled yes or no. Two open-ended questions at the end of this section asked for further details about any action or actions they had indicated and details of anything that they had done that wasn't included on the scale provided.

The sections for school students and school teachers also included open-ended questions, soliciting additional information. Two other open-ended questions at the end of the PVOI asked respondents to provide any additional comment about their visit and their perception of what the ISTC aimed to achieve. The latter was added following a suggestion of the acting CEO of *Scitech.*

Most of the last section was similar to that on the PVII and collected demographic data about respondents' ages, sex and level of education in science. The PVOI also collected data about the social context of a visit based on the group with whom a respondent visited. There were three alternatives: by themselves, with their family or with friends.

Draft PVOI Review and Pilot Field-test

A total of 27 people reviewed the draft PVOI prior to a pilot field-test, including the *Scitech* Education Team (twice), two school principals, four primary school teachers, two high school teachers, two primary school children, eight adult visitors and two science education lecturers. Each person was asked to check items for clarity, categorisation and appropriateness, and to comment on the format and content of the draft PVOI.

A number of problems with both the content of the items and the format of the draft PVOI were identified and discussed. Consequently, changes were made involving the wording of some of the items, the discarding of one item, the nomenclature for the response format of the Likert scale, the format of the instrument and layout of the cover page. The "no opinion" option of the Likert scale was challenged by two of the reviewers who believed that people would have an opinion about all the items on the draft PVOI. After discussion with an experienced researcher, the "no opinion" option was changed to "neither disagree nor agree." In the section on action people may have attributed to their visit, an item about giving up smoking was dropped. Six reviewers were of the opinion it would be included in the change of lifestyle item. For this section, it was also recommended there should be only a "Yes" box available to tick instead of the two labelled "Yes" and "No." This recommendation was adopted.

Recommendations were made to change some of the general format. One reviewer believed the font size should be increased from 10 to 12 so people could read it more easily. This was done. There was a strong recommendation from four members of the *Scitech* Education Team for the descriptions and instructions not to be used at top of each section. The reason given was potential respondents would be put off by the repetition and also miss the wording of the opening statement. One of these reviewers made the point that once people read the same instruction a few times they would tend to ignore it. The description and instructions were dropped from the PVOI for the field tests and the heading for each section was individualised by having a descriptive phrase heading each section. Following the suggestion of one reviewer, the order of the sections was changed so the sections all respondents were required to answer were in the first part of the PVOI. Each section was made to fit on one page. There were small changes to the wording of six items so they were more clear. For example, one item originally worded "The 'hands-on' activities left me with a longer lasting impression of scientific concepts" was changed to "The 'hands-on' activities helped me to remember scientific concepts."

The value of the first two items in the "Parents" section were questioned. Two of the reviewers with experience in educational research, had pointed out these items, by their nature, would invoke only positive responses. One asked, "What parent will say they don't like to see their children having fun" (G. Sellinger, personal communication, May 25, 1995). However, the parents who reviewed the PVOI were unanimous that they "wanted the opportunity to express their feelings." The parent reviewers' opinion received support from all members of the *Scitech* Education Team. Consequently, the two items were left on the draft PVOI.

A question was raised about using flamboyant descriptors in items. Phrases such as " marvellous place," "amazed by science and technology" were "inspired to try" were criticised by two of the experienced researchers as having an inherent ceiling effect. However, when this matter was raised with the visitor reviewers and the *Scitech* Education Team, they were opposed to changing the statements. They felt such descriptors were appropriate since they had been supplied by some of the visitors. Following that feedback, the researcher decided to retain the phrases for the field tests.

The revised draft PVOI was subjected to two further checks. First, it was given to each of the seven members of the education team and the acting CEO at *Scitech* for further critical comment. They all approved of the changes and commented favourably on the revised format. Second, a trial field test was conducted using fifteen randomly selected members of the public while they were visiting *Scitech*. They were offered an incentive of a free pass for commenting on the revised draft PVOI. There were 13 replies. Twelve returned their copy without any suggestions for change. One of these wrote that the "instructions were clear" and the questions were "user-friendly." There was one exception, who stated there was an assumption in some of the questions that made it impossible for people who were predisposed favourably towards science and technology to express an opinion. After further consultations with a science educator and an educational researcher, the researcher decided not to change these items as it was thought respondents could indicate they either strongly disagreed or disagreed with those items. This proved to be an error of judgement, as quite a number of respondents, particularly at one ISTC, objected to those items. They perceived there was inadequate facility to register their reaction. Full details of the consequences of that error are reported later in this chapter. The revised draft PVOI was used in the main field test and is shown in Appendix 7-B.

Main Field-test

Method

Six ISTCs in Australia and New Zealand initially agreed to participate by collecting data and all except one were sent 200 copies of the PVOI. One in New Zealand had requested 250 copies. However, only three ISTCs returned useable data. One of the ISTCs in New Zealand had a change of staff and the initial contact person was replaced. Follow-up telephone contact was made and the new contact person agreed to organise the data collection. Subsequently, at the time for data collection, volunteer staff resources were limited and so they were not able to collect any data in time to be involved in the analysis. One of the ISTCs in Australia had a change of director and although the questionnaires were sent and a follow-up telephone call was made to a contact staff person, no data were received from that centre. Another centre in Australia collected a small number of PVOIs but it was obvious from the comments of some respondents that the PVOIs had been completed during a visit, and not following a visit, as they had been instructed. These data were not included in the analysis for this study. However, they were analysed separately and a report supplied to that ISTC.

The remaining three ISTCs, two in Australia and the one in New Zealand, indicated they had followed the guidelines for random selection of participants and subsequent data collection. Two of them, one in Australia and one in New Zealand, offered incentives of a complimentary return pass for completing and returning the PVOI (see Appendix 7-C). A letter containing instructions for administering the PVOI was sent to each ISTC and is shown in Appendix 7-D. In return, an undertaking was given to provide individual confidential reports to each centre after the data were analysed.

One of the Australian ISTCs did not offer any incentive for completing the ISTC because most of their visitors were tourists who would not be able to take advantage of the offer. They did not achieve as high a return rate as the other two but their return rate was still high when compared to the usual response rates to mail out questionnaires. Table 7.2 shows the response rates from each centre.

Results

In this section, the results of the main field test are reported, commencing with a demographic analysis of respondents based on sex, age, level of education in science, and the social context when visiting. An analysis of the frequencies of responses to the items in each section follows.

Table 7.2
PVOI Return Rates

Instruments	ISTC Centre B	Centre D	Centre E	Total
No. distributed	200	250	200	650
No. returned	152	170	103	425
Return rate (%)	76	68	52	65

Initially, consideration was given to condensing the responses for each section into one score by adding over all the items. For that to be appropriate, the unidimensionality of scales would need to be confirmed by factor analysis. However, it was considered that too much data would be lost as each item provides unique information. Each section is therefore designed to be used on an item by item basis and no whole section statistics are relevant. This is in contrast to the PVII which had clear sections with items measuring similar concepts.

Data were collected from 425 voluntary visitors at the three centres. Table 7.3 is a demographic breakdown of age, sex, and background education in science. It reveals a similar demographic pattern for visitors at the three centres.

The social context of the respondents when visiting is shown in Table 7.4 and reveals that there was a similar pattern across each of the centres. Almost all respondents visited as part of a social group with only 2% visiting alone. There were 68% who attended as a family grouping, 21% with friends and 9% as family and friends. The family and friends social group was not a separate item on the PVOI for the main field test and some people had linked the separate "family" and "friends" boxes to indicate the social context of their visit. Some others wrote a separate comment on the PVOI indicating they were with family and friends. Both of these groups of respondents have been placed in a family and friends social group. Any future demographic item should then, include this group.

All the PVOIs were manually scored with Likert-scale items coded 5 to 1 for Strongly Agree to Strongly Disagree and analysed for means, standard deviations and percentage response frequencies using SPSSx. Section E, with check boxes, was analysed for the percentage of yes responses. The results are reported in tables for each section of the PVOI. In addition, breakdowns of responses for subgroups based on centre, age group, education in science, and sex for Sections A, B, C, D, E, F, G and H, are given in Appendices 7-E, 7-F, 7-G, 7-H, 7-I, 7-J, 7-K and 7-L, respectively. Noteworthy data about any item are reported in the text.

Table 7.3
Demographics of Respondents in the PVOI Main Field-test

Demographic Group	*Centre B*		*Centre D*		*Centre E*		Total	
	n	%	*n*	%	*n*	%	*n*	%
Sex								
Male	61	40	49	48	65	38	175	41
Female	91	60	54	52	105	62	250	59
Total	152	100	103	100	170	100	425	100
Age (years)								
11 to 12	10	7	16	16	11	6	37	9
13 to 17	14	9	13	13	11	6	38	9
18 to 25	8	5	6	6	30	18	44	10
26 to 35	43	28	8	8	31	18	82	19
36 to 45	60	39	35	34	58	34	153	36
46 to 55	8	5	13	13	17	10	38	9
56^{+}	9	6	12	12	12	7	33	8
Total	152	100	103	100	170	100	425	100
Education level								
Pre-secondary	11	7	23	22	18	11	52	12
Secondary	85	56	52	50	77	45	214	50
TAFE/Polytechnic	21	14	3	3	17	10	41	10
University	35	23	25	24	58	34	118	28
Total	152	100	103	100	170	100	425	100

Table 7.4
Respondents' Social Context While Visiting the ISTC

Mode of Visit	*Centre B*		*Centre D*		*Centre E*		Total	
	n	%	*n*	%	*n*	%	*n*	%
Alone	3	2	1	1	5	3	9	2
Family	104	68	76	74	107	63	287	68
Friends	22	14	18	17	47	28	87	20
Family and friends	23	15	8	8	11	6	42	10
Total	152	100	103	100	170	100	425	100

Section A: Your overall impression of your visit.

This section consists of six items (see Table 7.5) which together give a general overview of a visit and express a measure of satisfaction with a visit. It contains statements that relate more to administration and marketing rather than outcomes that are educationally oriented.

The responses to each item are very positive indicating the people in this study are satisfied with their visit and they believe the ISTCs are a good place for a family to visit. The majority intend to repeat their visit. It is clear the ISTCs in this survey are enjoying a high level of public endorsement as a place to visit.

Table 7.5

Means, Standard Deviations and Percentage Responses for Section A: Your Overall Impression of Your Visit

	Item	*M*	*SD*	SD	D	U	A	SA
A1	It is a good place for a family outing.	4.54	0.56	0	1	2	41	57
A2	I intend to return.	4.29	0.80	0	3	10	40	47
A3	I would recommend it as a place to visit.	4.62	0.55	0	0	2	33	65
A4	Children are free to explore without being told "don't touch."	4.73	0.50	0	0	2	22	76
A5	There was something for all ages.	4.60	0.56	0	0	2	36	62
A6	The visit was "good value for money."	4.25	0.80	1	3	10	44	43

Note. *n* = 425

Item A2 is more suitable for a questionnaire used by ISTCs that service a mainly static population rather than where tourists and people have travelled long distances to visit. It is not surprising that *Centre D*, which has mainly tourists, had a much higher rate of undecided (31%) and disagree (12%) responses than *Centre B* (3%, 1%) or *Centre E* (4%, 1%) (see Appendix 7-E). The item should be omitted from any PVOI used by ISTCs with a high proportion of tourist visitors, otherwise it could bias a measure of visitor satisfaction.

Section B: Your own learning and understanding as a result of your visit.

The terms "learning" and "understanding" have been combined as a title for this section as it implies a full range of cognitive levels from recall through to evaluation (Krathwohl et al., 1964) . They are also representative of the two areas from which most of the items in this section were developed – the area about understanding on the PVQs and, to a much lesser extent, the question about learning in the interviews.

All of the items in this section contain elements of visitor statements indicating some type of cognitive activity that has been directly invoked by their experiences while interacting with exhibits. This section does not, however, attempt to assess either the level or type of cognitive activity. Rather, it is designed to capture all types of cognitive activity amongst visitors by using a range of different items expressing varying levels of learning both as implicit and explicit outcomes. It simply isn't possible to determine exactly what has been learned, given the wide range of visitors with their individual backgrounds and visit experiences.

Table 7.6 shows items B7, B8, B9 and B10 all have relatively high undecided rates. Item B7 had the highest undecided response rate (42%) in the five main scales. With 38% of people indicating they do now think about scientific things more, it was also the lowest agreement responses for any item. It also has a comparatively high level of disagreement for males (25%) and for people with a university level of

Table 7.6

Means, Standard Deviations and Percentage Responses for Section B: Your Own Learning and Understanding as a Result of Your Visit

	Item	*M*	*SD*	SD	D	U	A	SA
B1	The hands on activities helped me to remember scientific activities after my visit.	4.04	0.67	0	3	12	63	22
B2	I now know how some things work that I didn't understand before.	4.01	0.74	0	5	12	60	23
B3	The element of discovery helped me learn.	4.05	0.68	0	2	15	59	24
B4	I was challenged about "why" some things happened.	4.06	0.70	0	2	15	58	25
B5	Learning was easy.	4.08	0.67	0	2	12	62	24
B6	It was easy to understand because things were explained in everyday language.	4.17	0.68	0	3	8	59	31
B7	I think about scientific things more.	3.25	0.92	1	19	42	28	10
B8	I learned that science is not always predictable.	3.75	0.81	0	6	29	48	17
B9	I was able to relate scientific concepts to my everyday life.	3.67	0.79	1	6	31	51	12
B10	I learned something new about myself.	3.32	0.95	2	18	34	36	9
B11	I learned something new about the world around me.	4.00	0.74	0	4	13	60	23

Note. *n* = 424

education in science (25%). For Item B10, there was a high 46% undecided in the 46-55-year-old age group (see Appendix 7-F).

It is clear this sample of visitors perceive themselves as having learnt something. It is also clear, in the perception of this sample of visitors, that the unique nature of the learning experiences offered by ISTCs does invoke cognitive activity. However, it is not within the scope of this instrument to determine categorically what it is that people do learn.

Section C: Your thoughts and feelings as a result of your visit.

This section incorporates statements that collectively give a measure of the affective nature of learning people believe they have experienced as a result of their visit to an ISTC. Table 7.7 shows visitors' responses to items in the thoughts and feelings section. Six of the items, C1, C2, C3, C6, C7 and C8, relate directly to enjoyment, excitement, interest and motivation, and are all fundamental ingredients in the affective domain of learning. The three other items, C4, C5, C9, refer to people's confidence in their relationship with science and technology. The explicit notions in those three items – intimidation and complexity – have overtones of feelings about a visitor's perception of the accessibility of science, a key element in the affective domain of learning.

Table 7.7

Means, Standard Deviations and Percentage Responses for Section C: Your Thoughts and Feelings as a Result of Your Visit

	Item	*M*	*SD*	SD	D	U	A	SA
C1	My interest in science and technology has been reinforced.	3.87	0.78	1	5	20	57	18
C2	I am amazed by science and technology.	4.02	0.77	0	5	14	56	26
C3	The unexpected results of some of the activities made them exciting.	4.09	0.76	1	3	14	53	30
C4	I no longer think that science and technology are beyond my grasp.	3.71	0.84	1	8	25	52	15
C5	I enjoyed finding out how and why some things work.	4.33	0.58	1	0	3	59	37
C6	I am no longer intimidated by science and technology.	3.54	0.90	2	9	36	39	14
C7	I am no longer bored by science and technology.	3.74	0.91	2	7	25	48	18
C8	I would have been more interested in science if I had visited a place like this when I was a child.	4.11	0.96	1	6	15	36	42
C9	I now think that complex scientific concepts can be made understandable for people of all ages.	4.21	0.79	0	5	7	50	38

Note. *n* = 425

It is possible that there is flaw in the wording of item C2. It could be referring to science and technology in general or to the experiences ISTCs provided. However, there is a strong possibility people would assume it was related to their visit as are all the other items. To make sure, the wording of the item has been altered on the final PVOI to contextualise the item. It now reads, "I was amazed by the science and technology at the centre."

Item C4, C6 and C7 attracted undecided responses of 25%, 36% and 25% respectively. The level of undecided for item C6 rose to 51% for those with a TAFE or Polytechnic level of education in science (see Appendix 7-G). When scoring the PVOI data, it quickly became was clear there a reason for those rates as some respondents had written comments on the items. The comments "Never did" and "Never was" were written on items C4, C6 and C7 and almost all of these respondents had checked the undecided box. Each of the three items contain the words "no longer", hence the comments.

At the time of construction of the items, it was thought people would strongly disagree if they were already confident with their capabilities in science and technology. However, upon reflection after receiving the completed field tested PVOIs, it was evident that there could be two categories of people who did not agree with the item. First, there are those for whom the experiences at an ISTC did not change their perception. Second, there are those who were already confident with science and technology and did not experience any change. It was the respondents in the second group who wrote the comments.

The problem has been overcome in the final PVOI by placing these three items (C4, C6, C7) together in a separate group at the end of Section C. As well, Items C6 and C7 were reworded to commence with "I am not . . ." from "I am no longer . . . ." Item C4 has been altered to "I think that science and technology are within my capability." There had been criticism of the use of the word "grasp" from respondents as well as negative wording in the original item. The group of three items is preceded by a skip statement that invites people who are already confident about science and technology to go straight to the following Section D. This can be seen in the final PVOI provided in Appendix 7-M. This solution to the problem met with unanimous approval from the final respondent review group.

Item C8 assumes respondents did not have an ISTC style facility available to them when they were younger. That is the case for people native to Australia or New Zealand as most ISTCs have only been in existence for a short time. It would not be an appropriate question to use for a visitor to an ISTC in San Francisco, Toronto or London for example.

This is one of the items, in the whole PVOI, that scored highest overall in the strongly agree option (highest in Section C), a trend which held for all subgroups except the 18-25 year olds (see Appendix 7-G). Because of their age, some in the 18-25 year age group may well have already visited an ISTC as that would be in the era when many of the ISTC came into existence. The strongest agreement came from the over 56 years age group. This question will become obsolete in the future, but currently it provides an indication of the high level of value people put on having access to an ISTC as part of their science education.

Section D: Your views about science and technology as a consequence of your visit.

This section is different to Section C because it focuses on people's general awareness and appreciation of science and technology. Earlier in the process of developing the PVOI, these items had been listed under a tentative group title of "World-wide View." It is designed to give a measure of what is really an intangible outcome of a casual visit. Usually, one part of an ISTCs mission statement (Smith, 1995) is to make people more conscious and aware of modern science and technology. Any positive shift in views about science and technology as a result of a visit, would be a successful outcome for an ISTC. The responses are shown in Table 7.8. and Appendix 7-H.

Table 7.8

Means, Standard Deviations and Percentage Responses for Section D: Your Views about Science and Technology as a Consequence of Your Visit

	Item	*M*	*SD*	SD	D	U	A	SA
D1	I now realise how important science and technology are in my everyday life.	4.06	0.77	1	2	16	53	28
D2	I now realise how much science influences modern technology.	4.23	0.74	1	2	8	51	38
D3	I now have a better appreciation of the laws of nature.	3.80	0.79	1	5	24	56	15
D4	I now have a better appreciation of some of the things I have taken for granted.	3.88	0.79	1	4	23	53	20
D5	I am now more aware of how fast science and technology change.	4.01	0.91	1	7	15	45	32
D6	I am now more aware of advances in modern technology.	3.89	0.91	1	7	20	46	26
D7	I now realise there is a need to keep up with changes in current technology.	4.06	0.83	1	4	16	48	31
D8	I now appreciate that living standards can be improved through technology.	4.08	0.79	1	3	11	56	28

Note. n = 419

A major flaw in the wording of some of the items in this section became apparent during the main field-test, even though the PVOI had been field tested in a pilot study. Some people, who already held positive views about science and technology, wrote that they were not able to indicate their position about some of the items. In the final PVOI the whole section is to be skipped by people who had very positive views about science and technology before their visit. The section is headed, "Your views about science and technology as a consequence of your visit," and the word 'now' has been dropped from every item. All the reviewers agreed the change had alleviated the problem.

Section E: What did you do as a result of your visit?

Any action carried out by visitors is the only tangible evidence of an outcome of a visit to an ISTC. While the evidence for some of the items relies on people's memories, it does provide a measure of application of their visit experiences and demonstrates that people have been motivated into some action.

Table 7.9 shows the total number of reported actions for this sample at each centre. Overall, there were 1400 reported actions from the sample of 425 voluntary visitors, which is a rate of 3.29 actions per person.

Table 7.9

Total Numbers of Actions Reported as a Consequence of a Visit to the ISTCs for Section E: What Did You Do as a Result of Your Visit?

Measures of actions	*Centre B*	*Centre D*	*Centre E*	Total
No. of actions	549	278	562	1389
No. of respondents	152	103	170	425
Actions per respondent	3.61	2.70	3.31	3.27

The results for all the different actions are presented in Table 7.10 and Appendix 7-I, which give both the number and the percentage of visitors who responded yes. Consequently, Table 7.10 and Appendix 7-I are a different format to the tables and appendices used to report the results for the other Sections. Item E7 is the most frequent reported action, with 81% of respondents indicating they had recommended a visit to other people. Item E15 also had a high response rate with 80% of visitors reporting they had spoken about their visit to people outside of their family group. All fifteen listed actions attracted responses, with "changing of lifestyle", "starting a new hobby" and "building something" ranking lowest on the frequency scale.

Table 7.10

Frequency of Actions Undertaken as a Consequence of a Visit for Section E: What Did You Do as a Result of Your Visit?

	Item	*n*	%
E1	Bought a piece of scientific equipment.	47	11
E2	Bought a kit that demonstrates scientific principles.	34	8
E3	Bought a toy that clearly shows a scientific principle.	76	18
E4	Read an article about a scientific principle was demonstrated by an exhibit.	70	16
E5	Watched more TV programs related to science.	128	30
E6	Read more science-related articles in newspapers or magazine.	93	22
E7	Suggested to other people that they visit the science centre.	345	81
E8	Conducted an experiment at home.	64	15
E9	Built something based on an idea I got from an exhibit.	15	4
E10	Changed my lifestyle.	14	3
E11	Started a new hobby.	18	4
E12	Started an exercise program.	38	9
E13	Became more energy conscious in my home.	89	21
E14	Influenced my decisions at work.	29	7
E15	Talked about my visit to people other than those who visited with me.	340	80

The last two items in this section, E16 and E17, asked people to describe their actions, and gathered some useful information. For example, in response to Item E16, three responses were:

> Have decided to purchase a family pass as our children always enjoy visiting the centre and would happily go there to see already visited displays develop as well as new ones. (M, 26-35, U)
>
> As a teacher, I was able to recommend exhibitions to others. (M, 36-45, U)
>
> Conducted a seed experiment. (M, 13-18, S)

However, the few people (14%) who did respond to item E16 tended to either repeat or rephrase the actions listed on the PVOI. The comments "bought a toy" and "did an experiment" were two such cases. Others just wrote "see above." Only thirteen (3%) respondents wrote any comment in Item E17, which indicates the most likely actions are already listed in Section E. The other actions these people reported were bought a book or CD ROM encyclopaedia (8), joined a science club (4) and joined an environmental interest group (1).

Section F: For parents in a family group.

This section explores the impact of a visit on children and their parents from the perspective of the parents. Research reported in the literature review has shown that for a large proportion of visitors, a visit to an ISTC is a social occasion. In this sample 68% visited as a family group while another 10% (see Table 7.4) visited with family and friends.

The influence of the social context in a visit to an ISTC on the outcomes of learning has been studied extensively and the outcomes reported in Chapter 2. Parents are in a unique position to give an opinion of their children's reactions based on first-hand observations and communication with their children both during and following a visit. The statements that gave rise to the items in this section refer to perceived learning, reinforcement of learning, enjoyment, social development and attitude shift. The items in this section collectively provide a measure of outcomes that have not previously been the focus of any reported study. Some who responded in the older age groups, 46-55 and 56^{+} years, indicated they were attending with their grandchildren and their responses have been included in the analysis. The responses of those who completed Section F are shown in Table 7.11 and Appendix 7-J.

The concern about items F1 and F2, expressed by reviewers of the pilot PVOI with experience in educational research, were borne out by the results when everyone agreed with both items. During the data collection phase, the researcher spoke with an ISTC professional at *Centre D* who coordinated the data collection. She stated that she thought some "thirty something year-old males might take exception to some of the questions." She was correct. One male respondent wrote "Isn't motherhood grand" (M, 36-45, U) referring to items F1 and F2. The ISTC professional from *Centre D* also commented that it would be very difficult to write items to suit visitors from all backgrounds. In view of the differing opinions about items F1 and F2, it is recommended that individual ISTCs make their own decision whether to include these items or not.

The wording of Item F6 caused a problem for eight respondents who wrote "always did" on the questionnaire. The question has been dropped from the final questionnaire. While the content of the item has merit, it is not possible to alter the wording and keep the same intent.

Table 7.11

Means, Standard Deviations and Percentage Responses for Section F: For Parents in a Family Group

	Item	*M*	*SD*	SD	D	U	A	SA
F1	Watching my children enjoy themselves was a joy to me.	4.66	0.47	0	0	0	34	66
F2	Being able to watch my children actively engaged with the exhibits was a pleasure to me.	4.64	0.49	0	0	0	35	65
F3	It was a challenging and stimulating experience for my children.	4.53	0.56	0	0	3	41	56
F4	It gave me an opportunity to discuss the displays with my children.	4.33	0.63	0	0	5	54	40
F5	My children asked me about the exhibits.	4.16	0.83	1	3	11	48	37
F6	I now encourage my children to question and find out things.	4.09	0.82	1	2	17	47	33
F7	We talk as a family about what we did on our family visit.	4.07	0.84	0	5	15	47	33
F8	I believe my children learned something from the visit.	4.40	0.64	0	0	5	48	46
F9	The fun aspect of a visit is an attraction for my children.	4.62	0.53	0	0	1	34	64
F10	The way the centre presents science and technology has educational value for my children.	4.58	0.58	0	1	2	36	61
F11	I was looking after my children so I didn't learn as much as I would have liked.	2.78	1.24	14	38	14	23	10
F12	I look forward to a return visit as much as my children.	4.16	0.82	0	4	16	42	39
F13	I would enjoy a visit without my children so I could be more free to experience the exhibits as I wish.	2.94	1.26	12	30	23	20	14

Note. *n* = 259

Item F11 and Item F13, which is on a similar theme, were the only items to have more people disagreeing than agreeing. It is worth emphasising however, that one third of all parents would appreciate a visit by themselves. For the 26-35 year age group almost half of the 65 parents would like a chance to visit an ISTC without their children. It is possible their children are more likely to be at an age that is more demanding. The over 56 year age group, presumably grandparents, were different as more were undecided (28%) about Item F11 than any other age group. It is also interesting to note that more females would like a visit without their children (F11, 38% and F13, 38%) compared to males (F11, 26% and F13, 27%). As a result of the comments that led to the development of Items F11 and F13, and the response to both items on the PVOI, *Scitech* were to consider organising a "children free" occasion when parents will be free to explore without being distracted by their children (V. Dodds, personal communication, December 11, 1995).

For Item F12, 35% of respondents at *Centre D* were undecided, like the response to Item A2 (31%), and this is probably a consequence of the large number of tourists who visit that centre and would not be able to return. Item F12 could be excluded from any PVOI used by ISTCs with a large tourist clientele.

Section G: For school students.

There were far fewer statements from which to develop items for this section as there were 31 school students who responded to the PVQ. Some of the items were developed from one or two statements only. The theme for the first five items is similar – that students may have been motivated by their visit to be more interested in their school science and perhaps achieve better results. The sixth item refers to career choice. Table 7.12 shows the responses of the school students in this study.

Table 7.12

Means, Standard Deviations and Percentage Responses for Section G: For School Students

	Item	*M*	*SD*	SD	D	U	A	SA
G1	I now understand more about my science lessons.	3.88	0.90	1	5	24	44	26
G2	I have more interest in my science lessons at school.	3.78	1.03	2	10	24	37	28
G3	I now have a greater awareness of scientific ideas.	4.17	0.65	0	1	11	59	30
G4	Since my visit my marks in science have improved.	3.16	1.02	7	12	52	17	12
G5	I was able to use some information for a school project.	2.69	1.07	17	21	42	16	4
G6	As a result of my visit, I am considering a career in science or technology.	3.20	1.24	8	25	28	19	20

Note. *n* = 94

It is noted that a large proportion of respondents (21 out of 94) across the three centres filled this section only as part of their parent's or adult companion's PVOI. This group is located in the Appendix 7-K under a heading "No details supplied." Given the small numbers left in the demographic sub-groups, further data would need to be collected before any conclusions could be reached about those groups.

There are some points about this section that are worth highlighting. First, the relatively high levels of undecided and disagreement suggest that student respondents are giving the items consideration. Second, little should be read into the higher proportion of disagreement for Items G4, G5, or G6, as it is unlikely those items would apply to all student visitors. Third, there is a problem with eager children below the lower age limit wanting to give their opinion and pressuring parents to let them fill it in. As the researcher discovered, some of those parents believe their children are very good at science and would therefore be quite capable of completing the questionnaire. A solution in those cases would be for the ISTCs to use this section independently of the PVOI.

Section H: For teachers.

During the period of randomly enlisting volunteers for the interviews and PVQs, it transpired that a number of teachers were amongst the volunteers. They gave comments on the PVQ that indicated their experiences while visiting were of professional value to them. After discussions with the acting CEO of *Scitech* it was decided to include a section on the PVOI for collecting data about teachers who visited *Scitech* while not part of a school visit. Their responses to the PVOI are shown in Table 7.13 and Appendix 7-L.

Table 7.13

Means, Standard Deviations and Percentage Responses for Section H: For Teachers

	Item	*M*	*SD*	SD	D	U	A	SA
H1	I have used some ideas that I got from exhibits in my lessons.	3.21	1.06	4	25	25	38	8
H2	I intend to make changes in my teaching program based on ideas from exhibits.	3.37	0.92	0	25	17	54	4
H3	I now include more "hands-on" activities in my science lessons.	3.26	1.05	4	22	26	39	9
H4	I now include more "hands-on" activities in lessons other than science.	3.13	0.81	4	13	48	35	0
H5	I decided to try out new strategies in my classroom teaching.	3.43	0.95	0	17	35	35	13
H6	I now explain scientific concepts by using every-day examples.	3.30	1.05	8	13	21	54	4
H7	I feel more confident about teaching science.	3.46	0.72	0	8	42	46	4
H8	I have decided that my class would benefit from a visit to the science centre.	4.13	0.99	4	4	4	50	38

Note. *n* = 24

The sample of 24 is too small to provide a substantive benchmark about teachers' reactions to a visit and it is recommended that this section be used by itself for teachers. There were however some useful findings. At the time of constructing this section, the seven member education team at *Scitech*, who are all experienced teachers, wanted to include secondary teachers in the survey and a section to determine the teaching level of respondents was added. This request should have been resisted, as some of the items, particularly H4 and H7, proved inappropriate for some secondary school teachers and attracted critical comment from them. They wrote: "Already do" and "Doesn't apply to me" on the items. Two recently qualified primary teachers wrote they "already do" to items H3, H4, H6 and H7.

In the final version of the PVOI, the heading has been changed to specify primary school teachers to complete the section. As well, an introductory instruction has been added to complete the section only if they made any change, or intend to make any change, in their teaching as a result of their visit to the science centre.

Section I Any other comments.

This section was included to allow visitors the opportunity to make additional comment about their visit. There were 56% of this sample of visitors who volunteered a comment. Most were comments summarising their feelings about their visit and were similar in nature and content to those on the PVQs and PVIIs. The large majority were positive about a visit and a few were negative. Each of the participating centres was provided with a copy of the comments for their centre.

Section J Your thoughts please!

Section J was included at the request of the Acting CEO of *Scitech* to find out what the visitors believe each ISTC aimed to do. This section attracted a higher response rate (66%) than Section I (56%). The responses showed that it is the opinion of the people that ISTCs aim to present science in an engaging environment that is stimulating, educational, interesting and exciting. As for Section I, copies of comments about individual centres were provided to the respective contact person. It is recommended that Section J be optional for ISTCs.

Final Review

Once the responses to all of the items were analysed and subsequent alterations had been made to the Main Field-test PVOI, a final review was conducted. All the 15 visitors to *Scitech* who had given critical comment were contacted by letter (see Appendix 7-N) and asked to review the altered Main Field-test PVOI. All except two replied positively and a copy of the altered PVOI was posted to each. They were asked to focus on the items that had attracted critical comment during the main field test and provide feedback about the alterations to the items and to the new format of Section C and Section D. They were unanimous that the problems they had identified about items were solved and the new format catered for respondents from different backgrounds. Some comments were: "This is better," "Much better," "The requirement to only fill in those questions that appear relevant is good" and "This is a lot better." None of these people suggested any changes to the items. Consequently, no further changes were made and the final PVOI is shown in Appendix 7-M.

As the responses at *Scitech* to the interviews and PVQ had been overwhelmingly positive, the statements and phrases could be interpreted to have a positive bias. This caused some criticism from some respondents at *Centre E* with one person refusing to complete the PVOI "because of the bias toward the centre." The format did allow him to disagree and to record a negative reaction. The instrument also allowed for any other critical comment, whether it be negative or positive, and the comments can be made anonymously.

Sensitivity of the PVOI

The PVOI is more difficult to test for sensitivity than the PVII as it does not have scales. As each section consists of items that are loosely related it would be necessary to conduct an analysis for every item to analyse the instrument for effects on the same variables used in the PVII analysis. However, the results of such an analysis would be questionable as each item is a five point scale and does not lend itself to a parametric analysis. It is possible, however, to get an indication whether the PVOI is sensitive enough to detect differences in the variables of sex, age and centre by looking at the means of items in the different sections. The level of respondents' education in science was not considered here as it is not independent of age. Similarly to the PVII, there are no established precedents for investigating differences in variables and any differences found may be real or random. Further research would be needed to clarify the issue.

The data used for this analysis were collected in the main field-test of the PVOI. In order to be consistent with the PVII sensitivity analysis, the same sub-groups for the variables of age, sex and centre were retained. Table 7.14 reports the numbers of respondents in each age x sex x centre grouping. As Table 7.14 shows, some of the numbers in subgroups are very small and examination of differences based on such small numbers may be misleading. Thus it was decided to examine the data in two ways. First, results are examined for age x sex groupings, and then for centre. Detailed results of the number of respondents, means and standard deviations for each item in Sections A, B, C, D and F for groupings based on the age and the sex groups of respondents are presented in Appendices 7-O, 7-P, 7-Q, 7-R and 7-T respectively. Details for Section E are different because it recorded affirmative responses only, and the number of respondents and percentage of yes responses are reported in Appendix 7-S for the same age and sex groups. (Results for centre were earlier reported in Appendices 7-E, 7-F, 7-G, 7-H, 7-I and 7-J.) Analysis by age and sex was not conducted for Sections G and H. Section G for school students and Section H for teachers were answered by respondents already roughly grouped by age, and although they could be analysed by sex, the numbers were too small to be meaningful.

Table 7.14
Number of Respondents in each Age x Sex x Centre Grouping

	School-age		Young Adult		Older Adult	
Centre	Male	Female	Male	Female	Male	Female
B	16	8	20	31	25	52
D	20	9	4	10	25	35
E	9	13	20	35	36	51

Figures 7.1, 7.2, 7.3, 7.4, 7.5 and 7.6 are drawn from the data in Appendices 7-O, 7-P, 7-Q, 7-R, 7-S and 7-T, respectively, show that, apart from school-age males, females are responding more favourably than males. This is consistent with the responses on the PVII, and is especially clear on Figure 7.6 which reports Section F aimed at parents and has no school-age groups. It is noticeable that school-age males gave the most positive responses on almost every item in Section B: Your Own Learning and Understanding as a Result of Your Visit (10 out 11), Section C: Your Thoughts and Feelings as a Result of Your Visit (8 out of 9), Section D: Your Views about Science and Technology as a Result of Your Visit (8 out of 8) and Section E: What Did You Do as a Result of Your Visit (12 out of 15). In contrast, it is the young adult males who indicated most of the least favourable responses, although almost all were still positive. The differences between school-age males and young adult males is greatest for Items B7, "I think about scientific things more" (0.91), B8, "I learned that science is not always predictable" (0.95), and D6, "I am now more aware of advances in modern technology" (0.95). These differences can possibly be

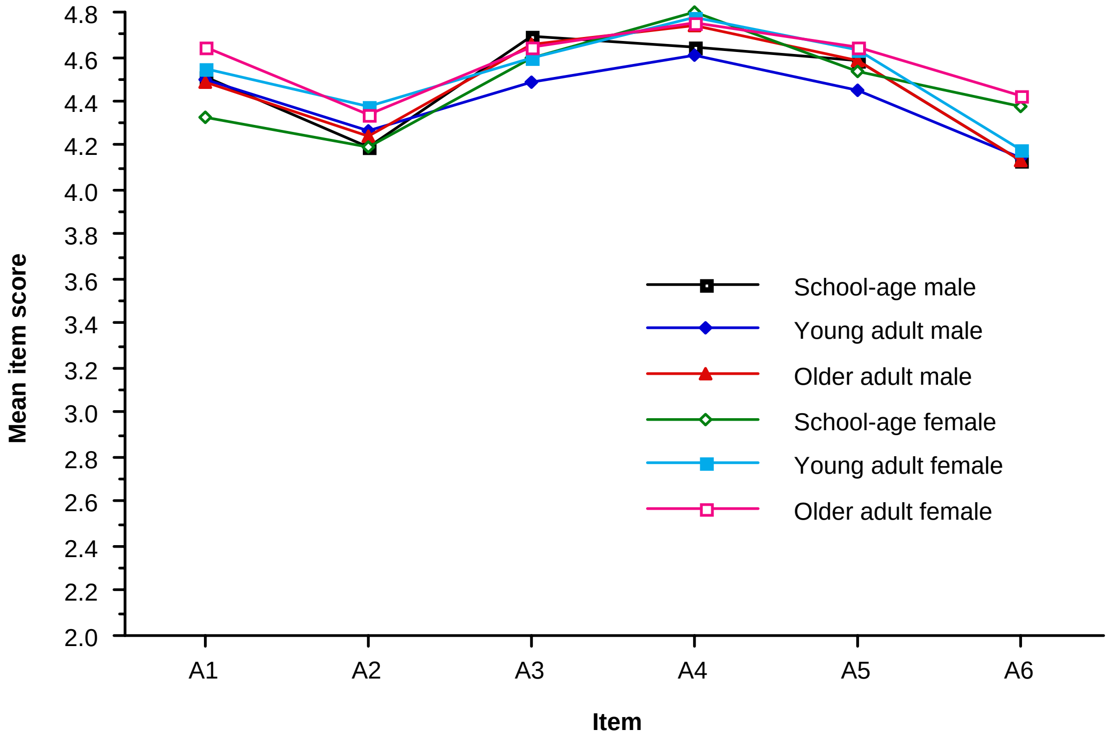

Figure 7.1. Mean scores for sex and age for items in the PVOI Section A: Your Overall Impression of Your Visit.[5]

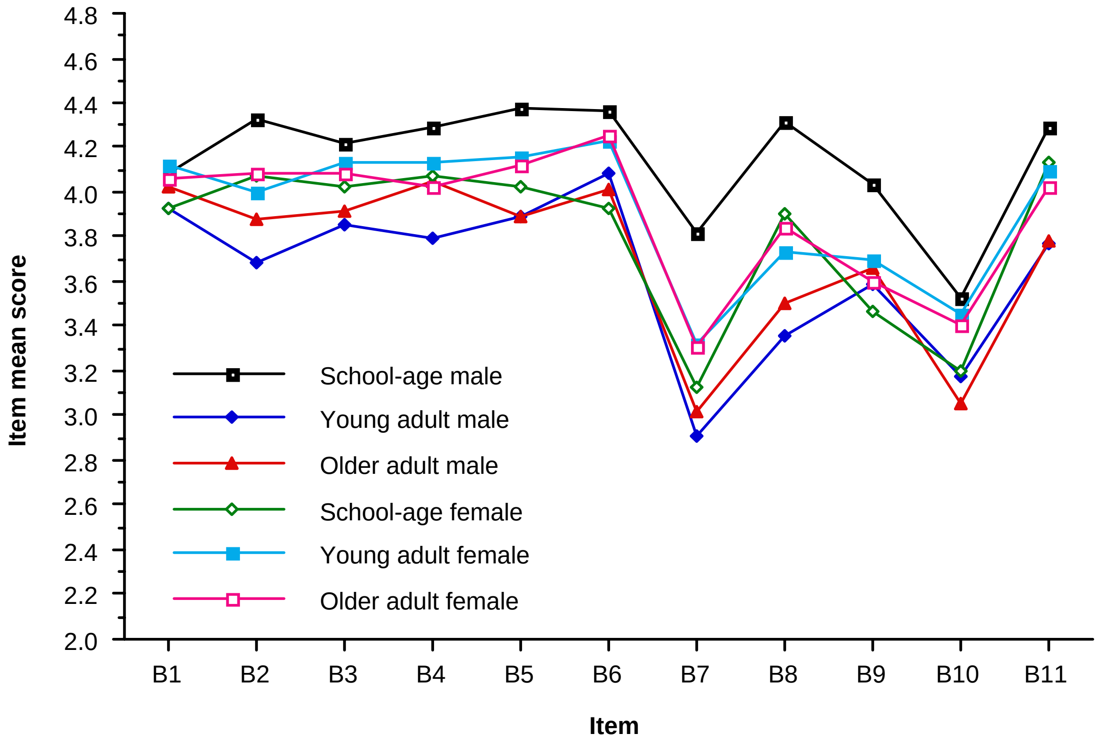

Figure 7.2. Mean scores for sex and age for items in the PVOI Section B: Your Learning and Understanding.

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[5] It is noted that the points on all graphs are joined for ease of visual inspection and do not imply any relationship between the items.

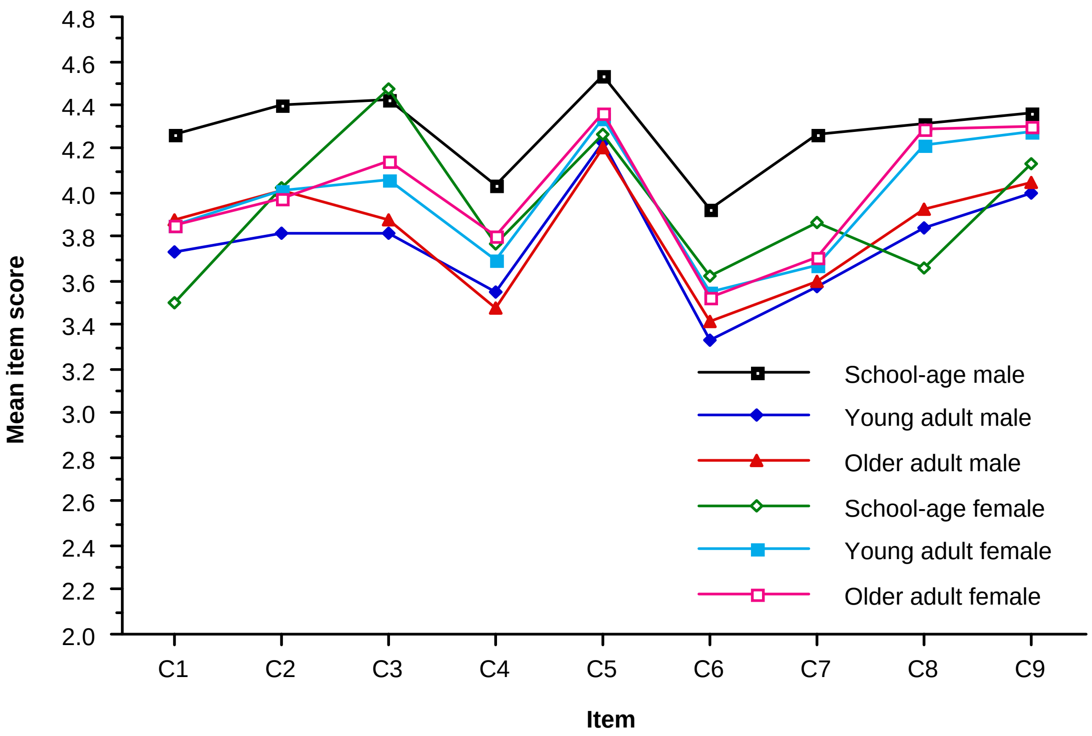

Figure 7.3. Mean scores for sex and age for items in the PVOI Section C: Your Thoughts and Feelings as a Result of Your Visit.

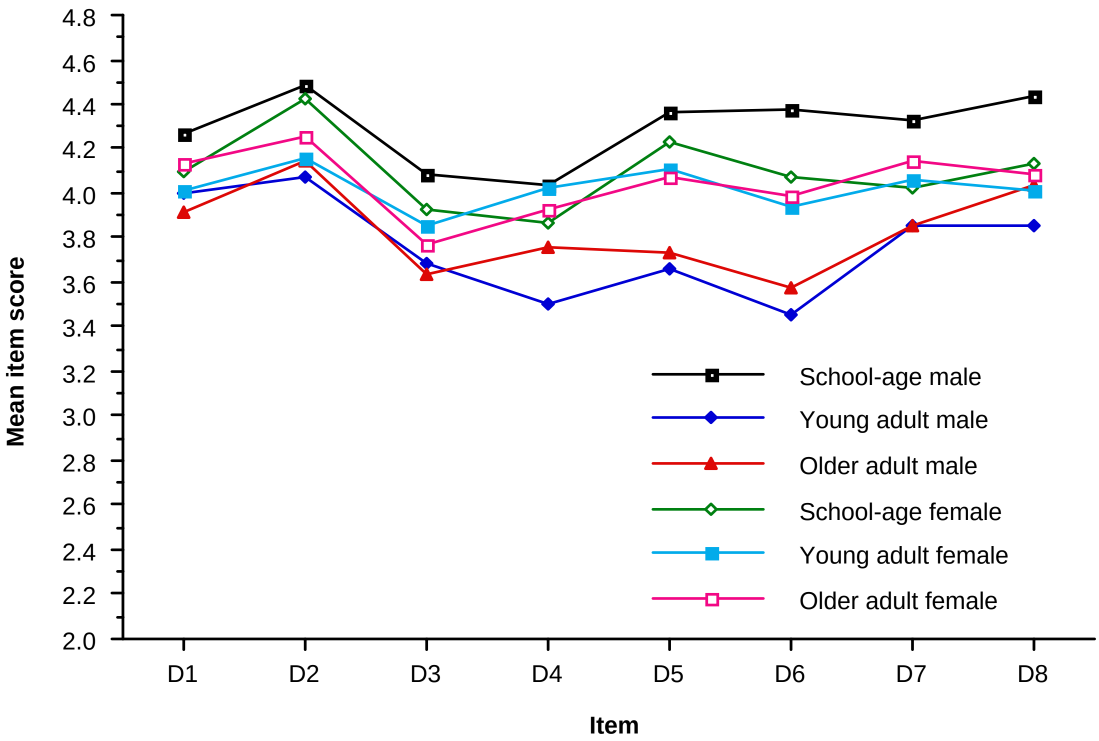

Figure 7.4. Mean scores for sex and age for items in the PVOI Section D: Your Views about Science and Technology as a Consequence of Your Visit.

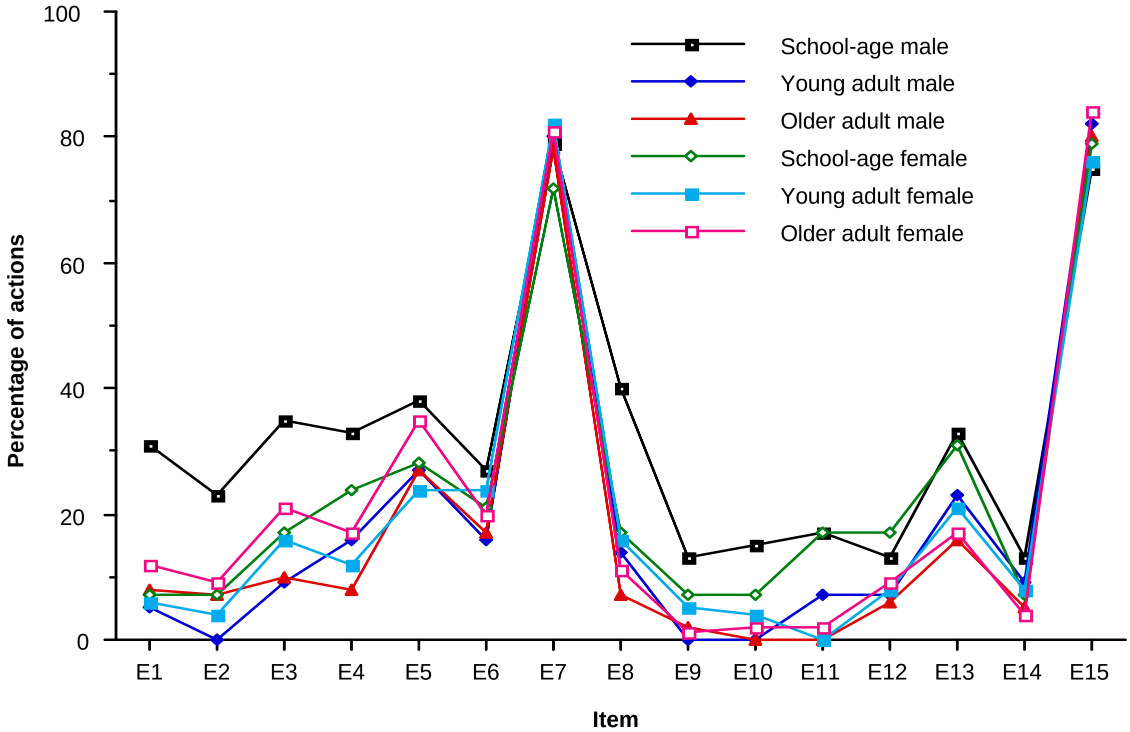

Figure 7.5. Percentage scores for sex and age for items in the PVOI Section E: What You Did as a Result of Your Visit?

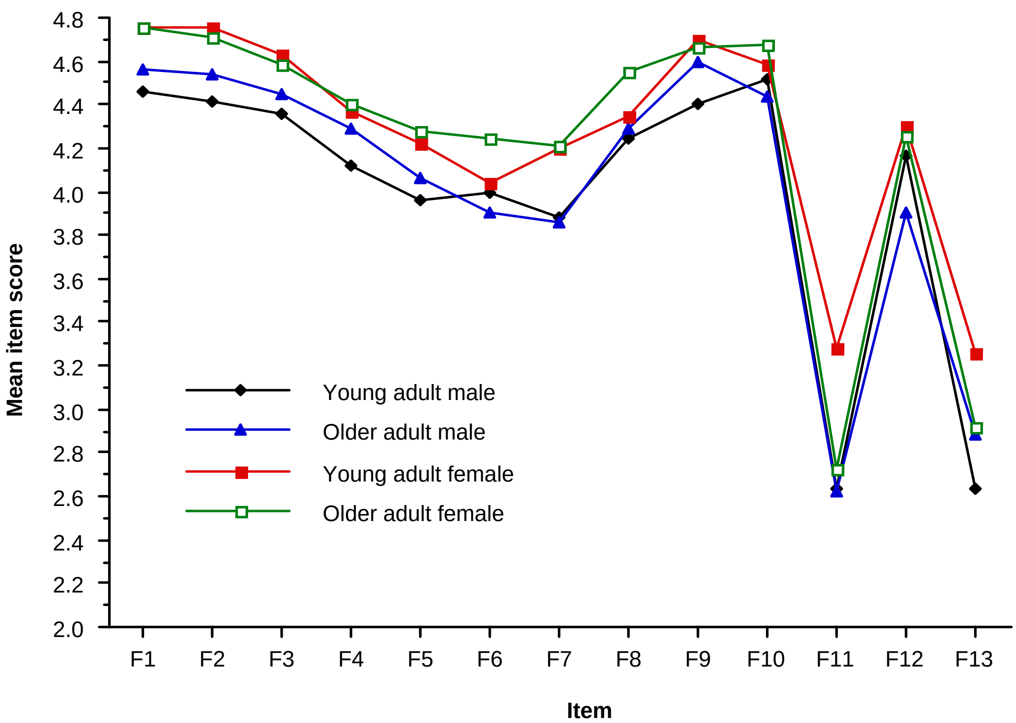

Figure 7.6. Mean scores for sex and age for items in the PVOI Section F: For Parents in a Family Group.

attributed to maturation and experience whereby the young adult males have passed into a different phase of their lifelong learning process. It is noted that each of these items is an indicator of a general process of learning rather than identifying specific facts or pieces of knowledge that may have been learned during a visit.

Overall Figures 7.1 to 7.6 show the least difference between age and sex groups for Section A, referring to overall impression of the visit. Given this similarity, the differences between school-age and young adult males for Sections B, C, D and E are very noticeable. In contrast, the responses for the different age groups of females are quite consistent over each section, and usually more positive than both groups of adult males.

These next set of graphs report the data for the sections of the PVOI for each centre. Figures 7.7, 7.8, 7.9, 7.10, 7.11, 7.12, 7.13 and 7.14 are drawn from the data in Appendices 7-E, 7-F, 7-G, 7-H, 7-I, 7-J, 7-K and 7-L. Overall, there is a trend for *Centre B* to attract the most positive responses, but for most items the mean scores of respondents are similar across the centres. There are some noteworthy differences however. The means for Item A2, "I intend to return", are clearly lower for *Centre D* which has by far the largest proportion of tourists amongst its visitors. It is likely that this is the cause of the difference. *Centre B* charges the highest entrance fee and scored the lowest mean for Item A6, "The visit was 'good value for money'." This

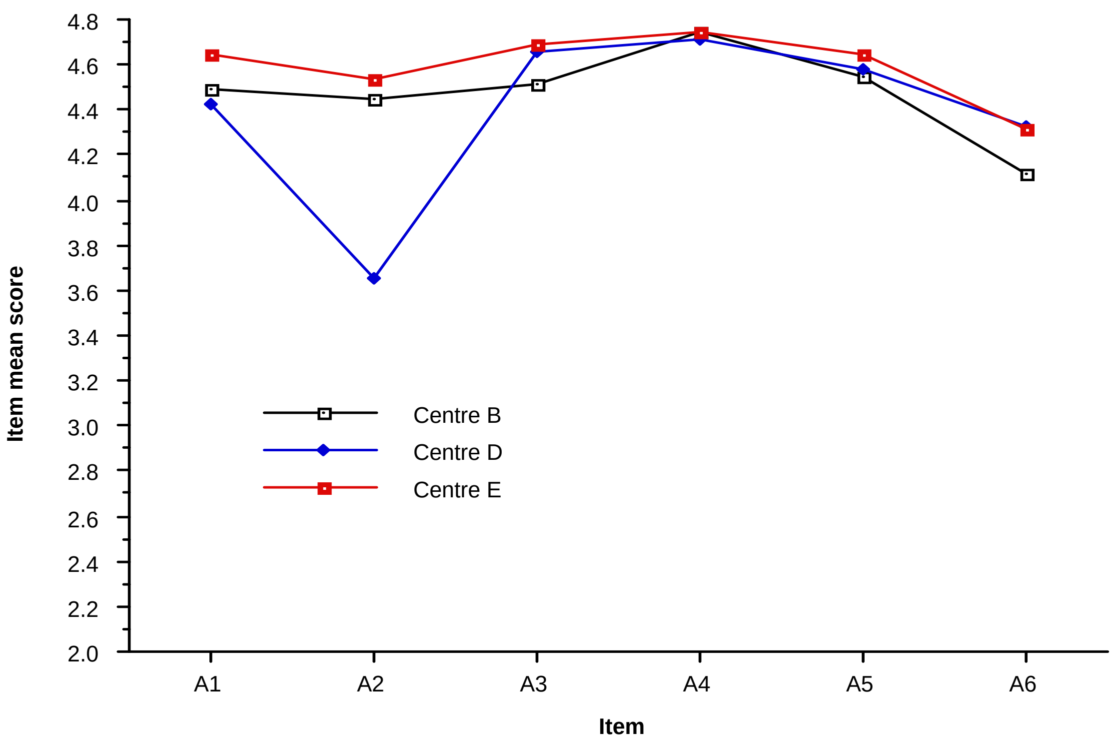

Figure 7.7. Mean scores for centres for items in the PVOI Section A: Your Overall Impression of Your Visit.

sample of visitors must feel that it is expensive, yet they rate *Centre B* highest on most of the items overall which signals an effect of the centre.

The results for Sections B, C and D which report visitors' perspectives of their learning and understanding, thoughts and feelings, and views about science and technology, are reported in Figures 7.8, 7.9 and 7.10 respectively. There are no consistent differences between centres for Section B, and for Sections C and D there is a tendency for *Centre B* to be viewed most positively, but the differences are small.

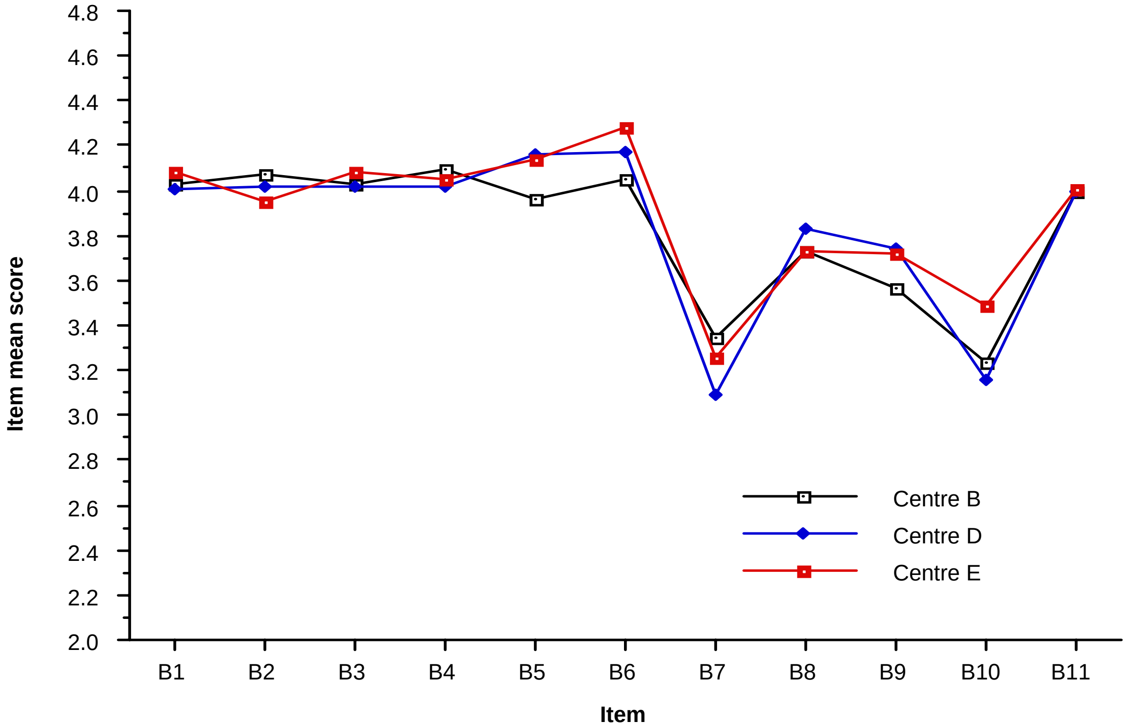

Figure 7.8. Mean scores for centres for items in the PVOI Section B: Your Learning and Understanding.

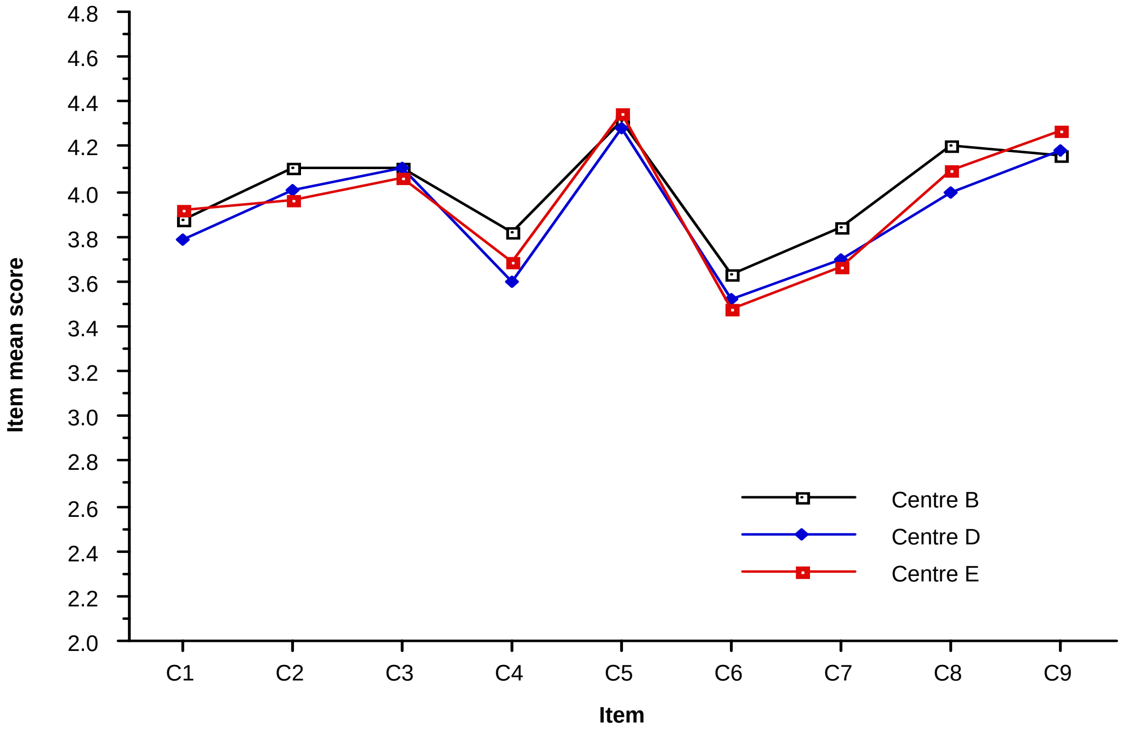

Figure 7.9. Mean scores for centres for items in the PVOI Section C: Your Thoughts and Feelings as a Result of Your Visit.

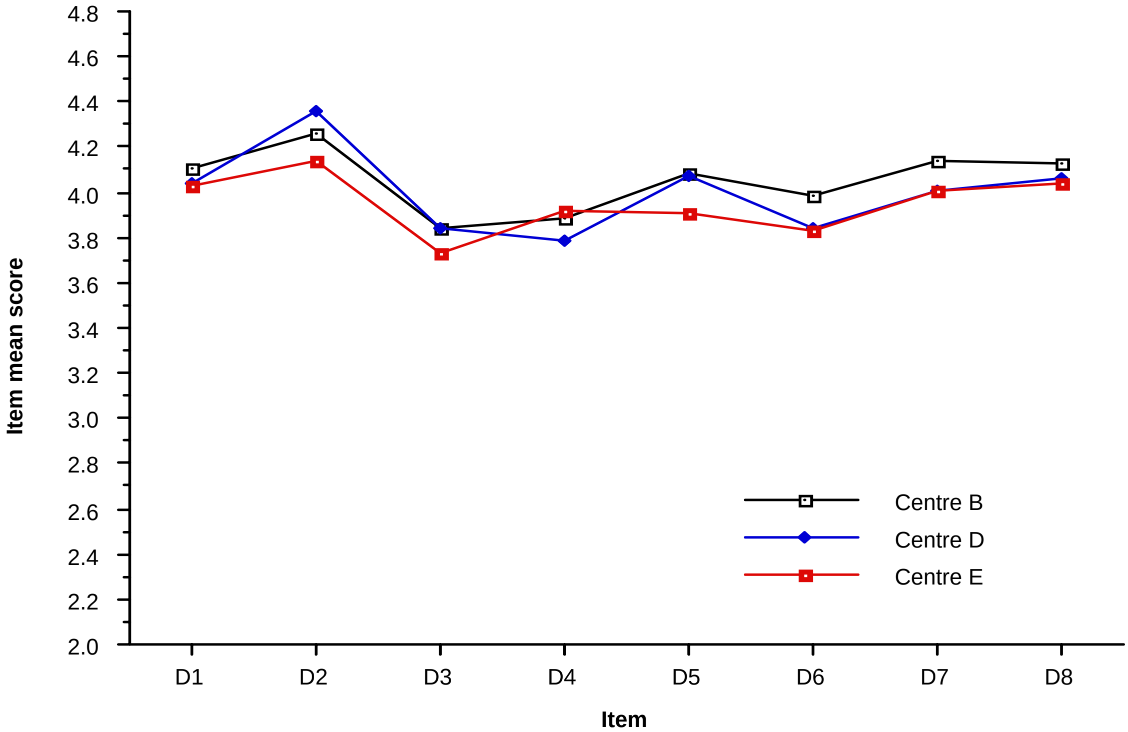

Figure 7.10. Mean scores for centres for items in the PVOI Section D: Your Views About Science and Technology as a Consequence of Your Visit.

The results of Section E about post-visit actions attributed to a visit indicate generally similar trends for each centre with *Centre B* mostly recording the highest percentages. Table 7.9 and Appendix 7-I, reported earlier, show that *Centre B* stimulates the most actions per person following a visit for this sample of visitors. The trends are illustrated in Figure 7.11. There are some clear differences between centres on some of the items, however. On item E13, "Became more energy conscious in my home," *Centre B* visitors indicated a 30% rate which was approximately double that of the other two centres. *Centre B* has a permanent group of exhibits designed to show relative amounts of electricity consumption by common household appliances. Neither of the other centres have a dedicated group of exhibits explicitly demonstrating this theme. Items E1, E2 and E3 all involve purchasing something that enables further pursuit of scientific knowledge. On each of these items *Centre B* has the highest rate which may reflect the availability of items in the respective museum shops. The science shop at *Centre B* has the widest range and the

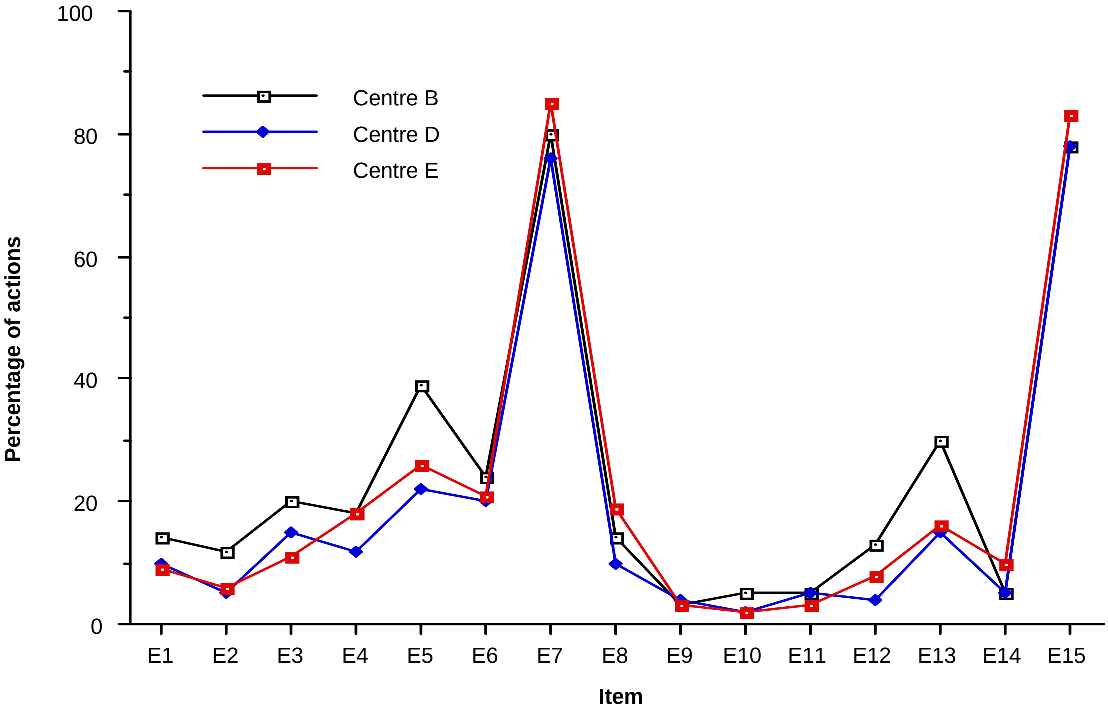

Figure 7.11. Percentage scores for centres for items in the PVOI Section E: What Did You Do as a Result of Your Visit?

most plentiful stocks of scientific and technologically oriented kits, toys and games out of the shops at the three centres. It is likely that another difference between centres on the items in Section E can be attributed to a major exhibition that was dedicated to physical fitness. At *Centre B* the percentage of this sample of visitors who commenced an exercise program (Item E12) was about double that of *Centre E* and about triple that of *Centre D*. There is also a discrepancy between the centres (second largest in Section E) on Item E5 which refers to watching more TV programs related to science. There is no obvious reason for this difference.

Figure 7.12 reports the results for Section F: Parents in a Family Group. There are few differences between centres. *Centre D* has noticeably lower mean scores on Items F11 and F12. Item F11 referred to looking after children, and as *Centre D* has many small galleries, it may simply be easier to keep children in sight, than at other centres where the galleries are large. Item F12 refers to return visits, and as already noted, *Centre D* has a large clientele who are tourists.

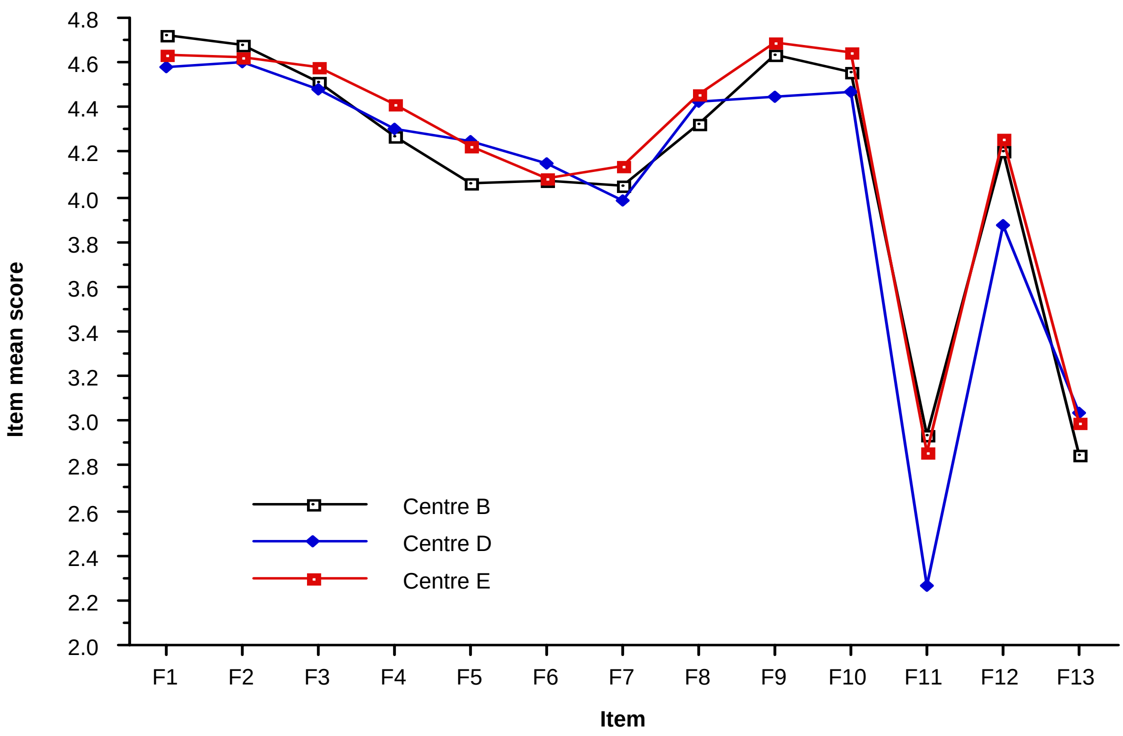

Figure 7.12. Mean scores for centres for items in the PVOI Section F: For Parents in a Family Group.

Two items in Section G showed differences between the centres (See Figure 7.13). Item G5, "I was able to use some information for a school project," showed school children at *Centre E* responded more positively than at the other two centres. It is possible that some respondents were able to use their experiences at an exhibit or exhibits directly related to a project set at that time. For Item G6, "I am considering a career in science," there was a low mean from respondents at *Centre D*. There is no clear reason for this, other than the possibility that *Centre D* is regarded as a destination for tourists in this city, so it attracts a wide range of visitors.

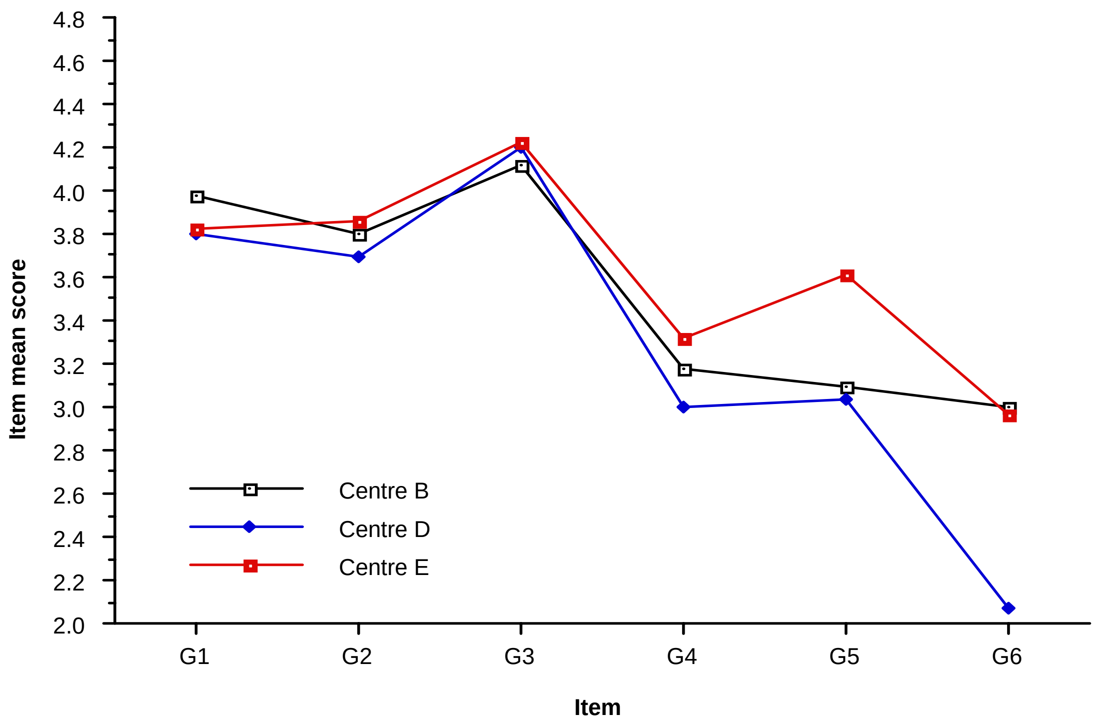

Figure 7.13. Mean scores for centres for items in the PVOI Section G: For School Students.

On Section H, the sample of teachers visiting *Centre B* are clearly responding most positively (see Figure 7.13). Unlike the other centres, *Centre B* has been conducting in-service sessions for primary teachers for a number of years. Given the large proportion of primary school teachers in the region who have completed the sessions, it is probable that some of these respondents may have attended the sessions and were favourably influenced by that experience. If this were the case,

they would be more likely to see the teaching possibilities from their visit in a more positive light. This proposition is speculative only and a further study would need to be conducted to see if the proposition is correct.

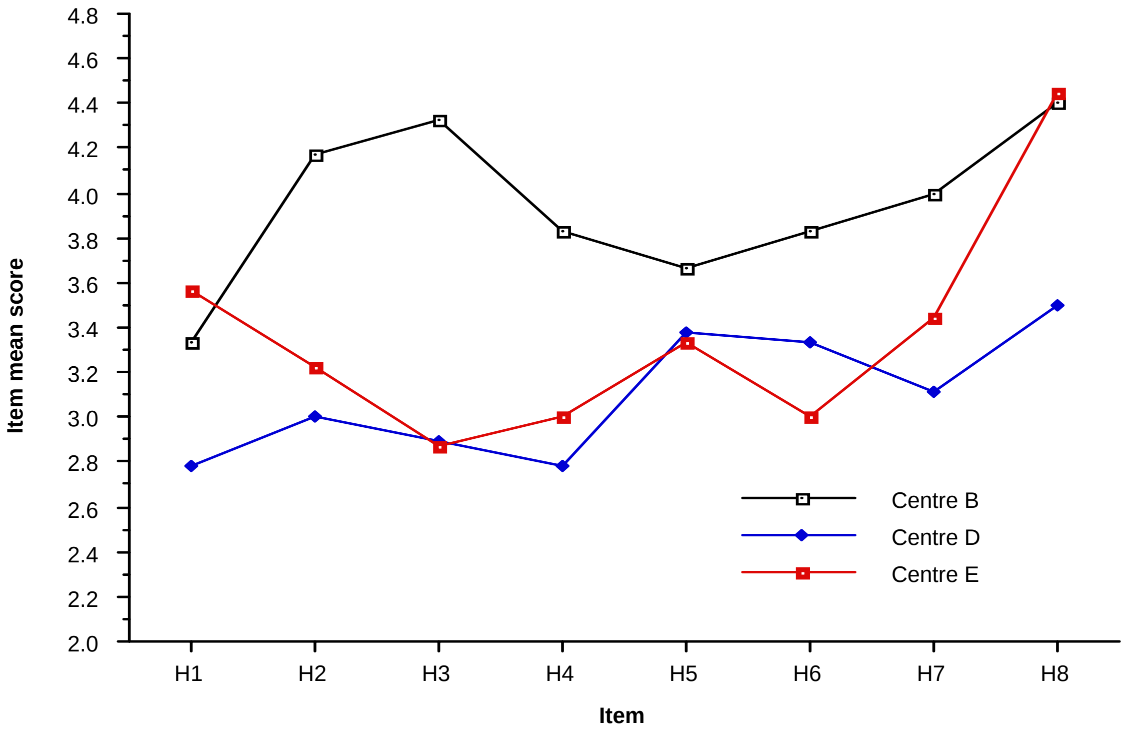

Figure 7.14. Mean scores for centres for items in the PVOI Section H: For Teachers.

Although the differences described for the PVOI were not tested for statistical significance, they indicate some degree of sensitivity by registering differences over the scales. There was a consistent difference for school-age males in particular and between males and females in general. There are some differences between centres on some items that can be linked to particular characteristics of a centre. These items relate to the nature of a visitor (tourist or not), the physical features of the centre and, in some cases, specific exhibits.

In testing the sensitivity of the PVII, it was possible to collect data from visitors to a modern, but static, technology exhibition and make comparisons across the different kinds of centres. It was not possible to do this for the PVOI. First, the PVOI is tailored for the general public visiting an ISTC, and several of the sections of the PVOI were not relevant to the audience for the modern technology exhibits. Second, permission to collect data was refused by the administration of the institution presenting the modern technology exhibits. As the prime purpose of this exhibition was to encourage potential students to enrol in Diploma courses, the administration were concerned that seeking contact details to allow a follow-up questionnaire could be misinterpreted by potential students and their families.

ISTC Feedback

Each of the participating centres was provided with a report of an analysis of the results for their ISTC only. No sample is provided as the alias of the only centre to give permission for its results to be published (*Scitech*) could be identified by cross referencing data. The report was a copy of the PVOI with the percentage of responses given for each alternative for the Likert-style items. For each of the checked box responses a raw score was supplied along with a summary of the written comments. At the same time, a letter expressing the researcher's appreciation for their assistance was sent to the management and staff of the ISTCs. They were also asked to supply feedback about the PVOI on an identical form that was used for feedback about the PVII.

The feedback from all three centres was very positive and all indicated they found the PVOI was a valuable tool for providing information they did not previously have. The CEO from *Centre B* stated that the findings of the PVOI had been used as a basis for submissions for grants for public funding and for corporate sponsorship. Some of those submissions had been successful and attracted sponsorship in excess of AU$ 1,000,000. The CEO also stated, in written feedback, that the results of the PVOI were used "often in speeches" and indicated its value "was 10^{+}, very, very valuable." This centre intends to use the PVOI on an annual basis using the initial results as a benchmark (Manager of Education, personal communication, March 15, 1996).

Feedback from *Centre E* indicated the PVOI results for their centre were to be used as a benchmark for future surveys as they would be using the PVOI again and it had provided them with very useful information that they did not have before. *Centre E* did state that the only negative comment they had received "all the time we were using the form was from a few people who felt that the questions presupposed a rather negative attitude to science and technology." (Manager of Education, *Centre E*, personal communication, October 10, 1995). That fault has been addressed by the alterations made to the PVOI following the main field test.

At *Centre D,* the PVOI provided them with "very interesting results" and that it was "satisfying to get so many positive responses" (Education Officer, *Centre D*, personal communication, December 1, 1995). They found the PVOI to be "useful" and also commented "How very important speaking to others is for Science Centre publicity!" The education officer from the *Centre D* suggested examining the characteristics of respondents who disagreed with some items as knowing more about them "in terms of their age and sex . . . might lead us to make constructive changes."

Using the PVOI

The PVOI is designed to be flexible in its application. The nine sections in the PVOI can be used together in one survey, however, it is also possible to use any section at a time, or to use a combination of sections. For example, by using Section F only, an ISTC could collect information about the outcomes of a visit for parents who visited in a family group. It is also possible to select an individual item, or any combination of separate items, from a section or sections to give a measure of a more specific outcome. Agreement with Item B9 "I was able to relate scientific concepts to my everyday life" for instance, would indicate whether visitors are able to transfer their understanding of experiences at an ISTC to an environment external to the centre. In the case of a respondent's agreement with Item B4, "I was challenged to think about 'why' some things happened," higher level cognition can be presumed to have occurred. It does not necessarily mean a person has solved a problem, achieved a desired result or scored a correct answer; rather it means a person has been engaging in some form of cognitive activity at a level beyond recalling factual information. As well, some items may be grouped to form a sub-category. Items B9 "I was able to relate scientific concepts to my everyday life", B10 "I learned something new about myself" and B11 "I learned something new about the world around me" could be grouped to form a sub-category of learning about individual awareness. Thus, ISTC staff or other researchers could use combinations of items for the PVOI to design a survey to match their requirements. In the final chapter, further suggestions are made for its use.

If centres want to find out about visitors' perceived gains in scientific literacy, there are a number of items that imply facets of scientific literacy. If the view of Lucas (1983) is taken, then the number of people who attribute reading articles about science or watching TV to their visit (Items E4, E5 and E6 on the PVOI) can be used as an indicator for potential gain of cultural scientific literacy. Of course it does not mean necessarily that those visitors will be more scientifically literate as they will construct their own meaning of the article or TV program which itself may or may not be accurate.

Items that can be used as general indicators of practical scientific literacy are B9 "I was able to relate scientific concepts to my everyday life," and B10 " I learned something new about myself." Items that are more specific are E10 "Changed my lifestyle," E12 "Started an exercise program," E13 "Became more energy conscious in my home" and B14 "Influenced my decisions at work". Item B11 "I learned something new about the world around me" could indicate practical, civic of cultural scientific literacy. If a criterion of change of attitudes to science (Miller, 1983) is taken as one indicator of scientific literacy, then all the items on Section C of the PVOI can be used as a source of data.

The PVOI does not have items that are able to give a specific indication of civic scientific literacy. It should be noted that some issues related to civic scientific literacy can change rapidly and the lead-in time to establish an exhibition would be too lengthy for ISTCs to establish and remain relevant. However, there are some issues that are ongoing. For example, "The Great Australian Treasure Hunt" contained some exhibits about revegetation of mined areas, a long standing issue. In its present form, the PVOI is not able to discriminate finely enough to detect reactions to a few exhibits embedded within many constituting a thematic exhibition.

There are some points that need to noted about the limitations of using the PVOI to distinguish between centres or specific exhibits at centres. These points would apply to any instrument designed to give a summary profile of outcomes. First, there is the nature of the items on the PVOI. They were developed from comments made by a diverse group of visitors after viewing a wide range of exhibits and are therefore encompassing in nature, rather than focussing on particular attributes of one exhibit or a group of thematic exhibits making up an exhibition. Consequently, most items are generic in nature and will give ISTCs an overview of visitors' perceptions of outcomes rather than a measure of small changes. However, it is important to note that the method of collecting data with the PVOI is also generic, so it would easily be possible for items to be developed which related to a specific exhibition.

Second, there are physical constraints to controlling visitors' experiences. While it is possible, it would be difficult to limit visitors experiences such that they interacted with only one exhibit or an exhibition so their perceptions are related to specific experiences. Most ISTCs have one entrance and exit and what a visitor does in between is random and unique. Any interference would contaminate results because, as Lucas, McManus and Thomas (1986) pointed out, "the context of informal learning must be preserved if the results are to have validity" (p. 344). Furthermore, isolating exhibits and exhibitions is often not practical because of physical restraints.

Third, the nature of an individual's ISTC experience is unique. It is acknowledged that while centres have their differences (Beetlestone, 1989; Lucas, 1991; Rennie & McClafferty, 1996), they do have similarities. One similarity is in the nature of the experience: It is one of direct engagement with exhibits. In responding to the PVOI, the visitors may well be responding to the interactive experience rather than to a particular exhibit. If that is the case then it would be difficult to have its items able to distinguish between exhibits.

For these reasons it will be impractical for ISTCs to use the PVOI in its present form to detect small changes from time to time. Given the generic nature of many items it is probable that the response rates for those items will remain steady unless there are quite large, obvious changes in an ISTC. There are some items that are sensitive enough to respond to particular experiences but these may need to be adapted to suit new circumstances. But, as noted earlier, it would be possible to construct exhibit-specific items if the ISTC had a purpose for doing this, and collect data using the method which was successful for the PVOI.

CHAPTER 8

SUMMARY, CONCLUSIONS AND IMPLICATIONS

Overview

This final chapter summarises the study and its findings. The research design is examined critically and conclusions relating specifically to the research question and the two specific research questions are given. Implications of the findings of this study for the ISTCs that were involved and for ISTCs in general are discussed. Finally, suggestions for further research are made.

Summary of the Research

Background to the Study

This study aimed to develop a method for measuring the effectiveness of visits to ISTCs in terms of the perceived outcomes for visitors who were not part of a school group. The research was set in a context of accountability where large amounts of funding from public and private sources have been invested in establishing and operating ISTCs. The money has been invested in the belief that science and technology will be brought to the public in a stimulating, entertaining and accessible format (Gore, 1989) . In addition, there is a clear expectation that visitors will be motivated by their experiences, learn something about science and technology and become more aware of their relevance in their everyday living (Smith, 1995) . There is also a stated expectation by some CEOs of ISTCs, politicians and government funding agencies that scientific literacy will be improved.

A range of opinions exist about the appropriateness of the experiences ISTCs provide and about whether the outcomes are biased towards entertainment rather than education. Some believe ISTCs do not portray the rigour of the scientific process (Baggott, 1995) nor the hard work involved in scientific research (Champagne, 1975) . Beetlestone (1993) reported that some people have been critical because they perceived ISTCs to be primarily places of enjoyment. To others these criticisms are not the issue, the real issue is getting a message to the public (Boyd, 1993; Gore, 1990) . Boyd (1993) wrote that, "It is said showmanship is replacing scholarship in museums. The issue, however is not showmanship versus scholarship, but rather how to convey scholarship to a diverse public" (p. 764).

Given the considerable investment in ISTCs and differing opinions about their effectiveness, there have been calls for research into measuring the outcomes of visits to ISTCs (see for example, Bitgood, Serrell & Thompson, 1994; Falk, Dierking & Holland, 1995a) . Accordingly, the main research question in this study asked, how can the outcomes of a voluntary visit to an ISTC be measured? Prior to answering that question, two more specific questions were first addressed. They were:

- What are the personal outcomes of visits to *Scitech* as perceived by the visiting public?
- How can research instruments capable of measuring those perceived outcomes be developed?

The study focussed on voluntary visitors in response to a specific request by Dr. Seddon Bennington, the CEO of *Scitech* at the commencement of this study. Most of the visitors to *Scitech* (75%) were people who were not part of an organised school visit and little was known about the impact of their visit experiences. Dr. Beddington stated that this area of research was a priority for *Scitech* and offered support and cooperation where possible. For example, free passes as incentives for potential respondents to participate were provided.

A literature search revealed that there was little research conducted in ISTCs about identifying and measuring outcomes of visits. A likely reason for the paucity is the difficulty of designing and executing studies in an informal learning environment where the experiences are unique for each visitor. There was, however, enough research available to identify some likely outcomes of visits and to examine the methods used to try to measure them.

The results of studies about outcomes for voluntary visitors indicated that all outcomes can be considered to be a form of learning. The learning is a holistic experience and influenced by many factors. Furthermore, attempts to distinguish between different types of learning, such as cognitive, affective and psychomotor learning have met with difficulties because they are interdependent.

Studies aimed at measuring learning for voluntary visitors have produced mixed results. A variety of methods have been used to collect data. These include written measures, face-to-face interviews with visitors both during and following a visit, post-visit telephone interviews, observation of visitor behaviour and recording their conversations. However, instruments requiring written responses are practical for ISTCs to use because they are more efficient in terms of cost of administration and data analysis.

The literature review did not provide any one model to follow in this study. There was, however, enough information to suggest possible outcomes and to offer a guide into commencing the study by using an investigative approach by the researcher immersing himself in the working culture of an ISTC at *Scitech*.

Procedure

Stage 1: Immersion at Scitech

An ethnographic technique was adopted for the initial field work with the researcher taking the role of a participant observer to gain an understanding of the working culture of an ISTC. This immersion phase enabled familiarisation with the administration, planning and daily functioning of *Scitech*. He was attached to the education team as an honorary staff member and included in the daily activities of *Scitech.*

The immersion phase proved to be valuable. Casual conversations with staff and visitors gave an insight into the perspectives of two groups of stakeholders (visitors and *Scitech* staff) and a better understanding of the operation of an ISTC. As well, an element of trust was established with the researcher by *Scitech* staff. Casual conversations with visitors and unobtrusive observations of visitors interacting with exhibits provided a better understanding of a visit experience.

Stage 2: Interviews with Staff and Visitors

Interviews were conducted with professional staff, voluntary staff, and with visitors, both at the time of their visit and after it. Seventeen professional staff from the different sections of *Scitech* were targeted for one-to-one, open-ended interviews and the volunteer staff of explainers were interviewed in two focus groups. The professional staff provided a large amount of data about their roles and gave a variety of possible outcomes for visitors. The outcomes included enjoyment, learning, increased interest, a positive shift in attitude, a realisation that science and technology are accessible, and that a visit is a valuable social occasion. These findings were mostly similar to those found by Stevenson (1993) when he interviewed the professional staff at the *Launch Pad*.

A total of 17 explainers were interviewed in two different focus groups. The explainers, who of all the staff have the closest contact with visitors, had perceptions that visitors enjoy themselves, that both intended and incidental learning occurs, and that visitors are able to relate concepts demonstrated by exhibits to their own experiences.

Interviews were also conducted with 90 voluntary visitors in two different formats. The first was semi-structured interviews on a one-to-one basis with 70 randomly selected visitors at the time of their visit and the second was two focus group sessions with 20 visitors well after a visit. Participants in the focus groups had either been interviewed previously or had been part of a visiting group from which one member had been interviewed at the time of a visit.

The results of the one-to-one interviews indicated that visitors enjoy themselves and many were able to provide statements that showed they did learn from their experiences. Other outcomes of visits were: motivation, a change of attitude, a feeling that science and technology are accessible, that it was a rewarding social experience and there was a potential for application of some of the experiences. Some were able to relate memories of experiences of previous visits extending over a lengthy period and to provide details of what they had learned. All these outcomes matched the expectations of the *Scitech* staff and most are congruent with the potential outcomes identified in the literature.

Each visitor focus group session had a dual purpose. First, they were both used to verify the explainers' perceptions about outcomes and learning experiences for visitors. Second, one visitor focus group was used to provide feedback about the effectiveness of the trial field-test PVQ and the other was used to pre-test the PVII prior to its field testing.

Stage 3: Development of the PVQ and Its Field Testing

Following the interviews, a written post-visit questionnaire was developed mainly from the interview data and supplemented by data from the research literature and informal conversations. The purpose of the PVQ was to obtain written statements from visitors about three to four weeks following their visit after they had time to reflect on their visit and to act upon anything that may have motivated them.

The PVQ was field tested with 153 respondents. Thirty six of these were from the first phase of the randomly selected group of visitors to be interviewed who had agreed to participate further. The other 117 were randomly selected during a visit. Analysis of the PVQ data confirmed all the potential outcomes identified during the interviews, particularly that people enjoyed a visit and that it was perceived to be an educational experience. It was also clear that the visit experience does not finish at the exit door because many people discuss their visit afterwards, link their experiences to events in their lives, actually do something as a direct consequence of their visit and experience a positive change of attitude. The responses for this sample of visitors indicated that they perceived increases in their interest and awareness of science and modern technology that were statistically significant ($p<.001$). Some parents reinforced their children's learning experiences by providing related follow-up experiences, discussing the visit with them and pointing out related phenomena and applications. Memories of their visit were still very clear at the time of completing the PVQ. Importantly for this study, a large data base of statements was able to be developed from the PVQ which, along with data from the interviews, formed the basis for items on the PVII and PVOI.

Stage 4: Development of the PVII and Its Field Testing

The PVII is an instrument with a semantic differential format and is designed to be administered to randomly selected visitors at the point of exit immediately following a visit to an ISTC. Responses to the item on the PVQ asking for the three best words to describe a visit were used to develop the 14 bi-polar adjectives that make up the final PVII.

The development process involved previewing and pre-testing of a draft instrument before it was field tested in a pilot study. It then underwent a stability field-test followed by an extensive main field-test at five different ISTCs in two countries. In all 1152 randomly selected, voluntary visitors provided data for statistical analysis.

The PVII has three scales – Affective, Cognitive and Sensory – that were developed using principal component analysis to confirm the dimensionality of the instrument by the grouping of items to form three intuitively logical scales. The PVII has acceptable coefficients of test-retest reliability on all three scales and they each have an acceptable level of internal consistency. In a subsequent trial with 218 visitors to a gallery of modern but static technology exhibits, the results of the PVII showed large differences between the perceptions of visitors to the gallery and the perceptions of visitors to the ISTCs. Effect sizes of over 2 standard deviations indicated that visitors to ISTCs rated their experience much more positively on the Affective and Sensory scales, and also on the Cognitive scale, where the effect size was .87.

The PVII has the advantage of being quick to administer as engaging respondents is convenient and can be conducted by one person. It is easy to score and received favourable comment about its usefulness from all five ISTCs involved in the study.

Stage 5: Development of the PVOI and its Field Testing

The PVOI is a very different instrument to the PVII. It is designed to be administered three to four weeks after a visit and gives an overview of the outcomes of a visit from a range of dimensions. It consists of nine sections that together provide data to give a complete profile of outcomes of a visit. Sections may also be used separately to gather data about a single outcome. For example, Section E can be used by itself to find out what people have done as a result of their visit. As well, data from individual items or combinations of similar items may be used for more specific outcomes.

Items on the PVOI were derived empirically from a very large quantity of visitors' comments. They were refined after reviews by experts from ISTCs, researchers and visitors, and using data collected at three ISTCs. The items are grouped into the following nine sections: Your overall impression of your visit, Your own learning and understanding as a result of your visit, Your thoughts and feelings about science and technology as a result of your visit, Your views about science and technology as a consequence of your visit, What you did as a result of your visit, For parents in a family group, For school students, For primary school teachers and, Are there any other comments you would like to make about your visit to the centre?

The instrument has a mixed format comprising mostly Likert scale items with some open-ended and checked box items. It was previewed by 27 experts in education and research and trial field-tested with 13 randomly selected visitors to *Scitech* before being field-tested with 425 randomly selected visitors across three ISTCs in two countries.

Field-testing the items used both quantitative and qualitative data. Descriptive statistics in the form of means and standard deviations were calculated and the response patterns for each item were examined for the level of undecided responses. Comments, written by respondents in the field tests, were taken into account as the instrument evolved. A final review of the amended field-test instrument was conducted by a voluntary group of respondents who had been critical of some of the items and the structure of the instrument.

The PVOI has an advantage of collecting data about outcomes of visits when sufficient time has elapsed for the visitors to reflect and, in some instances, act on their experiences. ISTCs will be able to use the data to develop a profile of the outcomes of visits as an indicator of their effectiveness from the perspective of the visitors. Although it requires more resources to administer than the PVII, the PVOI does provide a greater depth of information which can easily be collated. The comments of staff at the three ISTCs who used it indicate that it is a valuable instrument because of the data it provides.

In the open-ended items at the end of both instruments, many respondents took the opportunity to explain why they found their visit to be a positive experience and to highlight areas of dissatisfaction. The mix of satisfaction and dissatisfaction is important because it suggests that those people are not just trying to please and be polite by giving positive responses, but are willing to provide constructive criticism for the ISTCs to improve their service. As well, some respondents volunteered criticism of some of the items on the PVOI which can be interpreted as a balanced response giving credibility to the otherwise overwhelmingly positive responses about their visit.

Reflections on the Research Design

There were inherent difficulties in approaching this study because of the diversity of the subjects and the unstructured nature of a visit experience. The visiting public covers a wide range of people with differences in age, gender, ethnicity, level of education, prior interest and experience in science and technology, personal agendas and time spent engaging with exhibits. These are all variables that can influence the outcomes of a visit. Attempting a classical experimental method of pre- and post-tests with a control group was clearly inappropriate because of the difficulties posed by so many variables operating in an open, informal learning environment.

Using an emergent research design based on both naturalistic and positivistic paradigms proved to be successful in this study. An initial ethnographic approach enabled the researcher to get valuable insights into the context of the study and into the perspectives of *Scitech* staff and voluntary visitors about visit experiences and potential outcomes. Interviews, focus group sessions and the PVQ all yielded rich and relevant data. While semi-structured interviews and closed and open-ended questions on the PVQ proved effective tools to discover details of visitors' perceptions of their experiences, they were not efficient in terms of resources and time and should not be considered an effective tool as a summative measure.

Because a diverse population was involved, particular care was taken to try to use the language of respondents when interviewing and developing instruments (Borg & Gall, 1989; Lincoln & Guba, 1985; Patton, 1990) . Due to the informality of the learning environment and the variety of experiences, questions for the interviews were generic in nature. Lederman and O'Malley (1990) found that language used by respondents and researchers may often be interpreted differently by both. This has led to misinterpretations of respondents' views and perceptions. In order to avoid ambiguity, the language and structure of the items on the PVII and PVOI were derived from data supplied by visitors and not from a theoretical or researcher-based viewpoint.

At all stages of the development of the PVII and PVOI, input was sought from experts and the visitors. This proved to be a worthwhile strategy as it enabled opportunities for continual improvement as the instruments evolved. By using methods of the postivistic paradigm – random sampling, large sample size, and collecting data from different centres – claims for generalisabilty can be made. Later in the study, descriptive statistics were used for analysing quantitative data (means, standard deviations and percentage responses) about items on the PVII and PVOI. As well, statistical analysis was used successfully in selecting items and developing scales for the PVII and for testing the reliability of the scales based on internal consistency and test-retest stability.

The most simplistic definition of validity is that it is the degree to which a test measures what it is supposed to measure (Gay, 1992) . In short, a test is valid for a particular purpose and for a particular group. The research design led to instruments which have construct validity because they are grounded in the perceptions of voluntary visitors to ISTCs. Further, an integral component of the instruments' development process was logical analyses of the item content and confirmation by empirical processes, both of which are considered essential for "defending the validity of test interpretations" (Shepard, 1993, p.406). All the items on the PVII and the PVOI are based on the principles of construct validity, which according to Shepard (1993) , "is the one unifying and overarching framework for conceptualising validity evaluations" (p. 406).

In Chapter 1, five criteria were documented which would indicate that the research instruments were successful. The first, that the instruments needed to be based on the public's own perceptions of their experiences while visiting an ISTC was fully met by using visitors' statements as the source of items on both instruments. The second criterion was that the instruments would be reliable and valid. Reliability and validity were easier to establish on the PVII. The dimensionality of its scales was demonstrated with factor analysis, the scales were shown to be internally consistent and to have test-retest stability. Further, it was used to distinguish between visitors' perceptions of different kinds of exhibits in two kinds of galleries. The PVOI, like the PVII, has construct and face validity by virtue of its method of development but its reliability is more difficult to establish because it is designed to provide a profile using a large number of items. In this sense internal consistency among items is not an issue, but it demonstrated consistency in responses across the testing stages, and also across ISTCs.

The third criterion was ease of administration and analysis of data. The main field-tests with other ISTCs demonstrated the ease of administration. The instruments are easily scored and although in the study the researcher analysed the data as a service to the ISTCs where the data were collected, the analysis and results were readily understood by the recipients.

The fourth criterion was flexibility, that there would be items measuring both generic outcomes across different ISTCs as well as items responsive to individual features of the ISTCs. The latter part of this criterion was not fully met, particularly for the PVOI. The PVII certainly measured similarities across the ISTCs and distinguished between these and a gallery with static exhibits. Further, there were interpretable differences between ISTCs on some scales. The PVOI was not able to be tested in an environment other than an ISTC. Again there were interpretable differences between centres on particular items, but overall, ISTCs were found to be more similar than they were different. On the one hand, this is not surprising, all of the participating ISTCs belong to the same network, their exhibits are generally similar and exhibitions rotate between them. On the other hand, it is disappointing that greater differences were not discovered.

The fifth and final criterion was that the instruments would be acceptable to the staff of ISTCs or they would not be used. This criterion was tested by feedback sheets to the ISTCs, and the feedback was very positive. The interstate and international ISTCs have not since been contacted, but *Scitech*, the ISTC where most of the study was conducted, has instituted a program of visitor research which is still continuing.

Limitations

An important feature of any survey instrument is that its findings are generalisable. The generalisability of any study depends on the methods of population sampling (Gay, 1992). It is reasonable to assume that people visiting *Scitech* and the four other centres from which data were collected would be similar to visitors to other ISTCs in Australia and New Zealand, and possibly other Western countries. Although instructions had been given to the different ISTCs on procedures to be followed to obtain data from randomly selected subjects, it is possible the procedures were not followed, and this would affect generalisability. During the data analysis for the PVOI, it became clear that instructions about administering the instrument were not followed at one centre because respondents wrote comments that indicated they were completing the instrument at the time of the visit, not afterwards. The data from that centre were not included in the data used in the development of the PVOI. There was no evidence that any of the other ISTCs failed to follow instructions for subject selection or data collection.

Demographic data over the different collection sites showed there was reasonable consistency about the sex, age and levels of education in science for all the respondents in the field-tests for the PVII, the PVOI and the PVQ. This suggests that there is a case for generalisability of the results to other ISTCs.

Demographic data about the first language of respondents collected on the PVQ and PVII showed virtually all respondents spoke English as a first language. Therefore, it is possible that the results would not be generalisable to any ISTC where a bigger proportion of the visiting public did not speak English as a first language. Both the instruments should then only be administered by ISTCs to visitors who use English as a first language.

The instruments are limited by their design, structure and content. The PVII can only provide data immediately following a visit while the PVOI is limited to collecting data about one month after a visit. Data collected by the PVII gives a precise, but narrow, indication of outcomes because it has three different scales. The PVOI collects data about a diversity of outcomes, but it does not have scales. Together, both instruments provide a more comprehensive picture of outcomes of a visit than when they are used individually. Despite the care taken to obtain a wide-ranging data base from which to develop items, the content of the items on both instruments remains limited by the data collected during this study. It is probable that additional items could be developed from data collected at other ISTCs and by using other methods.

As foreshadowed in the previous section, a limitation of the study is that the PVII and the PVOI demonstrated that the centres were more similar than they were different. This may mean that the scales are insensitive or that differences really are small. There were consistent differences in response by subgroups of the population, females were generally more positive than males for example, and the other differences, particularly for some items on the PVOI, were interpretable in terms of features of the ISTCs. This provides some argument for scale sensitivity. However, the items are generic, rather than specific, and without some refinement, would probably not distinguish easily between different interactive exhibitions. Further research is needed to test for responses to particular interactive exhibitions.

Conclusions

This study attempted to answer the research question by identifying the personal outcomes of visits from visitors' own perspectives and using these to develop instruments to measure those outcomes. First, it showed that there are diverse and tangible outcomes of visits to ISTCs from the voluntary visitors' point of view. Visitors are almost unanimous that they have enjoyed themselves while visiting and that they regard it as an educational experience where they may have learned something specific or have just become aware of something new. People are motivated by their experiences and the effects can be lasting. Some reported that they were stimulated to watch more TV programs, read more articles about science and technology and to carry out activities based on their visit experiences. Some also reported taking up new hobbies and changing their lifestyles while some school students indicated they would now be considering a career in science. For many visiting in groups, it was a valued social experience with families and friends. The experience also had an effect on people's attitudes towards science and technology and they claimed to be more aware of how they impact on their daily lives. People were able to recall their visit experiences, and after three to four weeks their memories were quite vivid and detailed.

Second, this study also showed that the outcomes of a visit in a broad sense can be measured. Two instruments, capable of measuring many of the outcomes, were able to be developed and validated. Developing the instruments was a rigorous and time consuming process that involved the collection and analysis of a substantial amount of qualitative and quantitative data from a large number of subjects. The instruments are quite different and have two entirely different uses. They both, however, enable the collection of data about outcomes of visits, the PVII giving a measure of the immediate impact and the PVOI giving a profile of outcomes based on post-visit reflections and actions. Neither instrument provides a measure of fine detail for all outcomes.

The PVII is an instrument that allows ISTCs to obtain quickly and easily, a quantified indicator of the immediate impact of visit experiences. Because it has been tested at five different ISTCs in Australia and New Zealand and, provided the people who were responsible its administration followed instructions for random sampling, it should produce generalisable findings. ISTCs can use it to collect data and make comparisons over a period of time. Researchers are able to use the three different scales to investigate outcomes in three different areas to do with cognition, affect and sensory perception. If the comments of the ISTCs involved in collecting data for its development are any guide then it will be a useful instrument.

The PVOI requires more resources to be administered than the PVII because it is designed to be administered after respondents have left the premises. As well, more potential respondents need to be enlisted because a lower return rate can be anticipated than when people complete a questionnaire on site. Like the PVII, the PVOI provides a quantified indication of the impact of a visit. The PVOI has the capacity to provide data about a variety of outcomes by combining scores for the different sections or on a finer level, using a selection of similar items. In comparison, the PVII has scales reducing the outcome indicators to three scores, however, the data can also be examined at the level of individual items. Both instruments can be used to monitor outcomes over periods of time. Comments from the three ISTCs who field tested the PVOI indicate they believe it is a valuable instrument as it provides a variety of useful data that were not previously available to them.

Generally, visitor's comments derived from the interviews and PVQ were very positive and they were confirmed by the high mean scores for almost all of the items on both the PVII and the PVOI.

Implications

The implications of this study can be grouped into three broad areas. There are implications for the management of the ISTCs involved in this study and for ISTCs in general. There are also implications for educational researchers investigating outcomes of visits to ISTCs and other places that present science and technology to the public in an informal setting. As well, there were incidental findings that supported those of other research.

Implications for ISTCs

An immediate implication of this study is that its results have provided the ISTCs involved with two ways to measure people's perceptions about their visit. Further, when the ISTCs stage new exhibitions the PVII may be used to detect changes in visitors' responses. The generic nature of the items of the PVOI suggest that its use for this purpose may need to depend on the selection of relevant items or perhaps writing items to relate to specific exhibits. ISTCs will also be able to use visitors' perceptions over a longer period of time to gauge the value the public places on the experiences people have while visiting ISTCs. Furthermore, they now have new, relatively independent, data to present to their respective Boards of Directors as well as to existing and potential sponsors, something identified early in the study as an important issue for CEOs.

Both the instruments supplied data that can be extrapolated across the entire population of visitors to each of the ISTCs. For example, if 80% of a random sample of people who visited *Scitech* indicated they discussed their visit with someone outside their visit group, then there would be there would be approximately 200,000 such conversations per annum. Given that some of these are repeat visitors, it is still a large amount. If that same trend was extended to the US where it is estimated 25% of the population made approximately 87 million visits a science centre in 1990 (Miller, 1992) , the number of people talking about their visit is enormous. Even if an item with a more modest percentage is extrapolated, the outcome is still considerable.

The value of being able to extrapolate the data about items should also be of interest to the ISTC marketing people. For instance, results about Item A3 of the PVOI indicate 95 % would recommend the ISTC as a place to visit and 87% indicated they intend to return. Word-of-mouth is the best source of publicity according to the former marketing manager at *Scitech* (M. Henry, personal communication, February 8, 1994).

On a broader scale, ISTCs with a similar visiting clientele and similar learning environments to those involved in this study now have validated instruments with which they can collect quantitative and some qualitative data about outcomes of visits. The benefits to them would be similar to those outlined above. There is also potential for the instruments to be used by other institutions that present science and technology in an informal manner, such as zoos, aquaria, botanical gardens and national parks, for example. The instruments may also be pertinent for galleries or sections with interactive exhibits. In any case, further studies would need to be conducted to select and validate the items appropriate to each type of institution.

Another possible use of the instruments is the identification of areas where the ISTC is not performing well. The generally very positive and similar results across ISTCs found in this study would suggest that ISTCs who find patches of negative perceptions have identified an area where remediation is required.

Implications for Researchers

There are important implications for educational researchers working in ISTCs specifically and probably for those working in other institutions that present science in an informal setting. Researchers have been for trying for some time to establish outcomes and measure them and the results of this study are a contribution towards that goal. This study showed that this sample of visitors believe they are learning across a range of areas as a consequence of their experiences while visiting, but in specific cases it would be necessary to interview a visitor to find exactly what had been learned. The visitors involved in this study perceive learning takes place in the cognitive and affective domains and, for those who visit in a group, discussions are part of the experience. Many parents who visited with their children indicated they used their visit to engage in teaching activities with their children and for some the teaching continued after a visit. The learning is also transferable as respondents indicated they have used information learned during a visit and applied it to work, study, hobbies and domestic environments. Replication studies with other samples of visitors in ISTCs are needed to extend these findings.

Both the instruments have potential for further research. On the PVII, all three scales – Cognitive, Affective, Sensory – provide a basis for further exploration about the type of learning that may occur at different exhibitions and amongst different groups of visitors. It can also be used at institutions other than ISTCs that provide offerings of informal science education and those that offer other kinds of informal education such art galleries. It could also be tested with school groups. There is also the question of its ability to detect differences between subgroups of visitors. Further investigative tests would determine whether the differences it found with this sample were simply random or whether there are real and consistent differences between groups. As noted by the Manager of Education at *Questacon-The National Science and Technology Centre,* ability to distinguish outcomes for different groups of a visiting population would be a desirable asset. The PVOI also offers an opportunity for further investigations about differences between subgroups of visitors. For instance, females in this study had higher scores on 10 of the 11 items in Section B which consists of items related to with learning and understanding. Further investigation would show whether these differences are stable. The investigation could be extended to other subgroups and other Sections of the PVOI using this data and data collected from new samples of visitors. Similarly to the PVII, there is potential to use the PVOI for conducting research at other types of centres presenting science to the public informal context. In particular, the method of data collection used for the PVOI is adaptable to other kinds of items which could be designed to focus on particular exhibitions or other issues of interest to researchers at different kinds of institutions.

There are other grounds for further research arising out of this study. The demographic data collected for this study reveal that almost all visitors to ISTCs in Australia and New Zealand speak English as a first language. Given that both countries are multi-cultural societies it must be of some concern that, if this sample is an accurate indication, many people of different ethnic origins are not being attracted to ISTCs.

The results of this study also indicate there is a basis for further investigation into using ISTCs to make science and technology more inclusive for females. The following statement by a newspaper reporter making a case for the benefits of having an ISTC available illustrates the point. Under a heading "New science centre faces the same old knockers," she wrote:

> Scientific things may be obvious to scientists. But they are not necessarily obvious to me. In my heart, for instance, I still believe that an electric light has more to do with magic than with science. Chemistry and witchcraft are the same thing as far as I am concerned. Like so many people, I gave up science at the age of 13, defeated by strange goings-on in a test tube on the teacher's desk. I do not feel particularly inferior or guilt-ridden for not knowing what a double helix is. I possibly never will know. But it is nice to have the chance to redress the balance a little, and to feel that an avenue which I did not explore at school, whether because of rotten teaching or social conditioning, is not closed forever. (Burgess, 1988, p. 9)

The explainers, as a source of information, offer another opportunity for further studies. Investigations in ISTCs relating to education, exhibit design, visitor service, and marketing should all be able to obtain data from explainers. This also applies to museums, zoos, and art galleries that use explainers to interact with visitors. If ISTCs and other centres for informal science learning are to demonstrate outcomes related to increased awareness of science and technology among visitors, then every research avenue must be explored.

The focus groups provided a unique insight into the explainers' perception of visitors' experiences at an ISTC, which have not been documented before. All members had first hand experiences to relate providing consistent information about what visitors are perceived to do and learn. *Scitech* is typical of ISTCs, and the explainers were chosen to be representative. However, further research is required to determine whether the findings are generalisable to other ISTCs.

Incidental Findings

There were some other findings in this study that, although being peripheral to the main thrust, are worth mentioning because some of them support the findings of other studies and some suggest new areas for research. Those findings about visitors that support other studies include the average length of time taken for a visit, that memories of visits are clear, that people are motivated to do things as a consequence of their visit, and their main purpose for the visit is entertainment while education is secondary.

The average time taken for a visit is consistent with that found in similar centres in other countries. McManus (1992) and Stevenson (1991) in the UK, and Diamond (1986) and Falk (1991) in the US, all reported mean times for the length of a visit ranging from 1.5 to 2 hours, which is the same for the visitors who were involved in one-to-one interviews in this study.

The results of the PVQ showed memories of visits are quite clear and detailed after three weeks and some responses to the interview questions indicate visit experiences can be recalled after much longer periods. This supports the findings of Stevenson (1993), McManus (1993a) and Falk (1988).

That people are motivated to do something as a result of a visit supports the findings of Johnston (1995) and White (1990). Now that a broader range of potential activities has been identified, it is possible for further studies into the extent of these activities at other centres.

The results of one-to-one interviews with the 70 voluntary visitors in this study indicated that, for most, learning is not foremost on their overt agenda for visiting. That notion was supported by the opinions of the *Scitech* staff who were interviewed, and is in agreement with Hood (1992) and Rosenfeld (1979). There are others, however, who have found learning is an important reason for people to visit (Kelly, 1991; McManus, 1989).

Whether or not people come to an ISTC to learn is an interesting issue. ISTCs have learning objectives in their manifesto, educational exhibits designed carefully to provide experiences which are enjoyable but also intended to promote understanding of the concepts involved, and to stimulate interest in science and technology. That at least one explainer did not perceive this to be part of the philosophy suggests that the entertainment dimension of the ISTC visit is an important issue. There is little doubt some learning does occur, as the exhibit designer intended, however such learning may well be incidental if the visitor's intention was enjoyment.

Final Comments

Bitgood, Serrell and Thompson (1994) noted we should be developing new methods for research in informal settings such as ISTCs. This study has contributed in some ways towards answering that call. There are the two instruments that have been developed and there is the successful use of explainers to gather data. As well, use of the visitors' perceptions after a visit as a source of statements for items and using focus groups of visitors as reviewers are all new approaches to research in ISTCs that have been used successfully in this study. The new techniques developed for this study could be transferred to other institutions offering informal science education as well as art galleries and museums generally.

Establishing outcomes of visits to ISTCs and measuring them has long been seen as a vital piece of research that is difficult to execute successfully. This study has been able to identify and verify a range of outcomes for voluntary visitors, and in doing so, pioneer some innovative methods. This study has also produced two instruments that were regarded by the ISTCs who used them as being of value and very worthwhile. This study has been able to help in answering a long standing and difficult research question and to provide two research tools that have practical applications.

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APPENDICES

Appendix 3-A

Copy of Memorandum to *Scitech* Staff

Memo

To: All staff **From**: Vicky Dodds

Date: 22 November 1993

Re: Evaluation of *Scitech's* Effectiveness by David Johnston

Most of you have already met David Johnston, a PhD student at Curtin University. David's proposed research focuses on evaluating the effectiveness of science centres such as *Scitech* in terms of general public visitors. This is a priority of *Scitech's* within our 5 year corporate plan and will also be of great value to other centres world wide.

David will be spending a great percentage of his time at *Scitech* over the next year both during the week and on weekends. At this stage he is very interested in the "culture" of our organisation and would like to talk to as many staff as possible and become aware of the processes and strategies we use.

He will be attending many of the meetings within the Centre and making times to talk with most of you. If you are aware of anything about to happen or in the planning stage that would interest him, please let me know or contact David directly. (home ph: 291 6791)

Please give him all possible support and treat him as an honorary staff member.

If you are interested in a copy of David's proposed research summary, please let me know.

Many thanks

Vicky Dodds

Appendix 3-B

Brief Description of ISTCs Involved in the Study

Brief details of the ISTCs from which data were collected in this study are presented in this Appendix. In the following description, care has been taken to honour the undertaking of anonymity, therefore any details that might identify any particular centre are not included. The five ISTCs involved in the study have many similarities and a few differences. They were from the group of six suggested by the then acting CEO of *Scitech* at the start of the main PVII field-test part of the study because they were similar in the way they communicate science and modern technology – they have predominantly interactive exhibits. Most of their exhibits demonstrate a range of principles of the physical sciences which in some instances are linked to modern technology. Some of their exhibits are very similar. For example, at *Centre D* the electrical phenomenon known as Jacob's Ladder is demonstrated by an exhibit that is about 3 metres in height, while at *Centre B* it is demonstrated by an identical exhibit except that it is about 1 metre high. Consequently, for a visitor, the impact of size may be an influence. In addition, it is common for the centres to rent exhibits to each other and sometimes share the cost of hiring an exhibition from overseas. They all have explainers and demonstrators, and all charge for entry.

Centre B and *Centre C* are located in cities with a population of over 1 million, *Centre D* and *Centre A* are in cities of about 200,000 and *Centre E* is in a city of just under 100,000. All centres also service a rural population, and *Centre D* has easily the largest proportion of tourists among its visitors. Each centre is open seven days each week, and each has a shop which sells science related items, including books, games, posters, activities, artefacts and memorabilia from particular exhibits. The shops vary in size, with *Centre B* having the largest amount and greatest variety of stock.

The most obvious difference between the centres is their physical ambience. *Centre D* is the largest both in terms of floor space and the number of exhibits, followed by *Centre B*, *Centre C* and *Centre A* with *Centre E* being clearly the smallest. *Centre D* occupies an imposing purpose-built building with a relatively large number of small galleries occupying the largest total floor space. *Centre B* has the second largest floor space which is open allowing it to set up multiple temporary galleries according to its needs. The others have a smaller number of galleries. Four are stand-alone centres – the exception being *Centre E* which is adjacent to a traditional museum and consists of two galleries one of which houses a permanent set of exhibits and the other has changing exhibitions.

Centre B conducts a on-site, professional development program for teachers and has dedicated one staff member (a seconded teacher) to contact schools and run the sessions. During the program, teachers are familiarised with the exhibits and are engaged in developing pre- and post-visit activities for the students to enhance the educational value of any subsequent excursion to *Centre B*. Many teachers in the region around *Centre B* have completed the program. *Centre B* is the only one of the ISTCs in this study to have such a program.

Appendix 5-A

The Pilot Post Visit Questionnaire

Post Visit Questionnaire

1. Please write three words that you think best describe your own experiences at *Scitech*.

First word:

Please give your reason for choosing this word.

Second word:

Please give your reason for choosing this word.

Third word:

Please give your reason for choosing this word.

(Appendix continues)

Appendix 5-A (Continued)

2. Did your visit help you **understand** something that has helped you with

Item	Yes	No
a) your work or study?		
b) your general thinking about everyday events?		
c) your leisure / entertainment / hobby?		
d) an issue to do with science and technology?		

If you answered **yes** to any of a, b, c, or d would you **please explain** in the space below.

a)

b)

c)

d)

3. Can you give me an example of something you are **now doing** (or have done) that was a result of your trip to *Scitech*?

(Appendix continues)

4. Which exhibit did you like **best**?

   Please explain what you liked about it.

5. Which exhibit did you like the **least**?

   Please explain what you did not like about it.

(Appendix continues)

6. Would you please indicate your level of **interest** in science and modern technology before and after your visit to *Scitech* by placing a tick in the appropriate box.

Your level of interest **before** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

Your level of interest **after** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

7. Would you please indicate your level of **awareness** of science and modern technology before and after your visit to *Scitech* by placing a tick in the appropriate box.

Your level of awareness **before** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

Your level of awareness **after** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

8. If there has been a change of your **ideas** about science and modern technology as a result of your visit to *Scitech* please describe how they have changed.

(Appendix continues)

9. Do you think your visit to *Scitech* was **worthwhile**?

   Please give your reasons.

10. What other **comment** can you make about your visit to *Scitech*?

(Appendix continues)

7. Would you please provide us with some details about yourself to assist in this study.

Respondent details

Name ________________________________

Gender (Please circle)

Male Female

Occupation____________________________

Age (Please circle)

11-12 13-17 18-25 26-35 36-45 46-55 56^{+}

- What is your **highest** level of education in science? (Please circle)

  None Primary School Secondary School TAFE University

- Is English your main language? (Please circle)

  Yes No

- If I need to clarify some of your answers would it be all right if I contact you by phone at a convenient time? (Please circle)

  Yes No

Thank you for your assistance!

Appendix 5-B

Form For Potential Respondent Contact Details

SCITECH RESEARCH

Name: ____

Address: ____

____

____

____

Contact Ph No: ____

Thank you for volunteering. Any information you provide will be treated in complete confidence.

David Johnston
Researcher
Curtin University of Technology
Ph 2916791

Appendix 5-C

Covering Letter to Potential PVQ Respondents

21 March 1994

Scitech Discovery Centre
West Perth

Dear

Thank you for volunteering to complete a questionnaire about your experiences at *Scitech*. The project is being conducted to identify some of the aspects of *Scitech* that are of value to the community.

Would you please complete the enclosed questionnaire which is concerned with determining your reactions after visiting *Scitech*. Your complimentary pass will be forwarded to you when I receive the completed questionnaire.

If any of the people in your group who visited *Scitech* were 10 years of age or younger could you get them to draw a picture of their favourite exhibit, instead of filling in the questionnaire.

Your responses will be held in the strictest confidence. If you have any questions, please phone me at the number highlighted on my card.

I really do appreciate your help and cooperation.

David Johnston
Researcher
Curtin University of Technology
Ph 2916791

Appendix 5-D

Main Field Test Post Visit Questionnaire, Version A

Post Visit Questionnaire

1. Please write **three words** that you think best describe your own experiences at *Scitech*.

First word:

Please give your reason for choosing this word.

Second word:

Please give your reason for choosing this word.

Third word:

Please give your reason for choosing this word.

(Appendix continues)

2. Would you please indicate your level of **interest** in science and modern technology before and after your visit to *Scitech* by placing a tick in the appropriate box.

Your level of interest **before** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

Your level of interest **after** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

3. Would you please indicate your level of **awareness** of science and modern technology before and after your visit to *Scitech* by placing a tick in the appropriate box.

Your level of awareness **before** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

Your level of awareness **after** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

4. Can you give me an **example** of something you are now doing (or have done) that was a result of your trip to *Scitech*.

(Appendix continues)

5. Did your visit help you **understand** something that has helped you with

Item	Yes	No
a) your work or study?		
b) your general thinking about everyday events?		
c) your leisure / entertainment / hobby?		
d) an issue to do with science and technology?		

If you answered **yes** to any of a, b, c, or d would you **please explain** in the space below.

a)

b)

c)

d)

6. Do you think your visit to *Scitech* was **worthwhile**?

Please give your reasons.

(Appendix continues)

7. Would you please provide us with some details about yourself to assist in this study.

Respondent details

Name ________________________________

Gender (Please circle)

Male Female

Occupation____________________________

Age (Please circle)

11-12 13-17 18-25 26-35 36-45 46-55 56+

- What is your **highest** level of education in science? (Please circle)

None Primary School Secondary School TAFE University

- Is English your main language? (Please circle)

Yes No

- If I need to clarify some of your answers would it be all right if I contact you by phone at a convenient time? (Please circle)

Yes No

Thank you for your assistance!

Appendix 5-E

Main Field Test Post Visit Questionnaire, Version B

Post Visit Questionnaire

1. Please list the **three things** you remember most clearly about visit to *Scitech.*

First thing:

Please explain why you remember this.

Second thing:

Please explain why you remember this.

Third thing:

Please explain why you remember this.

(Appendix continues)

2. Did you discuss any of the exhibits with any one else **during** your visit?

   Please circle Yes No

   If yes please describe your discussion.

3. Did you discuss your visit experiences with anyone else **after leaving** *Scitech*?

   Please circle Yes No

   If yes please describe your discussion.

(Appendix continues)

Appendix 5-E (Continued)

4. a) Would you please indicate your level of **interest** in science and modern technology before and after your visit to *Scitech* by placing a tick in the appropriate box.

Your level of interest **before** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

Your level of interest **after** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

b) Would you please indicate your level of **awareness** of science and modern technology before and after your visit to *Scitech* by placing a tick in the appropriate box.

Your level of awareness **before** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

Your level of awareness **after** your visit

	None	Low	Moderate	High	Very High
In science					
In modern technology					

5. If there has been a change of your **ideas** about science and modern technology as a result of your visit to *Scitech* please describe how they have changed.

(Appendix continues)

6. Did you have contact with a *Sciguide* (an explainer) while looking at the exhibits during your visit?

Please circle Yes No

If yes please describe the nature of that contact.

7. What other **comment** can you make about your visit to *Scitech?*

(Appendix continues)

8. Would you please provide us with some details about yourself to assist in this study.

Respondent details

Name ________________________________

Gender (Please circle)

Male Female

Occupation____________________________

Age (Please circle)

11-12 13-17 18-25 26-35 36-45 46-55 56^{+}

- What is your **highest** level of education in science? (Please circle)

None Primary School Secondary School TAFE University

- Is English your main language? (Please circle)

Yes No

- If I need to clarify some of your answers would it be all right if I contact you by phone at a convenient time? (Please circle)

Yes No

Thank you for your assistance!

Appendix 5-F

<u>Follow-up Letter</u>

1 June 1994

Dear

Thank you for your help with my project and agreeing to complete the follow-up questionnaire. Even if you have not been able to complete the questionnaire, it is not too late and I would appreciate it if you could still assist. The information you can provide is very valuable for this research.

Your complimentary pass to *Scitech* will be forwarded to you on receipt of the completed questionnaire.

If you have any problem, or question, please contact me.

Thank you again.

David Johnston
Researcher
Curtin University of Technology
ph. 2916791

Appendix 5-G

Number and Percentage Responses to Post Visit Questionnaire Items by Demographic Subgroup

Item 1: The Best Three Words Describing Visit Experiences

Demographic Subgroup	Pilot Field-test		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male	17	47	25	40	42	43
Female	19	53	37	60	56	57
Total	36	100	62	100	98	100
Age (years)						
11-12	4	11	5	8	9	9
13-17	3	8	5	8	8	8
18-25	2	6	6	10	8	8
26-35	4	11	7	11	11	11
36-45	9	25	19	31	28	29
46-55	10	28	16	26	26	27
56^{+}	4	12	4	6	8	8
Total	36	100	62	100	98	100
Education level						
None	3	8	3	5	6	6
Primary	7	19	8	13	15	15
Secondary	10	28	23	37	33	34
TAFE	5	14	11	18	16	16
University	11	31	17	27	28	29
Total	36	100	62	100	98	100

(Appendix continues)

Appendix 5-G (Continued)

Item 2: Understanding of Science in Visitors' Everyday Lives

Demographic Subgroup	Pilot Field-test		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male	17	47	28	46	45	46
Female	19	53	33	54	52	54
Total	36	100	61	100	97	100
Age (years)						
11-12	4	11	7	11	11	11
13-17	3	8	2	3	5	5
18-25	2	6	3	5	5	5
26-35	4	11	6	10	10	10
36-45	9	25	15	25	24	25
46-55	10	28	22	36	32	33
56^{+}	4	12	6	10	10	10
Total	36	100	61	100	97	100
Education level						
None	3	8	3	5	6	6
Primary	7	19	9	15	16	16
Secondary	10	28	26	43	36	37
TAFE	5	14	8	13	13	13
University	11	31	15	25	26	27
Total	36	100	61	100	97	100

(Appendix continues)

Appendix 5-G (Continued)

Item 3: Actions Attributed to a Visit

Demographic Subgroup	Pilot Field-test		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male	14	44	18	37	32	40
Female	18	56	31	63	49	60
Total	32	100	49	100	81	100
Age (years)						
11-12	4	13	4	8	8	10
13-17	3	9	3	6	6	7
18-25	2	6	3	6	5	6
26-35	2	6	8	16	10	12
36-45	9	28	8	16	17	21
46-55	10	31	15	31	25	31
56^{+}	2	6	8	16	10	12
Total	32	100	49	100	81	100
Education level						
None	3	9	0	0	3	3
Primary	6	19	5	11	11	13
Secondary	9	28	20	40	29	36
TAFE	4	13	9	19	13	17
University	10	31	15	30	25	30
Total	32	100	49	100	81	100

(Appendix continues)

Appendix 5-G (Continued)

Item 4: Best Liked Exhibit

Demographic Subgroup	Pilot Field-test		Main Field-test*		Total	
	N	%	*N*	%	*N*	%
Sex						
Male	17	47			17	47
Female	19	53			19	53
Total	36	100			36	100
Age (years)						
11-12	4	11			4	11
13-17	3	8			3	8
18-25	2	6			2	6
26-35	4	11			4	11
36-45	9	25			9	25
46-55	10	28			10	28
56^{+}	4	12			4	12
Total	36	100			36	100
Education level						
None	3	8			3	8
Primary	7	19			7	19
Secondary	10	28			10	28
TAFE	5	14			5	14
University	11	31			11	31
Total	36	100			36	100

Note. * Item not included.

(Appendix continues)

Appendix 5-G (Continued)

Item 5: Least Liked Exhibit

Demographic Subgroup	Pilot Field-test		Main Field-test*		Total	
	N	%	*N*	%	*N*	%
Sex						
Male	17	47			17	47
Female	19	53			19	53
Total	36	100			36	100
Age (years)						
11-12	4	11			4	11
13-17	3	8			3	8
18-25	2	6			2	6
26-35	4	11			4	11
36-45	9	25			9	25
46-55	10	28			10	28
56^+	4	12			4	12
Total	36	100			36	100
Education level						
None	3	8			3	8
Primary	7	19			7	19
Secondary	10	28			10	28
TAFE	5	14			5	14
University	11	31			11	31
Total	36	100			36	100

Note. * Item not included.

(Appendix continues)

Item 6: Interest in Science and Modern Technology

Demographic Subgroup	Pilot Field-test		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male	17	47	43	37	60	39
Female	19	53	74	63	93	61
Total	36	100	117	100	153	100
Age (years)						
11-12	4	11	6	5	10	7
13-17	3	8	7	6	10	7
18-25	2	6	9	8	11	7
26-35	4	11	12	10	16	10
36-45	9	25	34	29	43	28
46-55	10	28	35	30	45	29
56^{+}	4	12	14	12	18	12
Total	36	100	117	100	153	100
Education level						
None	3	8	3	3	6	4
Primary	7	19	13	11	20	13
Secondary	10	28	65	56	75	49
TAFE	5	14	15	13	20	13
University	11	31	21	18	32	21
Total	36	100	117	100	153	100

(Appendix continues)

Appendix 5-G (Continued)

Item 7: Awareness of Science and Modern Technology

Demographic Subgroup	Pilot Field-test		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male	17	47	43	37	60	39
Female	19	53	74	63	93	61
Total	36	100	117	100	153	100
Age (years)						
11-12	4	11	6	5	10	7
13-17	3	8	7	6	10	7
18-25	2	6	9	8	11	7
26-35	4	11	12	10	16	10
36-45	9	25	34	29	43	28
46-55	10	28	35	30	45	29
56^{+}	4	12	14	12	18	12
Total	36	100	117	100	153	100
Education level						
None	3	8	3	3	6	4
Primary	7	19	13	11	20	13
Secondary	10	28	65	56	75	49
TAFE	5	14	15	13	20	13
University	11	31	21	18	32	21
Total	36	100	117	100	153	100

(Appendix continues)

Appendix 5-G (Continued)

Item 8: Ideas on Science and Modern Technology

Demographic Subgroup	Pilot Field-test		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male	15	45	9	29	24	38
Female	18	55	22	71	40	63
Total	33	100	31	100	64	100
Age (years)						
11-12	3	9	2	6	5	8
13-17	3	9	4	13	7	11
18-25	2	6	2	6	4	6
26-35	3	9	4	13	7	11
36-45	9	27	8	26	17	27
46-55	9	27	9	29	18	28
56^{+}	4	12	2	6	6	9
Total	33	100	31	100	64	100
Education level						
None	2	6	2	6	4	6
Primary	6	18	4	13	10	16
Secondary	10	30	14	45	24	38
TAFE	5	15	2	6	7	11
University	10	30	9	29	19	30
Total	33	100	31	100	64	100

(Appendix continues)

Appendix 5-G (Continued)

Item 9: Whether a Visit to *Scitech* Was Worthwhile

Demographic Subgroup	Pilot Field-test		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male	17	47	22	42	39	44
Female	19	53	31	58	50	56
Total	36	100	53	100	89	100
Age (years)						
11-12	4	11	8	15	12	13
13-17	3	8	3	6	6	7
18-25	2	6	1	2	3	3
26-35	4	11	2	4	6	7
36-45	9	25	9	17	18	20
46-55	10	28	27	51	37	42
56^{+}	4	12	3	6	7	8
Total	36	100	53	100	89	100
Education level						
None	3	8	3	6	6	7
Primary	7	19	7	13	14	16
Secondary	10	28	22	42	32	36
TAFE	5	14	4	8	9	10
University	11	31	17	32	28	31
Total	36	100	53	100	89	100

(Appendix continues)

Appendix 5-G (Continued)

Item 10: Any Additional Comments

Demographic Subgroup	Pilot Field-test		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male	17	47	25	42	42	44
Female	19	53	34	58	53	56
Total	36	100	59	100	95	100
Age (years)						
11-12	4	11	1	2	5	5
13-17	3	8	8	14	11	12
18-25	2	6	2	3	4	4
26-35	4	11	5	8	9	9
36-45	9	25	15	25	24	25
46-55	10	28	20	34	30	32
56^{+}	4	12	8	13	12	12
Total	36	100	59	100	95	100
Education level						
None	3	8	2	3	5	5
Primary	7	19	6	10	13	14
Secondary	10	28	26	44	36	38
TAFE	5	14	7	12	12	13
University	11	31	18	31	29	31
Total	36	100	59	100	95	100

(Appendix continues)

Appendix 5-G (Continued)

Item 12: Visitors' Discussions During a Visit

Demographic Subgroup	Pilot Field-test*		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male			19	39	19	39
Female			30	61	30	61
Total			49	100	49	100
Age (years)						
11-12			1	2	1	2
13-17			4	8	4	8
18-25			2	4	2	4
26-35			4	8	4	8
36-45			13	27	13	27
46-55			20	41	20	41
56^{+}			5	10	5	10
Total			49	100	49	100
Education level						
None			3	6	3	6
Primary			4	8	4	8
Secondary			21	43	21	43
TAFE			6	12	6	12
University			15	31	15	31
Total			49	100	49	100

Note. * Item not included.

(Appendix continues)

Appendix 5-G (Continued)

Item 13: Visitors' Discussions After a Visit

Demographic Subgroup	Pilot Field-test*		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male			19	39	19	39
Female			30	61	30	61
Total			49	100	49	100
Age (years)						
11-12			1	2	1	2
13-17			4	8	4	8
18-25			2	4	2	4
26-35			4	8	4	8
36-45			13	27	13	27
46-55			20	41	20	41
56^{+}			5	10	5	10
Total			49	100	49	100
Education level						
None			3	6	3	6
Primary			4	8	4	8
Secondary			21	43	21	43
TAFE			6	12	6	12
University			15	31	15	31
Total			49	100	49	100

Note. * Item not included.

(Appendix continues)

Appendix 5-G (Continued)

Item 14: Memories of a Visit to *Scitech*

Demographic Subgroup	Pilot Field-test*		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male			20	37	20	37
Female			34	63	34	63
Total			54	100	54	100
Age (years)						
11-12			2	4	2	4
13-17			3	6	3	6
18-25			3	6	3	6
26-35			4	7	4	7
36-45			13	24	13	24
46-55			20	37	20	37
56^{+}			9	16	9	16
Total			54	100	54	100
Education level						
None			3	6	3	6
Primary			4	7	4	7
Secondary			25	46	25	46
TAFE			7	13	7	13
University			15	28	15	28
Total			54	100	54	100

Note. * Item not included.

(Appendix continues)

Appendix 5-G (Continued)

Item 15: Contact With Explainers

Demographic Subgroup	Pilot Field-test*		Main Field-test		Total	
	N	%	*N*	%	*N*	%
Sex						
Male			20	37	20	37
Female			34	63	34	63
Total			54	100	54	100
Age (years)						
11-12			2	4	2	4
13-17			3	6	3	6
18-25			3	6	3	6
26-35			4	7	4	7
36-45			13	24	13	24
46-55			20	37	20	37
56^+			9	16	9	16
Total			54	100	54	100
Education level						
None			3	6	3	6
Primary			4	7	4	7
Secondary			25	46	25	46
TAFE			7	13	7	13
University			15	28	15	28
Total			54	100	54	100

Note. * Item not included.

(Appendix continues)

Appendix 5-H

First Three Words Given Once Only to Describe a Visit to *Scitech*

First Choice (n=14)	Second Choice (n=21)	Third Choice (n=7)
Enlightening	Chaotic	Excellent
Relaxing	Frustrated	Thorough
Important	Diverse	Comprehensive
Enhancing	Real	Expanding
Detailed	Interactive	Inquiring
Incomplete	Hands-on	Engrossing
Technical	Granted	Expensive
Disappointed	Visual	
Different	Time	
Enormous	Family	
Awesome	Well-done (sic)	
Overwhelmed	Accessible	
Surprised	Clever	
Kids	Aggravated	
	Provoking	
	Relevant	
	Entertaining	
	Challenging	
	Intriguing	
	Exasperating	
	Play	

Note. There were 42 words given once only which accounted for 14.2% of the total number of responses.

Appendix 5-I

Remaining Words (Supplied More Than Once) That Best Describe a Visit and the Reasons for Supplying Them

Informative

Great exposure to information. Friendly way of introducing information. (F, 36-45, T)

Stimulating

Personal satisfaction at being able to participate in experiments and activities gaining knowledge and understanding at one's own individual learning capacity. (F, 26-35, S)

Enjoyable

Enjoyed being able to participate in a practical manner with a good number of exhibits, also gaining a greater understanding of technical and scientific themes. (M, 18-25, S)

Exciting

It really was a very exciting time as a lot of the experiences were new to us. (M, 26-35, T)

Fascinating

There are so many interesting exhibits to see and examine. I love to read all the information and look at the displays in detail. (F, 36-45, T)

Busy

While the exhibits were good, it was hard for our children to get access to many displays. (M, 26-35, S)

Inspiring

Made me think about things that I'd already knew but ignored. (F, 26-35, S)

Worthwhile

For most of the time the children were off on their own and we parents could have some time to do their own thing, have our own fun. Time went very quickly when our family was there. (F, 26-35, T)

(Appendix continues)

Appendix 5-I (Continued)

Noisy

> The noise levels I found distressing. With the displays being as close as they are together, the noise from each display overlaps. There is also the noise of the visitors on top of that. (F, 36-45, U)

Experimental

> In my opinion the best kind of learning is through playing with hands on concrete materials. (F, 36-45, U)

Intellectual

> It taught me a couple of things that I didn't already know. (M, 26-35, S)

Variety

> The range of exhibits deal with a wide variety of interests so there is always something that will interest everyone. (F, 46-55, S)

Colourful

> *Lights, movement, action* - all these things made it very visual and colourful. (F, 36-45, U)

Active

> Everything moved, made noise. There was plenty of colour. It wasn't a matter of walking around looking. To get results you had to participate. (F, 18-25, T)

Superficial

> The exhibits generally only skimmed the surface of each topic. Greater depth of information would have been appreciated. More practical examples of how the theories/topics etc displayed affect/or are used in our every day life. (F, 26-35, U)

Knowledgeable

> I found it opened old doors of my experiences with science from school. It also showed me ways of simplifying science and also ways of making it interesting for my preschool-aged son. (F, 36-45, S)

Understandable

> *Scitech* simply explained complicated things. (M, 36-45, U)

Attractive

> Because it drew me in on certain *exhibitions*! (M, 56^{+}, S)

Learning

> I think *Scitech* is very important because it gives you a lot of knowledge and it makes you think a lot. (F, 11-12, P)

Appendix 5-J

Remaining Categories, Frequencies and Examples of Memories

Social (17)

Heart machine. We talked about it a lot afterwards. (F, 26-35, S)

Personal (12)

Lung. Fascinating - put you off smoking for ever. (F, 26-35, U)

Education (6)

The excellent explanations at each exhibit. After trying out the actual action of the exhibit there was a brief but concise explanation regarding the nature and function of the exhibit. It helped me to understand what was going on. (F, 36-45, U)

Frustration (4)

Hologram (Clear glass) Because I couldn't understand how it worked! No wires etc. and there was no explanation to read! (M, 36-45, U)

Creativity (3)

The rock exhibition with the musical rocks singing their funny tunes. It was a clever idea for a 'dull' subject. Equal first is the earthquake room. The children insisted we do this exhibit more than once. (F, 26-35, S)

Challenge (3)

Speed of basketball. It was a challenge to try and better your own score. (M, 13-17, S)

Advertising (1)

Earthquake. It was advertised so we deliberately looked for it. (F, 26-35, S)

Appendix 6-A.

List of Words Provided to Adult Volunteers From the Public Speaking Club

Opposite each word please write a word (or words) that for you would convey the opposite meaning.

Word	**Opposite**
informative	________________
intellectual	________________
educational	________________
understanding	________________
learning	________________
knowledgeable	________________
experimental	________________
valuable	________________
interesting	________________
fun	________________
enjoyable	________________
exciting	________________
stimulating	________________
fascinating	________________
inspiring	________________
active	________________
noisy	________________
colourful	________________
busy	________________
detailed	________________
variety	________________
attractive	________________

Appendix 6-B

The Pilot Field-test Perceptions of Visit Impact Instrument

Perceptions of Visit Impact Instrument

Please place a tick in the box along the line at the position where you **think you feel** about your recent visit to *Scitech.* There are **seven** boxes. The middle one is where you have no particular feeling.

Educational	☐	☐	☐	☐	☐	☐	☐	Non-educational
Trivial	☐	☐	☐	☐	☐	☐	☐	Intellectual
Informative	☐	☐	☐	☐	☐	☐	☐	Uninformative
Experimental	☐	☐	☐	☐	☐	☐	☐	Non-experimental
Learning	☐	☐	☐	☐	☐	☐	☐	Bewildering
Confusing	☐	☐	☐	☐	☐	☐	☐	Understandable
Ignorant	☐	☐	☐	☐	☐	☐	☐	Knowledgeable

Fun	☐	☐	☐	☐	☐	☐	☐	Boring
Unpleasant	☐	☐	☐	☐	☐	☐	☐	Enjoyable
Worthless	☐	☐	☐	☐	☐	☐	☐	Valuable
Inspiring	☐	☐	☐	☐	☐	☐	☐	Uninspiring
Exciting	☐	☐	☐	☐	☐	☐	☐	Dull
Interesting	☐	☐	☐	☐	☐	☐	☐	Uninteresting
Discouraging	☐	☐	☐	☐	☐	☐	☐	Stimulating
Monotonous	☐	☐	☐	☐	☐	☐	☐	Fascinating

Please turn over

(Appendix continues)

Appendix 6-B (Continued)

Active	☐	☐	☐	☐	☐	☐	☐	Passive
Colourful	☐	☐	☐	☐	☐	☐	☐	Bland
Noisy	☐	☐	☐	☐	☐	☐	☐	Quiet
Idle	☐	☐	☐	☐	☐	☐	☐	Busy
Superficial	☐	☐	☐	☐	☐	☐	☐	Detailed
Variety	☐	☐	☐	☐	☐	☐	☐	Uniformity
Attractive	☐	☐	☐	☐	☐	☐	☐	Repulsive

We need to know some details about yourself so the data collected can be analysed. All information is strictly confidential.

Respondent details

- **Gender** (Please circle)

  Male Female

- **Age** (Please circle)

  10-12 13-17 18-25 26-35 36-45 46-55 56-65 66+

- **Occupation** ________________________________

- What is your **highest** level of education in science? (Please circle)

  None Primary School Secondary School TAFE University

- Is English your main language? (Please circle)

  Yes No

Thank you for your assistance!

Appendix 6-C

Percentage Responses for Each Score on the Pilot PVII Field-test Items

Item No.	Bipolar Adjectives		Percentage Response for Each Score						
			7	6	5	4	3	2	1
1	Educational	Non-educational	73	18	7	2	0	0	0
2	Intellectual	Trivial	22	30	20	12	1	15	0
3	Informative	Uninformative	63	26	8	3	0	0	0
4	Experimental	Non-experimental	53	26	13	7	0	1	0
5	Learning	Bewildering	56	28	8	5	3	0	0
6	Understandable	Confusing	22	47	20	5	3	0	0
7	Knowledgeable	Ignorant	41	45	13	1	0	0	0
8	Fun	Boring	71	22	7	0	0	0	0
9	Enjoyable	Unpleasant	66	28	5	1	0	0	0
10	Worthwhile	Worthless	52	37	10	1	0	0	0
11	Inspiring	Uninspiring	40	31	19	8	1	1	0
12	Exciting	Dull	47	32	17	3	0	0	0
13	Interesting	Uninteresting	66	28	6	0	0	0	1
14	Stimulating	Discouraging	54	33	10	1	0	0	1
15	Fascinating	Monotonous	35	39	16	5	3	3	1
16	Active	Passive	45	39	13	2	1	0	0
17	Colourful	Bland	52	30	16	1	1	0	0
18	Quiet	Noisy	0	2	1	17	23	19	38
19	Busy	Idle	39	39	9	9	1	2	1
20	Detailed	Superficial	38	39	11	8	2	2	0
21	Variety	Uniformity	46	37	14	3	0	0	0
22	Attractive	Unattractive	63	28	9	0	0	0	0

Note. Underlined items were stated in a negative format.

Appendix 6-D

PVII Pilot Field-test Inter-item Correlations

Item	1	2	3	4	5	6	7	8	9	10	11	12	13
1													
2	.10												
3	.31**	.41**											
4	.40**	.24**	.45**										
5	.35**	.44**	.62**	.64**									
6	.11	.26**	.10	.07	.07								
7	.39**	.31**	.48**	.39**	.42**	.44*							
8	.41**	.18*	.32**	.53**	.33**	.09	.36**						
9	.16*	.17*	.24**	.36**	.13	.19**	.29**	.57**					
10	.43**	.35**	.38**	.50**	.39**	.16*	.48**	.67**	.51**				
11	.40**	.11	.38**	.43**	.41**	-.02	.22**	.55**	.28**	.51**			
12	.44**	.06	.19*	.40**	.15	-.08	.20**	.68**	.37**	.47**	.53**		
13	.25**	.19*	.29**	.40**	.33**	.20**	.23**	.27**	.29**	.28**	.21**	.22**	
14	.38**	.33**	.30**	.43**	.46**	.28**	.44**	.53**	.28**	.39**	.38**	.39**	.69**
15	.12	.38**	.13	.19*	.10	.27**	.36**	.37**	.28**	.49**	.37**	.30**	.43**
16	.44**	.40**	.47**	.60**	.48**	.25**	.48**	.62**	.40**	.66**	.57**	.38**	.23**
17	.32**	.32**	.34**	.48**	.46**	-.09	.20**	.47**	.21**	.41**	.48**	.62**	.16*
18	.01	.13	.18*	.05	.01	-.25**	-.08	.18*	-.01	.12	.25**	.30**	-.11
19	.22**	.46**	.15*	.22**	.16*	.09	.12	.25**	.09	.37**	.27**	.24**	.22**
20	.15*	.37**	.13	.20**	.13	.07	.25**	.11	.16*	.48**	.10	.09	-.02
21	.36**	.35**	.46**	.52**	.35**	.10	.33**	.46**	.31**	.46**	.32**	.33**	.34**
22	.25**	.26**	.48**	.53**	.50**	.03	.33**	.55**	.47**	.54**	.43**	.41**	.38**

Item	14	15	16	17	18	19	20	21	22
15	.51**								
16	.45**	.36**							
17	.32**	.08	.44**						
18	.07	-.01	.10	.41**					
19	.34**	.22**	.42**	.29**	.29**				
20	-.01	.20**	.23**	.24**	.01	.47**			
21	.35**	.26**	.45**	.27**	.13	.23**	.27**		
22	.32**	.12	.43$#	.41**	.03	.10	.23**	.56**	

Note. * $p < .05$ and ** $p < .01$. Underlined items were stated in a negative format.

Appendix 6-E.

Modified Draft PVII or Main Field-test PVII

Perceptions of Visit Impact Instrument

Please place a tick in the box along the line at the position where you **think you feel** about your recent visit to this "*Centre*". There are **seven** boxes. The middle one is where you have no particular feeling.

Educational	☐	☐	☐	☐	☐	☐	☐	Non-educational
Trivial	☐	☐	☐	☐	☐	☐	☐	Intellectual
Informative	☐	☐	☐	☐	☐	☐	☐	Uninformative
Experimental	☐	☐	☐	☐	☐	☐	☐	Non-experimental
Understandable	☐	☐	☐	☐	☐	☐	☐	Bewildering
Ignorant	☐	☐	☐	☐	☐	☐	☐	Knowledgeable
Fun	☐	☐	☐	☐	☐	☐	☐	Boring
Unpleasant	☐	☐	☐	☐	☐	☐	☐	Enjoyable
Worthless	☐	☐	☐	☐	☐	☐	☐	Worthwhile
Inspiring	☐	☐	☐	☐	☐	☐	☐	Uninspiring
Exciting	☐	☐	☐	☐	☐	☐	☐	Dull
Interesting	☐	☐	☐	☐	☐	☐	☐	Uninteresting
Discouraging	☐	☐	☐	☐	☐	☐	☐	Stimulating

Please turn over

(Appendix continues)

Monotonous	☐	☐	☐	☐	☐	☐	☐	Fascinating
Active	☐	☐	☐	☐	☐	☐	☐	Passive
Colourful	☐	☐	☐	☐	☐	☐	☐	Bland
Quiet	☐	☐	☐	☐	☐	☐	☐	Noisy
Idle	☐	☐	☐	☐	☐	☐	☐	Busy
Superficial	☐	☐	☐	☐	☐	☐	☐	Detailed
Variety	☐	☐	☐	☐	☐	☐	☐	Uniformity

Is there any other comment you would like to make about your visit?

Respondent details

For research purposes, we would like to know some details about yourself so the data I collected can be analysed. All information is strictly confidential.

* **Gender** (Please circle)

Male Female

* **Age** (Please circle)

8-10 11-12 13-17 18-25 26-35 36-45 46-55 56^+

* What is your **highest** level of education in **science**? (Please circle)

None Primary School Secondary School TAFE University

* Is English your main language? (Please circle)

Yes No

Thank you for your assistance!

Appendix 6-F

Letter Accompanying Instrument for Collection of Stability Field-test Data

7 December 1994

Dear

Thank you for your help with my project and agreeing to complete the follow-up questionnaire. The information you provide is absolutely essential for my study to be successfully completed. Even though the questionnaire is identical to the one you completed at *Scitech* your answers to the second questionnaire are crucial to the research.

Would you please complete the questionnaire as soon it is convenient for you and return it in the reply paid envelope. Your complimentary pass to Scitech will be forwarded to you on receipt of the completed questionnaire.

If you have any problem, or question, please contact me.

Thank you again.

David Johnston
Researcher
Curtin University of Technology
ph. 2916791

Appendix 6-G

Follow-up Letter

7 January 1995

Dear

Thank you for your help with my project and agreeing to complete the follow-up questionnaire. Even if you have not been able to complete the questionnaire, it is not too late and I would appreciate it if you could still assist. The information you can provide is very valuable for this research.

Your complimentary pass to *Scitech* will be forwarded to you on receipt of the completed questionnaire.

If you have any problem, or question, please contact me.

Thank you again.

David Johnston
Researcher
Curtin University of Technology
ph. 2916791

Appendix 6-H

Item Correlation Coefficients for PVII Stability Field-test

Cognitive Category

Test Item	Retest					
	1	2	3	4	5	6
1	**.43****	.02	.23**	.31**	.23**	.30**
2	.08	**.78****	.22**	.12	.07	.37**
3	.48**	.33**	**.47****	.39**	.44**	.33**
4	.49**	.13**	.36**	**.65****	.36**	.27**
5	.30**	.17*	.37**	.45**	**.75****	.46**
6	.27**	.33**	.33**	.22**	.11	**.37****

Affective Category

Test Item	Retest							
	7	8	9	10	11	12	13	14
7	**.53****	.23**	.34**	.34*	.49**	.25**	.21**	.26**
8	.17*	**.57****	.72**	.06	.04	.16*	.40**	.58**
9	.25**	.52**	**.77****	.25**	.21**	.28**	.46**	.70**
10	.53**	.23**	.46**	**.47****	.54**	.22**	.26**	.45**
11	.31**	.18*	.33**	.42**	**.60****	.09	.26**	.29**
12	.09	.10	.38**	.10	-.39	**.89****	.64**	.25**
13	.09	.28**	.63**	-.02	.08	.60**	**.81****	.43**
14	.22**	.37**	.58*	.26**	.32**	.39**	.48**	**.85****

Physical Environs Category

Test Item	Retest					
	15	16	17	18	19	20
15	**.74****	.63**	.08	.27**	.40**	.55**
16	.63**	**.73****	-.01	.33**	.52**	.53**
17	-.07	-.15	**.47****	-.11	-.08	-.07
18	.11	.16*	-.29**	**.71****	.49**	.04
19	.24**	.25**	.00	.42**	**.65****	.31**
20	.65**	.48**	.00	.30**	.32**	**.57****

Notes. * $p<.05$ and ** $p<.01$. Underlined items were stated in a negative format. The test-retest correlation for each item is bolded.

Appendix 6-I

Instructions for Data Collection Supplied to Participating ISTCs

Instructions for Administering the Perceptions of Visit Impact Instrument (PVII)

It is essential that consistent procedures are followed when administering the instrument. Data are to be collected over a period of time – at least one month.

Site for Data Collection

Data are to be collected when visitors have completed a visit, so data must be collected at the point of exit only. Provide tables and chairs so respondents can be comfortable when completing the PVII. An adequate supply of pencils or pens should be available.

Selection of Respondents

Random selection of respondents is absolutely essential. Approach every third person, or group, that exits from your centre. When a group exits, count it as a single person. When the third count is a group, approach the person in the group who is closest to you. Use only one person from a group as a respondent.

Instructions to Respondents

Explain that your centre is seeking their reactions to their visit and that the instrument requires them to select a position between an adjective and its opposite that best represents their thoughts and feelings about their visit. Also explain that the adjectives have been used by people to describe their reactions to a visit.

Thank you for your assistance!

David Johnston
Researcher
Curtin University of Technology
ph. 2916791

Appendix 6-J

Main Field-test Inter-Item Correlations Matrix

Item	1	2	3	4	5	6	7	8	9	10
2	.20**									
3	.45**	.23**								
4	.32**	.16**	.35**							
5	.33**	.09*	.20**	.22**						
6	.33**	.31**	.28**	.17**	.19**					
7	.37**	.21**	.39**	.44**	.22**	.21**				
8	.24**	.20**	.30**	.27**	.16**	.35**	.54**			
9	.32**	.21**	.33**	.25**	.14**	.32**	.52**	.73**		
10	.39**	.18**	.32**	.39**	.22**	.24**	.41**	.31**	.36**	
11	.32**	.15**	.28**	.37**	.12**	.19**	.56**	.34**	.43**	.61**
12	.30**	.18**	.36**	.35**	.24**	.20**	.52**	.41**	.44**	.47**
13	.30**	.28**	.26**	.23**	.12**	.28**	.40**	.44**	.44**	.33**
14	.30**	.23**	.29**	.26**	.22**	.27**	.42**	.46**	.49**	.43**
15	.22**	.13**	.27**	.33**	.24**	.17**	.40**	.23**	.29**	.35**
16	.26**	.14**	.29**	.28**	.21**	.15**	.36**	.24**	.32**	.31**
17	-.03*	.00	-.07*	-.11**	.01	-.01*	-.12*	-.04	-.04	-.10**
18	.20**	.27**	.19**	.24**	.09*	.20**	.26**	.25**	.27**	.21**
19	.29**	.34**	.33**	.24**	.17**	.29**	.29**	.33**	.33**	.33**
20	.30**	.14**	.34**	.32**	.17**	.18**	.39**	.27**	.34**	.35**

Item	11	12	13	14	15	16	17	18	19	20
12	.60**									
13	.39**	.46**								
14	.45**	.42**	.44**							
15	.41**	.43**	.25**	.42**						
16	.40**	.34**	.23**	.38**	.58**					
17	-.14**	-.05	.03	-.07	-.16**	-.22**				
18	.24**	.21**	.37**	.31**	.24**	.26**	-.29**			
19	.28**	.33**	.38**	.40**	.22**	.27**	-.10**	.42**		
20	.36**	.37**	.31**	.37**	.40**	.44**	-.11**	.28**	.33**	

Note. * $p < .05$ and ** $p < .01$. Underlined items were stated in a reverse format.

Appendix 6-K

Final PVII Items, Means, and Standard Deviations

Item	Adjective Pair		*M*	*SD*
Cognitive				
1	Educational	Non-educational	6.39	0.89
2	Intellectual	Trivial	5.07	1.68
3	Informative	Uninformative	6.33	0.98
6	Knowledgeable	Ignorant	5.92	1.25
19	Detailed	Superficial	5.60	1.42
Affective				
7	Fun	Boring	6.54	0.89
8	Enjoyable	Unpleasant	6.49	0.95
10	Inspiring	Uninspiring	5.75	1.27
11	Exciting	Dull	5.98	1.12
12	Interesting	Uninteresting	6.44	0.90
13	Stimulating	Discouraging	6.04	1.17
Sensory				
15	Active	Passive	6.26	1.12
16	Colourful	Bland	6.22	1.13
20	Variety	Uniformity	6.07	1.24

Note. Underlined items are stated in a negative format.

Appendix 6-L

The Final Perceptions of Visit Impact Instrument

Perceptions of Visit Impact Instrument

Please place a tick in the box along the line at the position where you **think you feel** about your visit to our centre. There are **seven** boxes. The middle one is where you have no particular feeling.

Educational	☐	☐	☐	☐	☐	☐	☐	Non-educational
Trivial	☐	☐	☐	☐	☐	☐	☐	Intellectual
Informative	☐	☐	☐	☐	☐	☐	☐	Uninformative
Ignorant	☐	☐	☐	☐	☐	☐	☐	Knowledgeable
Superficial	☐	☐	☐	☐	☐	☐	☐	Detailed
Fun	☐	☐	☐	☐	☐	☐	☐	Boring
Unpleasant	☐	☐	☐	☐	☐	☐	☐	Enjoyable
Inspiring	☐	☐	☐	☐	☐	☐	☐	Uninspiring
Exciting	☐	☐	☐	☐	☐	☐	☐	Dull
Uninteresting	☐	☐	☐	☐	☐	☐	☐	Interesting
Discouraging	☐	☐	☐	☐	☐	☐	☐	Stimulating
Active	☐	☐	☐	☐	☐	☐	☐	Passive
Bland	☐	☐	☐	☐	☐	☐	☐	Colourful
Variety	☐	☐	☐	☐	☐	☐	☐	Uniformity

Please turn over

(Appendix continues)

Appendix 6-L (Continued)

Is there any other comment you would like to make about your visit?

Respondent details

For research purposes, we would like to know some details about yourself so the data collected can be analysed. All information is strictly confidential.

* **Gender** (Please circle)

Male Female

* **Age** (Please circle)

8-10 11-12 13-17 18-25 26-35 36-45 46-55 56^{+}

* What is your **highest** level of education in **science**? (Please circle)

None Primary School Secondary School TAFE University

Thank you for your assistance!

Appendix 6-M

Analysis of Variance Results for Age x Sex x Centre on the Affective Scale

Effect	*SS*	*df*	*MS*	*F*	Eta^2
Age x Sex x Centre	5.08	8	.64	1.11	
Sex x Centre	.63	4	.16	.27	
Sex x Age	.44	2	.22	.38	
Age x Centre	8.39	8	1.05	1.83	
Sex	15.15	1	15.15	26.44***	.0317
Centre	5.30	4	1.32	2.30	.0110
Age	.73	2	.37	.64	.0002
Error	443.00	773	.57		
Total	477.54	802	.60		

Note. *** $p < .001$
Eta^2 = Sum squares effect / sum squares total

Appendix 6-N

Analysis of Variance Results for Age x Sex x Centre on the Cognitive Scale

Effect	*SS*	*df*	*MS*	*F*	Eta^2
Age x Sex x Centre	10.31	8	1.29	2.05*	
Sex x Centre	4.11	4	1.03	1.64	
Sex x Age	.28	2	.14	.22	
Age x Centre	15.85	8	1.98	3.16**	
Sex	16.64	1	16.64	24.49***	.0299
Centre	16.95	4	4.24	6.75***	.0305
Age	26.62	2	13.31	21.19***	.0479
Error	485.54	773	.63		
Total	555.99	802	.69		

Note. * $p < .05$ ** $p < .01$ *** $p < .001$
Eta^2 = Sum squares effect / sum squares total

Appendix 6-O

Analysis of Variance Results for Age x Sex x Centre on the Sensory Scale

Effect	*SS*	*df*	*MS*	*F*	Eta^2
Age x Sex x Centre	5.89	8	.74	.86	
Sex x Centre	.21	4	.05	.06	
Sex x Age	.37	2	.18	.21	
Age x Centre	7.01	8	.88	1.02	
Sex	21.36	1	21.36	24.95***	.0302
Centre	12.71	4	3.18	3.75**	.0180
Age	.32	2	.16	.18	.0004
Error	661.60	773	.86		
Total	706.23	802	.88		

Note. ** $p < .01$ *** $p < .001$
Eta^2 = Sum squares effect / sum squares total

Appendix 6-P

Sample of a Report to ISTCs Based on Results Using the PVII

Your Centre

Report on Perceptions of Visit Impact at the Point of Exit Survey

Background

The Perceptions of Visit Impact Instrument (PVII) was administered to a sample of visitors to *Your Centre* immediately following their visit early in 1995. It provides both quantitative and qualitative data about people's reactions to their visit. The PVII instrument was developed using the most frequent adjectives supplied by a sample of visitors to describe their visit to an interactive science and technology centre. All the adjectives fit into three groups or domains. The first group includes adjectives that indicate some form of mental processing, and is termed the cognitive category. The second group of adjectives indicate an attitudinal response and is termed the affective category. The third group of adjectives, that describe reactions to the physical nature of the exhibits and your centre, is termed the physical environs category.

The PVII was constructed by placing each adjective and its antonym at opposite ends of a line divided into seven intervals. Scoring for each item or adjective pair, ranges from seven for the most positive response, through four for a neutral response, to one for the most negative response. Therefore a score above four for any item should be interpreted as a positive response, while scores below four indicate a negative reaction.

The scores that give the best indicators for visitors' perceptions are those for all visitors in the overall cognitive, overall affective and overall physical domains. As well, average scores and graphs are provided for all items by age group.

Results

A random sample of 195 visitors to *Your Centre* completed the PVII at the point of exit after their visit. The average scores of 6.10 for the cognitive category, 6.29 for the affective category, and 5.50 for the physical environs category indicates a very positive visitor response to their experiences while visiting your centre. There is little difference between the scores of any age group. However, visitors in the 46^{+} year age group gave the highest ranking in all three domains.

Most additional visitor comments about the centre were positive and related to enjoyment and learning. Two examples are that *Your Centre* is "entertaining and informs" and it "provides interesting and challenging experiences." Two areas that

(Appendix continues)

some people suggested could be improved were the maintenance of some exhibits and more assistance from explainers would have been appreciated.

Overall the results clearly show there is a high level of visitor satisfaction and people leave feeling that the experiences provided by *Your Centre* have been both mentally stimulating and enjoyable.

I thank you for your assistance with this research project and I look forward to your cooperation with the next research project.

David Johnston
Researcher
Curtin University of Technology
ph 2916791

(Appendix continues)

Appendix 6-P (Continued)

Average Scores for *Your Centre*

Cognitive Category

Age group	All visitors	8-12	13-17	18-25	26-35	36-45	46^{+}
Number	195	27	18	27	49	48	26
Educational	6.58	6.70	6.50	6.67	6.73	6.29	6.65
Intellectual	5.07	4.30	3.78	4.70	5.35	5.54	5.73
Informative	6.54	6.52	6.56	6.52	6.63	6.38	6.69
Experimental	6.27	6.48	6.50	6.15	6.00	6.27	6.50
Understandable	6.07	6.11	6.06	6.15	6.00	6.00	6.23
Knowledgeable	6.06	5.85	5.89	6.89	6.35	5.92	6.23
Average	6.10	5.99	5.88	6.02	6.18	6.07	6.34

Affective Category

Age group	All visitors	8-12	13-17	18-25	26-35	36-45	46^{+}
Number	195	27	18	27	49	48	26
Fun	6.71	6.70	6.67	6.56	6.78	6.69	6.77
Enjoyable	6.54	6.30	6.56	6.56	6.65	6.44	6.77
Worthwhile	6.48	6.44	6.22	6.44	6.57	6.42	6.65
Inspiring	5.92	6.22	6.17	5.44	5.88	5.96	5.92
Exciting	6.07	6.52	6.11	5.63	6.22	5.87	6.08
Interesting	6.50	6.67	6.11	5.26	6.57	6.50	6.13
Stimulating	6.16	5.78	5.94	5.81	6.31	6.27	6.58
Fascinating	5.84	6.22	5.28	5.89	5.92	5.94	6.08
Average	6.29	6.37	6.13	6.07	6.36	6.26	6.45

Physical Environs Category

Age group	All visitors	8-12	13-17	18-25	26-35	36-45	46^{+}
Number	195	27	18	27	49	48	26
Active	6.31	6.41	5.94	6.07	6.45	6.48	6.15
Colourful	6.45	6.52	6.50	6.81	6.35	6.42	6.19
Quiet	2.10	2.41	1.89	1.90	2.08	2.10	2.23
Busy	6.00	5.22	5.56	5.78	6.18	6.33	6.38
Detailed	5.78	5.26	5.67	5.30	6.12	5.85	6.12
Variety	6.37	6.63	5.72	6.22	6.43	6.40	6.58
Average	5.50	5.41	5.21	5.33	5.60	5.60	5.61

(Appendix continues)

Your Centre

Perceptions of Visit Impact

8-12 year old visitors

Cognitive Category

	7		6		5		4		3		2		1	
Educational	°	x	°		°		°		°		°		°	Non-educational
Intellectual	°		°		°	x	°		°		°		°	Trivial
Informative	°	x	°		°		°		°		°		°	Uninformative
Experimental	°	x	°		°		°		°		°		°	Non-experimental
Understandable	°	x	°		°		°		°		°		°	Bewildering
Knowledgeable	°		°	x	°		°		°		°		°	Ignorant

Affective Category

	7		6		5		4		3		2		1	
Fun	°	x	°		°		°		°		°		°	Boring
Enjoyable	°	x	°		°		°		°		°		°	Unpleasant
Worthwhile	°	x	°		°		°		°		°		°	Worthless
Inspiring	°	x	°		°		°		°		°		°	Uninspiring
Exciting	°	x	°		°		°		°		°		°	Dull
Interesting	°	x	°		°		°		°		°		°	Uninteresting
Stimulating	°		°	x	°		°		°		°		°	Discouraging
Fascinating	°	x	°		°		°		°		°		°	Monotonous

Physical Environs Category

	7		6		5		4		3		2		1	
Active	°	x	°		°		°		°		°		°	Passive
Colourful	°	x	°		°		°		°		°		°	Bland
Quiet	°		°		°		°	x	°		°		°	Noisy
Busy	°		°	x	°		°		°		°		°	Idle
Detailed	°		°	x	°		°		°		°		°	Superficial
Variety	°	x	°		°		°		°		°		°	Uniformity

(Appendix continues)

Appendix 6-P (Continued)

Your Centre

Perceptions of Visit Impact

13-17 year old visitors

Cognitive Category

	7	6	5	4	3	2	1	
Educational	°	x °	°	°	°	°	°	Non-educational
Intellectual	°	°	°	° x	°	°	°	Trivial
Informative	°	x °	°	°	°	°	°	Uninformative
Experimental	°	x °	°	°	°	°	°	Non-experimental
Understandable	°	x°	°	°	°	°	°	Bewildering
Knowledgeable	°	° x	°	°	°	°	°	Ignorant

Affective Category

	7	6	5	4	3	2	1	
Fun	°	x °	°	°	°	°	°	Boring
Enjoyable	°	x °	°	°	°	°	°	Unpleasant
Worthwhile	°	x°	°	°	°	°	°	Worthless
Inspiring	°	x°	°	°	°	°	°	Uninspiring
Exciting	°	x°	°	°	°	°	°	Dull
Interesting	°	x°	°	°	°	°	°	Uninteresting
Stimulating	°	° x	°	°	°	°	°	Discouraging
Fascinating	°	°	x °	°	°	°	°	Monotonous

Physical Environs Category

	7	6	5	4	3	2	1	
Active	°	°x	°	°	°	°	°	Passive
Colourful	°	x °	°	°	°	°	°	Bland
Quiet	°	°	°	°	°	° x	°	Noisy
Busy	°	°	x °	°	°	°	°	Idle
Detailed	°	°	x °	°	°	°	°	Superficial
Variety	°	°	x °	°	°	°	°	Uniformity

(Appendix continues)

Appendix 6-P (Continued)

Your Centre

Perceptions of Visit Impact

18-25 year old visitors

Cognitive Category

	7	6	5	4	3	2	1	
Educational	° x	°	°	°	°	°	°	Non-educational
Intellectual	° x	°	° x	°	°	°	°	Trivial
Informative	°	x°	°	°	°	°	°	Uninformative
Experimental	°	x°	°	°	°	°	°	Non-experimental
Understandable	° x	°	°	°	°	°	°	Bewildering
Knowledgeable	°x	°	°	°	°	°	°	Ignorant

Affective Category

	7	6	5	4	3	2	1	
Fun	° x	°	°	°	°	°	°	Boring
Enjoyable	° x	°	°	°	°	°	°	Unpleasant
Worthwhile	° x	°	°	°	°	°	°	Worthless
Inspiring	°	°	x °	°	°	°	°	Uninspiring
Exciting	°	°	x °	°	°	°	°	Dull
Interesting	°	°	x °	°	°	°	°	Uninteresting
Stimulating	°	° x	°	°	°	°	°	Discouraging
Fascinating	°	° x	°	°	°	°	°	Monotonous

Physical Environs Category

	7	6	5	4	3	2	1	
Active	°	x°	°	°	°	°	°	Passive
Colourful	° x	°	°	°	°	°	°	Bland
Quiet	°	°	°	°	°	° x	°	Noisy
Busy	°	° x	°	°	°	°	°	Idle
Detailed	°	°	x °	°	°	°	°	Superficial
Variety	°	x °	°	°	°	°	°	Uniformity

(Appendix continues)

Your Centre

Perceptions of Visit Impact

26-35 year old visitors

Cognitive Category

	7		6		5	4	3		2	1	
Educational	°	x	°		°	°	°		°	°	Non-educational
Intellectual	°		°	x	°	°	°		°	°	Trivial
Informative	°	x	°		°	°	°		°	°	Uninformative
Experimental	°		x		°	°	°		°	°	Non-experimental
Understandable	°		x		°	°	°		°	°	Bewildering
Knowledgeable	°	x	°		°	°	°		°	°	Ignorant

Affective Category

	7		6		5	4	3		2	1	
Fun	°	x	°		°	°	°		°	°	Boring
Enjoyable	°	x	°		°	°	°		°	°	Unpleasant
Worthwhile	°	x	°		°	°	°		°	°	Worthless
Inspiring	°		°	x	°	°	°		°	°	Uninspiring
Exciting	°	x	°		°	°	°		°	°	Dull
Interesting	°	x	°		°	°	°		°	°	Uninteresting
Stimulating	°	x	°		°	°	°		°	°	Discouraging
Fascinating	°		°	x	°	°	°		°	°	Monotonous

Physical Environs Category

	7		6		5	4	3		2	1	
Active	°	x	°		°	°	°		°	°	Passive
Colourful	°	x	°		°	°	°		°	°	Bland
Quiet	°		°		°	°	°	x	°	°	Noisy
Busy	°	x	°		°	°	°		°	°	Idle
Detailed	°	x	°		°	°	°		°	°	Superficial
Variety	°	x	°		°	°	°		°	°	Uniformity

(Appendix continues)

Your Centre

Perceptions of Visit Impact

36-45 year old visitors

Cognitive Category

	7		6		5	4	3		2	1	
Educational	°	x	°		°	°	°		°	°	Non-educational
Intellectual	°		°	x	°	°	°		°	°	Trivial
Informative	°	x	°		°	°	°		°	°	Uninformative
Experimental	°	x	°		°	°	°		°	°	Non-experimental
Understandable	°		x		°	°	°		°	°	Bewildering
Knowledgeable	°		°	x	°	°	°		°	°	Ignorant

Affective Category

	7		6		5	4	3		2	1	
Fun	°	x	°		°	°	°		°	°	Boring
Enjoyable	°	x	°		°	°	°		°	°	Unpleasant
Worthwhile	°	x	°		°	°	°		°	°	Worthless
Inspiring	°		°	x	°	°	°		°	°	Uninspiring
Exciting	°		°	x	°	°	°		°	°	Dull
Interesting	°	x	°		°	°	°		°	°	Uninteresting
Stimulating	°	x	°		°	°	°		°	°	Discouraging
Fascinating	°		°	x	°	°	°		°	°	Monotonous

Physical Environs Category

	7		6		5	4	3		2	1	
Active	°	x	°		°	°	°		°	°	Passive
Colourful	°	x	°		°	°	°		°	°	Bland
Quiet	°		°		°	°	°	x	°	°	Noisy
Busy	°	x	°		°	°	°		°	°	Idle
Detailed	°		°	x	°	°	°		°	°	Superficial
Variety	°	x	°		°	°	°		°	°	Uniformity

(Appendix continues)

Appendix 6-P (Continued)

Your Centre

Perceptions of Visit Impact

46 + year old visitors

Cognitive Category

	7	6	5	4	3	2	1	
Educational	° x	°	°	°	°	°	°	Non-educational
Intellectual	°	° x	°	°	°	°	°	Trivial
Informative	° x	°	°	°	°	°	°	Uninformative
Experimental	° x	°	°	°	°	°	°	Non-experimental
Understandable	° x	°	°	°	°	°	°	Bewildering
Knowledgeable	° x	°	°	°	°	°	°	Ignorant

Affective Category

	7	6	5	4	3	2	1	
Fun	° x	°	°	°	°	°	°	Boring
Enjoyable	° x	°	°	°	°	°	°	Unpleasant
Worthwhile	° x	°	°	°	°	°	°	Worthless
Inspiring	°	°x	°	°	°	°	°	Uninspiring
Exciting	°	x°	°	°	°	°	°	Dull
Interesting	°	x °	°	°	°	°	°	Uninteresting
Stimulating	° x	°	°	°	°	°	°	Discouraging
Fascinating	°	x °	°	°	°	°	°	Monotonous

Physical Environs Category

	7	6	5	4	3	2	1	
Active	°	x °	°	°	°	°	°	Passive
Colourful	°	x °	°	°	°	°	°	Bland
Quiet	°	°	°	°	°	x °	°	Noisy
Busy	° x	°	°	°	°	°	°	Idle
Detailed	°	x °	°	°	°	°	°	Superficial
Variety	° x	°	°	°	°	°	°	Uniformity

(Appendix continues)

Your Centre

Perceptions of Visit Impact

All visitors

Cognitive Category

	7	6	5	4	3	2	1	
Educational	° x	°	°	°	°	°	°	Non-educational
Intellectual	°	°	x°	°	°	°	°	Trivial
Informative	° x	°	°	°	°	°	°	Uninformative
Experimental	° x	°	°	°	°	°	°	Non-experimental
Understandable	°	x°	°	°	°	°	°	Bewildering
Knowledgeable	°	x°	°	°	°	°	°	Ignorant

Affective Category

	7	6	5	4	3	2	1	
Fun	° x	°	°	°	°	°	°	Boring
Enjoyable	° x	°	°	°	°	°	°	Unpleasant
Worthwhile	° x	°	°	°	°	°	°	Worthless
Inspiring	°	° x	°	°	°	°	°	Uninspiring
Exciting	°	x°	°	°	°	°	°	Dull
Interesting	° x	°	°	°	°	°	°	Uninteresting
Stimulating	°	x°	°	°	°	°	°	Discouraging
Fascinating	°	° x	°	°	°	°	°	Monotonous

Physical Environs Category

	7	6	5	4	3	2	1	
Active	° x	°	°	°	°	°	°	Passive
Colourful	° x	°	°	°	°	°	°	Bland
Quiet	°	°	°	°	°	x°	°	Noisy
Busy	°	x	°	°	°	°	°	Idle
Detailed	°	° x	°	°	°	°	°	Superficial
Variety	° x	°	°	°	°	°	°	Uniformity

Appendix 6-Q

Letter to ISTC Directors Requesting Feedback on the Survey Using the PVII

18 July 1995

The Director
Your Centre

Dear

Report on Perception of Visit Impact Survey

I am seeking your assistance by way of feedback on the research report you recently received. Would you please complete the enclosed brief feedback form at your convenience and return it to me.

The results in all five participating interactive science and technology centres, two in New Zealand and three in Australia, are very similar with no statistical significant differences in the average scores for each of the cognitive, affective and physical domains. I want to emphasise that the results of this study do not provide any valid comparison of the participating centres. However, the results do show that the public are responding in a very positive manner to the way science and technology are being presented at each of the centres involved in the study.

I thank you for your cooperation to date, and look forward to compiling another report for you based on data I will analyse after the second survey questionnaires are returned.

Yours faithfully

David Johnston
Researcher
Curtin University of Technology

Appendix 6-R

PVII Main Field-test ISTC Feedback Form

***Your Centre* Feedback**

Perception of Visit Impact Survey
at Point of Exit

1. Usefulness of the report.
   Would you please indicate the value of the survey to you.

   How have you used, or do you intend to use, the results of the study?

   Would you use this survey again?

   What would be your reason/s for either using or not using it again?

2. Improvement of the Survey Instrument
   Do you have any suggestions for improving the instrument?

3. Any other comments.

Thank you for your help!

Appendix 7-A

PVOI Items and Their Source Statements

Section A: Your overall impression of your visit

A1 It is a good place for a family outing.

- ". . . a marvellous place for a family outing."
- " Great family day out."
- " . . . gives us a chance to talk about things . . . and to share experiences."

A2 I intend to return.

- "I will be returning for other visits."
- "My children always want to return."
- "Resisting the children's demands to return every week."

A3 I would recommend it as a place to visit.

- "I am going to tell my two teenage daughters they should visit."
- "I now recommend *Scitech* to friends."
- " . . . suggested to my husband he tell his father (72 years) to visit *Scitech*."

A4 Children are free to explore without being told 'don't touch'.

- "Freedom for children to experiment whereas in other places they may have been told 'don't touch'."
- ". . . hands-on is a good way for children to learn."
- "I like the idea that my children can choose activities for themselves."

A5 There was something for all ages.

- " . . . a place where all our ages merged as one."
- "Never too old to learn new things."
- " . . . something to learn for all age groups."

A6 The visit was 'good value for money.'

- "We certainly got our money's worth."
- " . . . wish we could afford to go more often."
- " . . . same price as a visit to the movies and to me it's better value."

Section B: Your own learning and understanding as a result of your visit

B1 The hands on activities helped me to remember scientific activities after my visit.

- "The hands-on activities left me with a longer lasting impression of scientific theory."
- "Learning is easier with a hands-on experience and harder to forget."
- "Learning from the hands-on exhibits is a very effective form of education."

(Appendix Continues)

B2   I now know how some things work that I didn't understand before.

- "Activities and experiments allow people to expand their existing knowledge . . . "
- "I was able to grasp or achieve a better understanding of how/why some general equipment works."
- "I now know how something works that I didn't understand before."

B3   The element of discovery helped me learn.

- "The element of discovery helped me learn."
- "It was exciting being able to learn by myself."
- " . . . expand their existing knowledge through discovery and personal experience."

B4   I was challenged about "why" some things happened.

- "Challenged as to why."
- "*Scitech* exhibits explain by 'doing' - how and why things do what they do. They make you think."
- "There were some activities that took a lot of patience to do."

B5   Learning was easy.

- " . . . easy to learn at *Scitech*."
- " . . . vital learning facility for young and old."
- "Made good sense. Easy learning."

B6   It was easy to understand because things were explained in everyday language.

- "Concepts can be explained quite simply through demonstrations of a theory using layman's language."
- "I have always found the language of science and technology confusing and best left to the scientist, but now I realise it doesn't have to be that way."
- "I wonder if the explanations of how things work could be simplified."

B7   I think about scientific things more.

- "Has sharpened my interest and now I think more about science."
- "Heightened my awareness and raised my curiosity so that I think about it more."
- "I now think about scientific things more."

B8   I learned that science is not always predictable.

- "I learned that science is not always predictable."
- " . . . sometimes surprised by the experiments."
- "There were times when I was surprised by what was happening in the exhibits. It wasn't what I thought would happen."

B9   I was able to relate scientific concepts to my everyday life.

- "An insight into things I take for granted in everyday living."
- "I was better able to grasp or achieve a better understanding of how and some things work."
- "Better understanding of how some things work in everyday living."

(Appendix Continues)

B10 I learned something new about myself.

- "I learnt something new about myself."
- " . . . learnt where my pacemaker goes."
- "I've just had a by-pass operation so it was interesting to see it on such a large scale."

B11 I learned something new about the world around me.

- "I learned something new about the world around me."
- "The mining exhibit let me experience things I would otherwise never get the chance to see."
- "The insects we've imported seem strange, for example the dung beetles."

Section C : Your thoughts and feelings as a result of your visit

C1 My interest in science and technology has been reinforced.

- "My interest has been reinforced."
- " . . . a reawakening of my interest."
- " . . . always been interested but this has whetted my appetite for more."

C2 I am amazed by science and technology.

- " . . . amazed by science and technology."
- "The science and technology that was displayed amazed me."
- "Awesome! The science experiences were totally amazing."

C3 The unexpected results of some of the activities made them exciting.

- "My interest was enhanced by an unusual 'curiosity element' in some of the exhibits."
- "The unexpected results of some of the activities made them exciting."
- "I was surprised by some of the results to the experiments."

C4 I no longer think that science and technology are beyond my grasp.

- "Complex scientific concepts can often be explained quite simply through demonstrations of a theory."
- "I have always found science and technology confusing, best left to the scientist, but now I realise it doesn't have to be that way."
- "Science and technology still seem like a lot of mumbo jumbo."

C5 I enjoyed finding out how and why some things work.

- "Being able to learn how some of the things worked made the visit interesting and enjoyable."
- " . . . personal satisfaction at being able to explore why things happen and expanding one's own existing knowledge through discovery."
- "I enjoyed finding out how to understand and why some things work."

(Appendix Continues)

C6 I am no longer intimidated by science and technology.

- "Made science and technology less intimidating."
- "I found science at school to be intimidating and not for me. Since my visit I realised that it need not be the case."
- "For me the image of science and scientists has always been esoteric. Now I see it as accessible."

C7 I am no longer bored by science and technology.

- "Science has a boring image and the visit helped break that down."
- "Whenever I go to *Scitech* nothing is boring."
- "My memories of school science are that of sheer boredom. This was so different."

C8 I would have been more interested in science if I had visited a place like this when I was a child.

- "I wish we had something like this when I was younger. I'm sure that I'd have been more interested."
- " . . . wish this was here when I was at school."
- "Maybe I would have been more interested in science if I'd visited one of these."

9 I now think that complex scientific concepts can be made understandable for people of all ages.

- "I now think that complex scientific concepts can be made understandable for people of all ages."
- "It simplifies science for us oldies too."
- "Even the kids can understand some of those complex principles."

Section D: Your views about science and technology as a consequence of your visit

D1 I now realise important science and technology are in my everyday life.

- "I now realise important science and technology are in my everyday life."
- "The information from the exhibits has shown me a different way to look at some of the things in my daily life."
- "I now realise how important science and technology is in our daily lives."

D2 I now realise how much science influences modern technology.

- "I now realise how much science influences modern technology."
- "I am now more aware if the dependence of modern technology on science and its development."
- "I used to think people just invented things. Now I see there is a scientific basis for so many things."

(Appendix Continues)

D3 I now have a better appreciation of the laws of nature.

- "It was good to see the insects we find in our backyard and to appreciate their role in our existence."
- "The displays showing the fragility of the WA mining areas and their rehabilitation were well done."
- "We were most impressed with dung beetle. I had no idea of how important it is."

D4 I now have a better appreciation of some of the things I have taken for granted.

- "I now have a better appreciation of some of the things I have taken for granted."
- "I used to take a lot for granted – now look at some things more closely."
- "Taking things for granted doesn't help me understand. I'll be more observant now."

D5 I am now more aware of how fast science and technology change.

- " . . . more aware of how fast science and technology are changing."
- "It gave me a better perspective of the rapid developments in technology."
- "Change is all around us. This gave me a chance to catch up on some of it."

D6 I am now more aware of advances in modern technology.

- "My awareness of modern technology improved."
- "My mind has been opened to the limitlessness of science and technology."
- "I saw some things in the computer section that I'd never seen."

D7 I now realise there is a need to keep up with changes in current technology.

- " . . . realised there is a need to keep in touch with what's going on in the world."
- " . . . science and technology is so important in our daily lives, and because it is constantly changing I'll be keeping myself better informed."
- "Technology changes so fast and we need to keep abreast of it."

D8 I now appreciate that living standards can be improved through technology.

- ". . . upgrading of living standards through technology."
- "It was interesting to see implications technology has for our quality of lifestyle."
- I wonder if people understand their living standard is related to technology."

Section F: For parents in a family group

F1 Watching my children enjoy themselves was a joy to me.

- "I am constantly reminded of the joy of discovery watching my children and that is a joy to me."
- "For me <u>the</u> most important aspect of the *Scitech* display is the fun my children derive from it. If they are happy so am I."
- " . . . has provided me with a resource that children enjoy and learn from."

(Appendix Continues)

F2 Being able to watch my children actively engaged with the exhibits was a pleasure to me.

- " . . . having the children gainfully occupied for 2 [sic] hours was great."
- "It was pleasing to see children constructively active."
- "I enjoyed watching my children totally immersed in the activities."

F3 It was a challenging and stimulating experience for my children.

- "It was a challenging and stimulating experience for my children."
- "Our children learnt and experimented with things not available elsewhere."
- "It's a wonderfully challenging, stimulating experience for children."

F5 My children asked me about the exhibits.

- " . . . they (children) keep asking me questions about some of the exhibits."
- "A great family experience. After three weeks my two daughters are still asking me questions."
- "I enjoyed being able to answer the questions the children asked me."

F6 I now encourage my children to question and find out things.

- "I now encourage my children to question and find out things."
- "After each visit I explain some things in terms of what they'd seen at *Scitech* and encourage them to ask questions."
- "I am always aware of encouraging my children to question and find out about new things. *Scitech* has made that easier."

F7 We talk as a family about what we did on our family visit.

- "We talked about our visit all the way home in the car."
- "My children talk constantly about the things they have seen and that gives us a chance to talk about things and share experiences."
- "It was a source of educational entertainment that could be shared by the whole family . . . discussed on many occasions since the visit."

F8 I believe my children learned something from the visit.

- "I take my children to give them a broader understanding of life and its workings."
- "My children love it. I am sure they learn from the various exhibitions and at the same time learn from the hands-on and "achievable experiments."
- "I believe it is a vital learning facility for young and old and allows access to experiences that are not available to the average family."

F9 The fun aspect of a visit is an attraction for my children.

- "The fun aspect of a visit is an attraction for my children."
- "I enjoyed it very much. I took my two children aged 5 and 6 years and they also thoroughly enjoyed it."
- " . . . seeing so many people having a great time participating at the exhibits, especially the children."

(Appendix Continues)

F10 The way the centre presents science and technology has educational value for my children.

- "*Scitech* has educational things to do and that aren't available elsewhere. That is why it is so interesting for our children. And us."
- "The way the exhibition has been designed there seemed to be a new 'discovery' around every corner."
- "It was a fun way to learn about many and varied topics."

F11 I was looking after my children so I didn't learn as much as I would have liked.

- "There were a lot of things I didn't get a go at as I was too busy keeping an eye on the children."
- "My kids took off in all directions, so I didn't get much of a go."
- "Ban kids!"

F12 I look forward to a return visit as much as my children.

- "All the family enjoy a visit."
- "There is always something to excite young and old alike."
- "Gave me an opportunity to have fun with my kids in an interesting environment."

F13 I would enjoy a visit without my children so I could be more free to experience the exhibits as I wish.

- "I would enjoy a visit without my children so I could be more free to experience the exhibits as I wish."
- . . . would have enjoyed some time on my own."
- "Time went very quickly when we were there. Some of the time the children were off on their own and we parents were enjoyed being able to do our own thing."

Section G: For school students

G1 I now understand more about my science lessons.

- " . . . better understand my science lessons."
- "Easier to understand school work when you actually see the exhibit in detail and with (an) explanation."

G2 I have more interest in my science lessons at school.

- "I am no longer bored by science."
- "The topic we are doing at school is a lot more interesting after I saw it at *Scitech*."

G3 I now have a greater awareness of scientific ideas.

- " . . . better understanding of scientific ideas."
- " . . . have broader horizons."

(Appendix Continues)

G4 Since my visit my marks in science have improved.

- "My science marks have gone to 100%"

G5 I was able to use some information for a school project.

- "At school we are now doing a project/assignment on rocks and minerals and the displays helped a lot."
- "When I went back to study after a long break, there were a lot of things demonstrated here that I was able to use directly, and to refresh my memory."

G6 As a result of my visit, I am considering a career in science or technology.

- "I got some ideas of what kind of job I want to do."

Section H: For teachers

H1. I have used some ideas that I got from exhibits in my lessons.

- " . . . it gave ideas and inspiration towards future science activities."
- "*Scitech* is a good source of ideas."

H2 I intend to make changes in my teaching program based on ideas from exhibits.

- "I intend to make changes in my teaching program based on ideas from exhibits."

H3 I now include more "hands-on" activities in my science lessons.

- I intend to include more "hands-on" activities in my science lessons.

H4 I now include more "hands-on" activities in lessons other than science.

This item was included at request the Education Team at *Scitech.* They wanted to know if primary teachers who visited *Scitech* were encouraged to try a more hands-on approach in the other curriculum areas.

H5 I decided to try out new strategies in my classroom teaching.

- "I decided to try out new strategies in my classroom teaching."

H6 I now explain scientific concepts by using every-day examples.

- "I now explain scientific concepts by using every-day examples."

H7 I feel more confident about teaching science.

- "I feel more confident about teaching science."

H8. I have decided that my class would benefit from a visit to the science centre.

- "I'm on holidays and have been visiting to see if it's worth bringing my class."

Appendix 7-B

The Revised Draft PVOI or Main Field-test PVOI

***P**rofile*
of
***V**isit*
***O**utcomes*
***I**nstrument*

We need your help to understand how well we at the centre present science and technology experiences to our visitors. This questionnaire was developed using comments made by visitors soon after their visit.

Please complete every section which applies to you. There are special sections for *parents* [Section F], *school students* [Section G] and *teachers* [Section H]. Everyone should complete all the other sections.

(Appendix continues)

Appendix 7-B (Continued)

Most sections ask you to tick a box to show how much you agree with each visitor comment.

Example Only	**Your visit**				
	SA	A	U	D	SD
It was a very enjoyable experience	☐	☐	☐	☐	☐

Tick the box:

SA	if you strongly agree
A	if you agree
U	if you can't decide whether you agree or disagree
D	if you disagree
SD	if you strongly disagree

For <u>all items in every Section</u> (unless directed otherwise) **please tick the box that best indicates your position about each statement.**

Section A	**Your overall impression.**				
	SA	A	U	D	SD
1. It is a marvellous place for a family outing.	☐	☐	☐	☐	☐
2. I intend to return.	☐	☐	☐	☐	☐
3. I would recommend it as a place to visit.	☐	☐	☐	☐	☐
4. Children are free to explore without being told "don't touch."	☐	☐	☐	☐	☐
5. There was something to learn for all age groups.	☐	☐	☐	☐	☐
6. The visit was "good value for money."	☐	☐	☐	☐	☐

(Appendix continues)

Section B **Your own learning and understanding.**

	SA	A	U	D	SD
1. The "hands-on" activities helped me to remember scientific concepts after my visit.	☐	☐	☐	☐	☐
2. I now know how some things work that I didn't understand before.	☐	☐	☐	☐	☐
3. The element of discovery helped me learn.	☐	☐	☐	☐	☐
4. I was challenged to think about "why" some things happened.	☐	☐	☐	☐	☐
5. Learning was easy.	☐	☐	☐	☐	☐
6. It was easy to understand because things were explained in everyday language.	☐	☐	☐	☐	☐
7. I now think about scientific things more.	☐	☐	☐	☐	☐
8. I learned that science is not always predictable.	☐	☐	☐	☐	☐
9. I was able to relate scientific concepts to my everyday life.	☐	☐	☐	☐	☐
10. I learned something new about myself.	☐	☐	☐	☐	☐
11. I learned something new about the world around me.	☐	☐	☐	☐	☐

(Appendix continues)

Section C **Your thoughts and feelings.**

	SA	A	U	D	SD
1. My interest in science and technology has been reinforced.	☐	☐	☐	☐	☐
2. I am amazed by science and technology.	☐	☐	☐	☐	☐
3. The unexpected results of some of the activities made them exciting.	☐	☐	☐	☐	☐
4. I no longer think that science and technology are beyond my grasp.	☐	☐	☐	☐	☐
5. I enjoyed finding out how and why some things work.	☐	☐	☐	☐	☐
6. I am no longer intimidated by science and technology.	☐	☐	☐	☐	☐
7. I am no longer bored by science and technology.	☐	☐	☐	☐	☐
8. I would have been more interested in science if I had visited a place like this when I was a child.	☐	☐	☐	☐	☐
9. I think that complex scientific concepts can be made understandable for people of all ages.	☐	☐	☐	☐	☐

(Appendix continues)

Section D **Your views about science and technology.**

	S A	A	U	D	S D
1. I now realise how important science and technology are for my everyday life.	☐	☐	☐	☐	☐
2. I now realise how much science influences modern technology.	☐	☐	☐	☐	☐
3. I now have a better appreciation of the laws of nature.	☐	☐	☐	☐	☐
4. I now have a better appreciation of some things that I have taken for granted.	☐	☐	☐	☐	☐
5. I am now more aware of how **fast** science and technology change.	☐	☐	☐	☐	☐
6. I am now more aware of advances in modern technology.	☐	☐	☐	☐	☐
7. I now realise there is a need to keep up with changes in current technology.	☐	☐	☐	☐	☐
8. I now appreciate that living standards can be improved through technology.	☐	☐	☐	☐	☐

(Appendix continues)

Section E What did you do as a result of your visit?

Please indicate anything you have done by placing a tick in the appropriate box.

1. Bought a piece of scientific equipment. ☐
2. Bought a kit that demonstrates scientific principles. ☐
3. Bought a toy that clearly shows a scientific principle. ☐
4. Read an article about a scientific principle which was demonstrated by an exhibit. ☐
5. Watched more TV programs related to science. ☐
6. Read more science-related articles in newspapers or magazines. ☐
7. Suggested to other people that they visit the science centre. ☐
8. Conducted an experiment at home. ☐
9. Built something based on an idea I got from an exhibit. ☐
10. Changed my lifestyle. ☐
11. Started a new hobby. ☐
12. Started an exercise program. ☐
13. Became more energy conscious in my home. ☐
14. Influenced my decisions at work. ☐
15. Talked about my visit to people **other** than those who visited. with me. ☐
16. If you answered **yes** to any of the above, would you please give details of what you did in the following space.
17. If there is anything else you have done that is a direct result of your visit, would you please give details in the space below.

(Appendix continues)

Section F **For parents in a family group.**

	SA	A	U	D	SD
1. Watching my children enjoy themselves was a joy to me.	☐	☐	☐	☐	☐
2. Being able to watch my children actively engaged with the exhibits was a pleasure to me.	☐	☐	☐	☐	☐
3. It was a challenging and stimulating experience for my children.	☐	☐	☐	☐	☐
4. It gave me an opportunity to discuss the displays with my children.	☐	☐	☐	☐	☐
5. My children asked me questions about the exhibits.	☐	☐	☐	☐	☐
6. I now encourage my children to question and find out things.	☐	☐	☐	☐	☐
7. We talk as a family about what we did on our visit.	☐	☐	☐	☐	☐
8. I believe my children learned something from their visit.	☐	☐	☐	☐	☐
9. The fun aspect of a visit is an attraction for my children.	☐	☐	☐	☐	☐
10. The way the centre presents science and technology has educational value for my children.	☐	☐	☐	☐	☐
11. I was looking after my children so I didn't learn as much as I would have liked.	☐	☐	☐	☐	☐
12. l look forward to a return visit as much as my children.	☐	☐	☐	☐	☐
13. I would enjoy a visit without my children so I could be more free to experience the exhibits as I wish.	☐	☐	☐	☐	☐

(Appendix continues)

Section G **For school students**

Please answer <u>each</u> question.

After my experiences during my visit to the science centre,

	SA	A	U	D	SD
1. I now understand more about my science lessons.	☐	☐	☐	☐	☐
2. I have more interest in science lessons at school.	☐	☐	☐	☐	☐
3. I now have a greater awareness of some scientific ideas.	☐	☐	☐	☐	☐
4. My grades in science have improved.	☐	☐	☐	☐	☐
5. I was able to use some information for a school project.	☐	☐	☐	☐	☐
6. I am considering a career in science or technology.	☐	☐	☐	☐	☐

7. If you tried an activity based on something you saw, please describe it in the space below.

8. If you have purchased a scientific game or experiment kit, please describe the game or kit in the space below.

9. Is there any other comment you can make about your school science classes after your visit to our science centre?

(Appendix continues)

Section H For teachers.

As a result of my experiences during my visit to the science centre,

	SA	A	U	D	SD
1. I have used some ideas that I got from exhibits in my lessons.	☐	☐	☐	☐	☐
2. I intend to make changes in my teaching program based on ideas from exhibits.	☐	☐	☐	☐	☐
3. I now include more "hands-on" activities in my science lessons.	☐	☐	☐	☐	☐
4. I now include more "hands-on" activities in lessons other than science.	☐	☐	☐	☐	☐
5. I decided to try out new strategies in my classroom teaching.	☐	☐	☐	☐	☐
6. I now explain scientific concepts by using every-day examples.	☐	☐	☐	☐	☐
7. I feel more confident about teaching science.	☐	☐	☐	☐	☐
8. I have decided that my class would benefit from a visit the science centre.	☐	☐	☐	☐	☐

9. Are there any other comments you can make about your teaching as a result of your visit to the science centre?

10. What is your area of teaching? (Please circle)

Pre-school Primary Secondary Tertiary

If you are a secondary or tertiary teacher would you please state your subject area in the following space.

____

(Appendix continues)

Section I **Any other comments**

Are there **any other comments** you would like to make about your visit to our science centre?

Section J **Your thoughts please!**

What do you think this science centre aims to do?

Section K **Respondent details**

We would like to know some details about yourself so the data can be analysed. All information provided is strictly confidential.

- **Gender** (Please circle) Male Female
- **Age** (Please circle) <u>11-12</u> <u>13-17</u> <u>18-25</u> <u>26-35</u> <u>36-45</u> <u>46-55</u> <u>56</u>$^{+}$
- What is your **highest** level of education in **science**? (Please circle)

  None Primary School Secondary School TAFE University
- **I visited** (Please circle)

  by myself with my family with my friends

Thank you very much for your assistance!

Appendix 7-C

Extracts From Letters to Visitors Who Agreed to Participate at *Scitech* and *Centre E*

2 August 1995

Dear

Thank you for agreeing to help us with our research. Please complete the enclosed questionnaire and return it in the envelope provided. As soon as I receive the completed questionnaire your FREE PASS to *Scitech* will be posted to you.

If you have any questions please contact me.

Yours faithfully

Thank you very much for agreeing to take part in the Profile of Visit Outcomes study being conducted here at *Centre E.*

We believe it will take about 20 minutes to complete and the results will be used as part of a PhD thesis by an Australian university researcher in Perth. There is very little information in any current literature that looks at the impact a visit to a science and technology exhibition has on the visitor. As a result of this survey, we may change the way they are presented that will make visits even more enjoyable and valuable than we hope they are at present.

I hope you will fill this in quickly and put it in the reply paid envelope and send it back to us.

Please include the original tear-off slip you filled in as well so we can send you a free pass to come back to visit some more exhibitions.

Coming up soon we have . . . .

Appendix 7-D

Instructions for Administering the PVOI

12 July 1995

Dear

Please find enclosed 250 copies of the second questionnaire. The second questionnaire is more extensive than the first and is designed to be administered two to three weeks after people have visited your centre. All questions have been developed from statements made by over 100 people after a visit to *Scitech*. It has been refined a number of times by getting museum professionals, science educators, teachers, university lecturers, school principals, researchers and a number of visitors to comment on its content and format. Its purpose is to provide a broad and detailed profile of what people get out of a visit to your centre.

The problem of getting a reasonable return rate arises when administering a questionnaire of this type. The procedure I have adopted at *Scitech* is as follows. Visitors are approached randomly and asked if they would be willing to participate in a study to help *Scitech* with its future planning by completing a questionnaire that will be posted to them in about 2-3 weeks time. If they agree, they are then asked to complete a prepared form that asks for their name, address, phone number and the names of anyone else in their group who is willing to complete the questionnaire. A note is made of the date of their visit. A reply paid envelope is included with the questionnaire. Participants are then offered an incentive of a free return pass on receipt of the completed questionnaire. The questionnaire is designed for people above the age of 10, but I ask for any under 10's to draw (2-3 weeks after their visit) a picture of their favourite thing at the centre so they feel included. If do you get any of these pictures, would you please include them as I will use them in another study. Trials indicate the questionnaire should take about 20 - 30 minutes to complete.

I do have a further request. Would you send me some information about your centre, such as its history of development, visitor numbers, future plans and a recent annual report. The information will be helpful for me when writing the thesis, but will be kept anonymous so no centre will be linked to any results, unless you instruct otherwise.

Would you please post completed questionnaires to me c/- SMEC, Curtin University of Technology, GPO Box 1987 U, Perth WA 6001. If you have any questions please contact me at Curtin University on ph 09 3513739 or at home 09 2916791 fax 09 3512503.

A very large thank you for your assistance.

Yours faithfully

David Johnston

Appendix 7-E

Number of Responses, Means and Standard Deviations and Percentage Response Frequencies by Demographic Subgroups for the PVOI Section A: Your Overall Impression of Your Visit

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Centre				
Centre B								
A1	152	4.49	0.56	0	0	3	44	53
A2	152	4.45	0.60	0	1	3	47	49
A3	152	4.51	0.59	0	0	5	40	55
A4	152	4.74	0.50	0	0	3	21	76
A5	151	4.55	0.61	1	0	2	38	59
A6	152	4.12	0.80	0	5	13	49	33
Centre D								
A1	103	4.42	0.63	0	2	2	48	48
A2	101	3.65	0.99	1	12	31	34	22
A3	102	4.66	0.50	0	0	1	32	67
A4	102	4.71	0.48	0	0	1	27	72
A5	102	4.58	0.55	0	1	0	39	60
A6	102	4.33	0.76	0	3	9	40	48
Centre E								
A1	170	4.65	0.49	0	0	1	33	66
A2	170	4.54	0.61	0	1	4	36	59
A3	170	4.69	0.52	0	1	1	26	72
A4	170	4.74	0.53	0	1	2	20	77
A5	170	4.65	0.53	0	0	2	31	67
A6	170	4.32	0.82	2	1	8	41	48
				Age (years)				
11-12								
A1	37	4.38	0.83	0	5	5	36	54
A2	37	4.27	0.73	0	0	16	41	43
A3	37	4.62	0.59	0	0	5	27	68
A4	37	4.70	0.62	0	0	8	14	78
A5	37	4.46	0.69	0	3	3	40	54
A6	37	4.27	0.69	0	0	14	46	40
13-17								
A1	38	4.50	0.51	0	0	0	50	50
A2	38	4.13	1.02	3	5	13	34	45
A3	38	4.68	0.47	0	0	0	32	68
A4	38	4.71	0.57	0	0	5	18	77
A5	38	4.66	0.53	0	0	3	29	68
A6	38	4.18	0.80	0	3	16	42	39
18-25								
A1	44	4.50	0.55	0	0	2	46	52
A2	44	4.14	0.70	0	0	18	50	32
A3	44	4.57	0.55	0	0	2	39	59
A4	44	4.61	0.54	0	0	2	34	64
A5	44	4.45	0.55	0	0	2	50	48
A6	44	4.11	0.75	0	0	23	43	34
26-35								
A1	82	4.54	0.55	0	0	2	42	56

(Appendix continues)

Appendix 7-E (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Age (years)				
26-35								
A2	82	4.44	0.72	0	2	6	37	55
A3	82	4.55	0.67	0	1	6	29	64
A4	82	4.77	0.45	0	0	1	21	78
A5	82	4.63	0.58	0	0	5	27	68
A6	82	4.20	0.95	2	5	7	42	44
36-45								
A1	153	4.58	0.51	0	0	1	41	58
A2	153	4.37	0.72	0	2	8	41	49
A3	153	4.65	0.50	0	0	1	32	67
A4	153	4.78	0.49	0	1	1	18	80
A5	152	4.63	0.56	1	0	0	34	65
A6	153	4.27	0.84	1	4	7	43	45
46-55								
A1	38	4.58	0.50	0	0	0	42	58
A2	38	4.13	0.91	0	8	11	42	39
A3	38	4.63	0.49	0	0	0	37	63
A4	38	4.68	0.47	0	0	0	32	68
A5	38	4.58	0.50	0	0	0	42	58
A6	38	4.29	0.65	0	0	11	50	39
56^{+}								
A1	33	4.58	0.61	0	0	6	30	64
A2	31	4.16	1.07	0	13	9	26	52
A3	32	4.59	0.50	0	0	0	41	59
A4	32	4.66	0.48	0	0	0	34	66
A5	32	4.63	0.49	0	0	0	38	62
A6	32	4.53	0.51	0	0	0	47	53
				Education level				
Primary								
A1	52	4.37	0.74	0	4	4	44	48
A2	50	4.24	0.77	0	0	20	36	44
A3	51	4.61	0.57	0	0	4	31	65
A4	51	4.69	0.58	0	0	6	20	74
A5	51	4.49	0.64	0	2	2	41	55
A6	51	4.24	0.71	0	0	16	45	39
Secondary								
A1	214	4.53	0.55	0	0	3	42	55
A2	214	4.25	0.86	1	5	9	40	45
A3	214	4.62	0.53	0	0	2	33	65
A4	214	4.75	0.50	0	1	1	21	77
A5	214	4.64	0.52	0	0	2	32	66
A6	214	4.27	0.82	1	4	8	43	44
TAFE / Polytechnic								
A1	41	4.68	0.47	0	0	0	32	68
A2	41	4.34	0.69	0	2	5	49	44
A3	41	4.44	0.71	0	2	5	39	54
A4	41	4.61	0.59	0	0	5	29	66
A5	41	4.54	0.55	0	0	2	42	56
A6	41	4.27	0.84	2	0	10	44	44

(Appendix continues)

Appendix 7-E (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Education level				
University								
A1	118	4.58	0.49	0	0	0	42	58
A2	118	4.37	0.74	0	2	10	37	51
A3	118	4.68	0.49	0	0	1	31	68
A4	118	4.75	0.45	0	0	1	23	76
A5	117	4.57	0.61	1	0	1	38	60
A6	118	4.23	0.81	1	2	11	44	42
				Sex				
Male								
A1	175	4.49	0.61	0	1	2	43	54
A2	173	4.24	0.79	0	4	10	44	42
A3	174	4.61	0.52	0	0	2	35	63
A4	174	4.68	0.50	0	0	2	28	70
A5	173	4.55	0.54	0	0	2	41	57
A6	174	4.13	0.79	1	3	12	51	33
Female								
A1	250	4.57	0.53	0	0	2	39	59
A2	250	4.33	0.81	0	3	10	36	51
A3	250	4.62	0.56	0	0	3	31	66
A4	250	4.76	0.51	0	0	3	18	79
A5	250	4.63	0.58	0	0	1	33	66
A6	250	4.34	0.80	1	2	9	38	50

Appendix 7-F

Number of Responses, Means, Standard Deviations and Percentage Responses by Demographic Subgroups for the PVOI Section B: Your Own Learning and Understanding as a Result of Your Visit

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Centre				
Centre B								
B1	150	4.03	0.65	0	3	11	66	20
B2	150	4.07	0.68	0	3	11	62	24
B3	150	4.03	0.62	0	1	15	64	20
B4	151	4.09	0.65	0	1	13	62	24
B5	149	3.96	0.60	0	1	16	68	15
B6	151	4.05	0.71	0	3	13	60	24
B7	150	3.35	0.88	0	18	38	35	9
B8	150	3.73	0.83	0	7	30	46	17
B9	151	3.56	0.85	1	8	35	45	11
B10	150	3.23	0.91	2	22	31	41	4
B11	150	3.99	0.70	0	3	16	60	21
Centre D								
B1	103	4.01	0.73	0	5	12	61	22
B2	103	4.02	0.77	0	7	8	62	23
B3	103	4.02	0.66	0	3	12	66	19
B4	103	4.02	0.74	0	3	18	54	25
B5	103	4.16	0.76	1	3	8	56	32
B6	103	4.17	0.73	0	4	8	55	33
B7	102	3.09	0.91	2	25	43	23	7
B8	103	3.83	0.75	0	3	29	51	17
B9	102	3.74	0.74	0	6	26	56	12
B10	101	3.16	0.98	4	22	36	31	7
B11	103	4.00	0.75	0	6	11	61	22
Centre E								
B1	170	4.08	0.65	0	2	12	62	24
B2	170	3.95	0.78	0	6	15	57	22
B3	170	4.08	0.75	0	2	18	50	30
B4	170	4.05	0.72	0	2	16	56	26
B5	170	4.14	0.65	0	1	12	59	28
B6	170	4.28	0.60	0	1	4	60	35
B7	170	3.26	0.94	2	17	46	23	12
B8	170	3.73	0.83	1	6	28	49	16
B9	170	3.72	0.76	1	5	29	53	12
B10	170	3.49	0.94	2	12	37	34	15
B11	170	4.01	0.78	1	5	12	58	24
				Age (years)				
11-12								
B1	37	4.05	0.70	0	0	22	51	27
B2	37	4.27	0.73	0	0	16	41	43
B3	37	4.16	0.65	0	0	13	57	30
B4	37	4.24	0.72	0	0	16	43	41
B5	37	4.14	1.06	3	5	16	27	49
B6	37	4.14	0.79	0	6	8	54	32
B7	37	3.78	1.03	3	8	24	38	27

(Appendix continues)

Appendix 7-F (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Age (years)				
11-12								
B8	37	4.03	0.90	0	8	14	46	32
B9	37	3.84	0.93	0	8	27	38	27
B10	37	3.49	1.12	8	8	27	41	16
B11	37	4.38	0.68	0	3	3	48	46
13-17								
B1	38	4.00	0.87	0	5	21	42	32
B2	38	4.18	0.83	0	3	18	37	42
B3	38	4.13	0.78	0	3	16	47	34
B4	38	4.16	0.72	0	3	10	55	32
B5	38	4.34	0.63	0	0	8	50	42
B6	38	4.24	0.79	0	5	5	50	40
B7	38	3.32	1.04	0	26	32	26	16
B8	38	4.26	0.79	0	3	13	39	45
B9	38	3.79	0.96	0	13	18	45	24
B10	38	3.32	1.04	2	21	32	32	13
B11	38	4.08	0.94	0	5	24	29	42
18-25								
B1	44	4.02	0.63	0	0	18	61	21
B2	44	3.61	0.78	0	11	23	59	7
B3	44	3.93	0.76	0	2	25	50	23
B4	44	3.95	0.71	0	5	13	64	18
B5	44	4.07	0.73	0	0	23	48	29
B6	44	4.27	0.66	0	2	5	57	36
B7	44	3.02	0.95	4	25	39	27	5
B8	44	3.68	0.71	0	2	39	48	11
B9	44	3.75	0.78	0	7	25	54	14
B10	44	3.39	0.99	2	16	36	32	14
B11	44	3.93	0.76	0	5	18	57	20
26-35								
B1	82	4.07	0.60	0	2	7	71	20
B2	82	4.04	0.60	0	2	12	68	18
B3	82	4.10	0.66	0	0	17	56	27
B4	82	4.05	0.61	0	1	12	67	20
B5	82	4.06	0.67	0	3	12	62	23
B6	82	4.13	0.62	0	1	10	63	26
B7	82	3.26	0.81	0	17	46	31	6
B8	82	3.56	0.77	0	7	39	44	10
B9	82	3.61	0.77	1	6	31	55	7
B10	82	3.34	0.85	1	15	39	39	6
B11	82	4.01	0.60	0	2	10	72	16
36-45								
B1	152	4.05	0.64	0	3	8	69	20
B2	152	4.04	0.74	0	6	7	64	23
B3	152	4.06	0.62	0	1	13	65	21
B4	152	4.07	0.68	0	1	16	58	25
B5	151	4.05	0.59	0	1	11	69	19
B6	152	4.13	0.69	0	3	10	59	28
B7	152	3.20	0.84	0	20	45	28	7
B8	152	3.68	0.78	0	7	32	49	12
B9	152	3.62	0.74	1	5	35	51	8

(Appendix continues)

Appendix 7-F (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Age (years)				
36-45								
B10	152	3.24	0.92	2	21	34	37	6
B11	152	3.97	0.63	0	3	14	68	15
46-55								
B1	38	4.13	0.70	0	3	10	58	29
B2	38	3.95	0.84	0	8	13	55	24
B3	38	3.87	0.74	0	5	18	61	16
B4	38	3.92	0.75	0	3	24	53	20
B5	38	3.97	0.59	0	3	10	74	13
B6	38	4.18	0.65	0	3	5	63	29
B7	38	3.24	0.94	3	16	47	24	10
B8	38	3.74	0.79	3	3	24	60	10
B9	38	3.61	0.75	3	3	31	58	5
B10	37	3.35	0.92	3	11	46	30	10
B11	38	3.79	0.99	3	11	13	53	20
56^{+}								
B1	32	3.91	0.73	0	6	13	66	15
B2	32	3.94	0.67	0	6	6	75	13
B3	32	4.00	0.76	0	6	9	63	22
B4	33	4.03	0.85	0	6	15	49	30
B5	32	4.03	0.40	0	0	6	84	10
B6	33	4.30	0.59	0	0	6	58	36
B7	31	3.13	0.99	3	19	52	13	13
B8	32	3.81	0.86	0	9	19	53	19
B9	32	3.66	0.79	0	6	34	47	13
B10	31	3.32	1.01	0	29	19	42	10
B11	32	3.94	0.88	0	9	13	53	25
				Education level				
Primary								
B1	52	4.02	0.67	0	0	21	56	23
B2	52	4.23	0.73	0	0	17	42	41
B3	52	4.19	0.60	0	0	10	62	28
B4	52	4.19	0.66	0	0	13	54	33
B5	52	4.15	0.89	2	2	15	41	40
B6	52	4.17	0.65	0	2	8	61	29
B7	51	3.65	0.93	2	8	31	41	18
B8	52	4.00	0.84	0	6	17	48	29
B9	51	3.80	0.83	0	6	28	47	19
B10	51	3.49	1.03	6	10	25	47	12
B11	52	4.21	0.70	0	2	10	54	34
Secondary								
B1	214	4.06	0.71	0	4	11	61	24
B2	214	4.08	0.72	0	5	8	61	26
B3	214	4.06	0.69	0	2	15	58	25
B4	214	4.06	0.72	0	2	18	53	27
B5	214	4.07	0.65	0	2	11	64	23
B6	214	4.19	0.71	0	3	9	55	33
B7	214	3.28	0.94	1	20	42	27	10
B8	214	3.86	0.79	0	4	26	49	21
B9	214	3.62	0.84	1	7	35	44	13
B10	214	3.31	0.95	2	18	37	33	10
B11	214	4.04	0.70	0	3	14	59	24

(Appendix continues)

Appendix 7-F (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Education level				
TAFE / Polytechnic								
B1	41	4.20	0.46	0	0	2	76	22
B2	41	4.05	0.59	0	3	7	73	17
B3	41	4.05	0.74	0	2	17	54	27
B4	41	4.07	0.72	0	5	7	64	24
B5	41	4.07	0.52	0	0	10	73	17
B6	41	4.22	0.61	0	2	2	66	30
B7	41	3.29	0.78	0	12	54	27	7
B8	41	3.76	0.83	0	7	27	49	17
B9	41	3.68	0.72	0	5	31	54	10
B10	41	3.41	0.84	0	15	37	41	7
B11	41	4.02	0.61	0	2	10	71	17
University								
B1	116	3.98	0.66	0	4	12	67	17
B2	116	3.78	0.78	0	9	18	60	13
B3	116	3.96	0.68	0	3	17	62	18
B4	117	4.00	0.66	0	3	13	65	19
B5	115	4.05	0.63	0	1	15	63	21
B6	117	4.13	0.66	0	3	8	62	27
B7	116	3.03	0.86	2	26	45	23	4
B8	116	3.45	0.75	1	9	40	47	3
B9	117	3.69	0.71	1	5	25	62	7
B10	115	3.22	0.94	3	22	33	36	6
B11	116	3.83	0.84	1	9	14	60	16
				Sex				
Male								
B1	175	4.02	0.66	0	3	12	66	19
B2	175	3.95	0.81	0	6	17	53	24
B3	175	3.98	0.73	0	2	23	51	24
B4	175	4.05	0.69	0	1	18	56	25
B5	174	4.02	0.72	0	2	18	56	24
B6	175	4.12	0.69	0	3	10	60	27
B7	174	3.20	0.98	1	25	37	26	11
B8	175	3.67	0.89	1	9	32	40	18
B9	174	3.74	0.79	1	4	28	53	14
B10	174	3.21	0.97	3	22	33	34	8
B11	175	3.91	0.80	1	5	17	56	21
Female								
B1	248	4.06	0.68	0	3	11	62	24
B2	248	4.06	0.69	0	4	9	64	23
B3	248	4.10	0.64	0	2	10	64	24
B4	249	4.07	0.70	0	3	13	59	25
B5	248	4.12	0.63	0	1	9	66	24
B6	249	4.21	0.67	0	2	7	58	33
B7	248	3.29	0.87	1	15	46	29	9
B8	248	3.81	0.74	0	4	27	54	15
B9	249	3.61	0.79	0	8	33	49	10
B10	247	3.40	0.93	2	15	35	38	10
B11	248	4.06	0.69	0	4	10	62	24

Appendix 7-G

Number of Responses, Means, Standard Deviations and Percentage Responses by Demographic Subgroups for the PVOI Section C: Your Thoughts and Feelings as a Result of Your Visit

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Centre				
Centre B								
C1	150	3.87	0.77	0	5	21	56	18
C2	149	4.11	0.76	1	3	10	56	30
C3	150	4.11	0.83	1	3	13	49	34
C4	149	3.82	0.75	0	5	23	56	16
C5	151	4.32	0.62	1	0	4	57	38
C6	147	3.63	0.80	0	8	33	48	11
C7	147	3.84	0.79	1	3	28	49	19
C8	149	4.21	0.87	1	3	17	33	46
C9	152	4.16	0.84	0	7	9	47	37
Centre D								
C1	103	3.79	0.82	1	9	14	62	14
C2	103	4.01	0.72	0	6	8	66	20
C3	103	4.11	0.61	0	0	14	62	24
C4	98	3.60	0.80	0	10	29	52	9
C5	103	4.28	0.58	1	0	1	66	32
C6	98	3.52	0.82	0	8	44	36	12
C7	97	3.70	0.86	1	8	25	52	14
C8	99	3.99	1.03	1	11	13	37	38
C9	103	4.18	0.78	0	5	8	51	36
Centre E								
C1	170	3.92	0.77	1	3	22	53	21
C2	170	3.96	0.81	0	5	20	49	26
C3	170	4.06	0.78	0	4	15	52	29
C4	170	3.69	0.92	2	9	24	48	17
C5	170	4.35	0.55	0	0	3	57	40
C6	168	3.48	1.03	4	11	35	33	17
C7	168	3.66	1.03	4	9	22	45	20
C8	169	4.09	1.00	2	6	13	37	42
C9	170	4.27	0.74	1	3	5	51	40
				Age (years)				
11-12								
C1	37	4.16	0.76	3	0	5	62	30
C2	37	4.38	0.79	0	5	3	41	51
C3	37	4.38	0.89	3	0	11	30	57
C4	37	3.89	0.88	0	8	19	49	24
C5	37	4.35	0.86	3	0	8	38	51
C6	37	3.81	0.97	0	11	24	38	27
C7	37	4.16	0.96	5	0	6	51	38
C8	34	3.97	1.00	3	3	24	35	35
C9	37	4.27	0.84	0	5	8	41	46
13-17								
C1	38	3.76	1.02	0	13	26	32	29
C2	38	4.13	0.81	0	3	18	42	37
C3	38	4.50	0.51	0	0	0	50	50
C4	38	3.97	0.68	0	0	24	55	21

(Appendix continues)

Appendix 7-G (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Age (years)				
13-17								
C5	38	4.50	0.56	0	0	3	45	52
C6	38	3.82	0.80	0	5	26	50	19
C7	38	4.05	0.84	0	3	24	39	34
C8	37	4.11	0.94	0	5	22	30	43
C9	38	4.26	0.83	0	5	8	42	45
18-25								
C1	44	3.77	0.77	2	2	23	61	12
C2	44	3.77	0.96	0	14	18	46	22
C3	44	3.93	0.82	0	7	16	55	22
C4	42	3.48	0.77	0	12	33	50	5
C5	44	4.36	0.53	0	0	2	59	39
C6	42	3.40	0.89	2	10	43	36	9
C7	42	3.52	0.80	2	2	45	41	10
C8	44	3.91	0.94	2	7	14	52	25
C9	44	4.14	0.88	0	9	5	50	36
26-35								
C1	82	3.83	0.78	0	7	18	59	16
C2	82	4.04	0.76	1	2	12	60	25
C3	82	4.00	0.86	0	5	22	42	31
C4	80	3.74	0.87	1	8	24	51	16
C5	82	4.27	0.52	0	0	4	66	30
C6	82	3.51	0.98	4	9	33	39	15
C7	82	3.70	0.96	3	11	18	51	17
C8	82	4.18	0.96	1	7	9	38	45
C9	82	4.21	0.77	0	5	6	52	37
36-45								
C1	151	3.85	0.66	0	3	22	62	13
C2	151	3.96	0.69	0	3	18	60	19
C3	151	3.97	0.73	1	3	17	59	20
C4	150	3.61	0.85	1	11	27	51	10
C5	152	4.30	0.60	1	0	3	61	35
C6	147	3.47	0.88	1	10	42	35	12
C7	147	3.67	0.84	1	6	30	49	14
C8	151	4.13	0.95	1	5	17	34	43
C9	153	4.16	0.76	0	5	8	53	34
46-55								
C1	38	3.92	0.91	0	11	13	50	26
C2	38	4.08	0.63	0	3	8	68	21
C3	38	4.11	0.51	0	0	8	74	18
C4	38	3.71	0.90	3	5	26	50	16
C5	38	4.32	0.47	0	0	0	68	32
C6	38	3.37	0.85	3	10	40	42	5
C7	37	3.54	1.07	5	11	24	43	17
C8	38	4.08	1.10	3	11	8	34	44
C9	38	4.21	0.91	3	3	8	44	42
56^{+}								
C1	33	3.91	0.84	0	6	21	49	24
C2	32	4.03	0.86	0	10	6	56	28
C3	33	4.30	0.59	0	0	6	58	36
C4	32	3.94	0.76	0	6	13	63	18
C5	33	4.33	0.48	0	0	0	67	33

(Appendix continues)

Appendix 7-G (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Age (years)				
56 plus								
C6	29	3.72	0.84	0	7	31	45	17
C7	29	3.76	0.91	0	14	14	55	17
C8	31	4.35	0.91	0	6	10	26	58
C9	33	4.39	0.56	0	0	3	55	42
				Education level				
Primary								
C1	52	4.04	0.71	2	0	12	65	21
C2	52	4.27	0.72	0	4	4	54	38
C3	52	4.33	0.79	2	0	8	44	46
C4	52	3.92	0.81	0	6	19	52	23
C5	52	4.29	0.75	2	0	6	52	40
C6	51	3.76	0.93	0	8	33	33	26
C7	51	4.18	0.87	4	0	6	55	35
C8	50	4.12	0.94	2	2	20	34	42
C9	52	4.29	0.78	0	4	8	44	44
Secondary								
C1	214	3.78	0.86	1	8	23	50	18
C2	214	4.11	0.76	1	3	13	53	30
C3	214	4.18	0.69	0	2	11	55	32
C4	214	3.80	0.77	0	5	27	51	17
C5	214	4.35	0.51	0	0	2	62	36
C6	213	3.68	0.80	1	5	35	45	14
C7	212	3.82	0.82	0	5	27	48	20
C8	212	4.22	0.87	1	5	12	37	45
C9	214	4.27	0.74	0	3	8	48	41
TAFE / Polytechnic								
C1	41	3.90	0.58	0	2	15	73	10
C2	41	3.93	0.65	0	0	24	59	17
C3	41	4.05	0.84	2	2	10	59	27
C4	41	3.68	0.69	0	7	22	66	5
C5	41	4.27	0.78	2	0	5	54	39
C6	41	3.37	0.77	0	10	51	32	7
C7	41	3.63	0.73	0	10	22	63	5
C8	41	4.24	0.80	0	2	15	39	44
C9	41	4.22	0.57	0	0	7	64	29
University								
C1	116	3.95	0.70	0	3	19	59	19
C2	115	3.78	0.80	0	10	16	60	14
C3	116	3.84	0.78	0	5	24	53	18
C4	110	3.45	0.97	3	16	24	47	10
C5	117	4.32	0.54	0	0	3	61	36
C6	108	3.24	1.04	6	18	34	32	10
C7	108	3.40	1.05	6	13	30	38	13
C8	114	3.87	1.14	3	11	17	32	37
C9	118	4.06	0.92	1	9	6	51	33
				Sex				
Male								
C1	174	3.94	0.77	0	3	22	52	23
C2	174	4.06	0.82	0	6	13	50	31
C3	174	4.01	0.82	1	2	19	50	28

(Appendix continues)

Appendix 7-G (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Sex				
Male								
C4	173	3.64	0.91	2	10	25	49	14
C5	175	4.30	0.60	1	0	4	60	35
C6	171	3.53	0.94	2	12	33	39	14
C7	171	3.77	0.95	3	8	19	50	20
C8	172	4.00	1.04	2	9	16	34	39
C9	175	4.11	0.84	1	6	8	52	33
Female								
C1	249	3.82	0.79	1	6	18	60	15
C2	248	4.00	0.74	0	4	14	60	22
C3	249	4.15	0.71	0	3	11	55	31
C4	244	3.77	0.78	0	7	24	54	15
C5	249	4.35	0.57	0	0	3	59	38
C6	242	3.55	0.88	2	7	39	38	14
C7	241	3.71	0.88	2	6	29	46	17
C8	245	4.19	0.90	1	4	14	37	44
C9	250	4.28	0.74	0	4	6	49	41

Appendix 7-H

Number of Responses, Means, Standard Deviations and Percentage Responses by Demographic Subgroups for the PVOI Section D: Your Views about Science and Technology as a Consequence of Your Visit

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Centre				
Centre B								
D1	149	4.11	0.77	1	3	11	55	30
D2	149	4.26	0.69	0	2	8	52	38
D3	149	3.84	0.73	1	4	20	62	13
D4	149	3.89	0.74	0	3	24	54	19
D5	150	4.08	0.93	1	8	11	43	37
D6	150	3.98	0.92	1	8	15	46	30
D7	150	4.14	0.80	0	3	16	46	35
D8	150	4.13	0.78	1	3	10	55	31
Centre D								
D1	101	4.04	0.71	0	1	20	54	25
D2	101	4.36	0.61	0	0	7	51	42
D3	100	3.84	0.75	0	5	22	57	16
D4	100	3.79	0.82	1	5	25	52	17
D5	100	4.07	0.73	0	3	14	56	27
D6	101	3.84	0.80	0	6	23	53	18
D7	100	4.01	0.73	0	3	17	56	24
D8	98	4.06	0.66	0	2	12	63	23
Centre E								
D1	169	4.03	0.81	1	2	17	51	29
D2	169	4.14	0.84	1	4	10	50	35
D3	169	3.73	0.86	2	5	28	49	16
D4	169	3.92	0.82	1	5	20	51	23
D5	168	3.91	0.97	2	7	20	41	30
D6	168	3.83	0.96	2	8	22	43	25
D7	168	4.01	0.91	2	5	16	46	31
D8	168	4.04	0.86	2	4	12	52	30
				Age (years)				
11-12								
D1	37	4.30	0.66	0	0	11	49	40
D2	37	4.49	0.73	0	3	5	32	60
D3	37	4.19	0.88	3	3	5	51	38
D4	37	3.95	0.94	3	3	22	43	29
D5	37	4.19	0.94	3	3	11	40	43
D6	37	4.16	0.80	0	3	16	43	38
D7	37	4.16	0.83	0	3	19	38	40
D8	35	4.37	0.73	0	3	6	43	48
13-17								
D1	38	4.11	0.76	0	3	16	50	31
D2	38	4.45	0.69	0	0	11	34	55
D3	38	3.87	0.70	0	3	24	58	15
D4	38	4.00	0.90	0	5	24	37	34
D5	38	4.42	0.68	0	0	11	37	52
D6	38	4.34	0.75	0	3	8	42	47
D7	38	4.26	0.60	0	0	8	58	34
D8	38	4.26	0.72	0	0	16	42	42

(Appendix continues)

Appendix 7-H (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Age (years)				
18-25								
D1	44	3.91	0.77	0	5	20	55	20
D2	44	3.98	0.93	0	11	9	50	30
D3	44	3.75	0.78	0	5	32	48	15
D4	44	3.91	0.74	0	5	18	59	18
D5	44	3.84	0.99	0	11	23	36	30
D6	44	3.70	1.00	0	14	27	34	25
D7	44	3.95	0.83	0	7	16	52	25
D8	43	4.00	0.85	0	7	14	51	28
26-35								
D1	81	4.06	0.80	1	4	10	58	27
D2	81	4.21	0.72	1	1	6	58	34
D3	81	3.81	0.71	1	3	21	64	11
D4	81	3.80	0.75	0	5	25	56	14
D5	81	4.01	0.94	1	7	14	45	33
D6	81	3.80	1.01	3	10	17	46	24
D7	81	4.01	0.86	1	6	10	56	27
D8	81	3.94	0.83	1	7	7	65	20
36-45								
D1	150	3.98	0.81	1	2	20	51	26
D2	150	4.19	0.70	1	1	9	57	32
D3	150	3.72	0.76	1	5	29	54	11
D4	150	3.82	0.76	1	3	27	53	16
D5	149	3.85	0.92	1	9	18	48	24
D6	149	3.79	0.90	1	8	25	45	21
D7	149	3.96	0.88	1	4	24	43	28
D8	149	4.01	0.76	1	2	14	59	24
46-55								
D1	37	4.14	0.63	0	3	5	68	24
D2	37	4.27	0.61	0	0	8	57	35
D3	37	3.62	0.92	3	8	27	49	13
D4	37	3.97	0.76	0	5	14	59	22
D5	37	4.05	0.78	3	0	11	62	24
D6	37	3.84	0.87	3	5	14	62	16
D7	37	4.19	0.81	3	0	8	54	35
D8	37	4.19	0.84	3	0	8	58	31
56^{+}								
D1	32	4.22	0.75	0	0	18	41	41
D2	32	4.25	0.80	0	3	12	41	44
D3	31	3.84	0.82	0	10	13	61	16
D4	31	3.94	0.85	0	10	10	58	22
D5	32	4.22	0.79	0	3	13	44	40
D6	33	4.00	0.71	0	3	15	61	21
D7	32	4.22	0.79	0	3	13	44	40
D8	33	4.18	0.73	0	3	9	55	33
				Education level				
Primary								
D1	52	4.17	0.71	0	0	17	48	35
D2	52	4.38	0.75	0	2	10	37	51
D3	51	4.04	0.87	2	2	18	47	31
D4	51	3.98	0.91	2	4	18	47	29
D5	51	4.14	0.87	2	2	14	45	37

(Appendix continues)

Appendix 7-H (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Education level				
Primary								
D6	52	4.15	0.70	0	0	17	50	33
D7	51	4.16	0.76	0	2	16	47	35
D8	50	4.20	0.73	0	2	12	50	36
Secondary								
D1	214	4.10	0.77	1	3	14	53	29
D2	214	4.32	0.67	1	1	5	52	41
D3	214	3.86	0.71	1	3	22	59	15
D4	214	3.94	0.80	1	4	21	51	23
D5	214	4.16	0.82	1	4	11	47	37
D6	214	3.98	0.90	1	7	15	48	29
D7	214	4.14	0.77	1	2	14	50	33
D8	214	4.16	0.73	1	2	10	55	32
TAFE / Polytechnic								
D1	41	4.05	0.80	3	3	7	63	24
D2	41	4.07	0.69	0	2	12	61	25
D3	41	3.80	0.68	0	5	20	66	9
D4	41	3.85	0.69	0	5	17	66	12
D5	41	4.05	0.86	0	7	12	49	32
D6	41	3.88	0.93	0	10	19	44	27
D7	41	4.20	0.60	0	0	10	61	29
D8	41	4.07	0.69	0	2	10	70	18
University								
D1	112	3.94	0.80	1	3	21	52	23
D2	112	4.05	0.84	1	5	13	51	30
D3	112	3.57	0.87	2	9	30	48	11
D4	112	3.71	0.74	0	5	30	54	11
D5	112	3.65	1.00	2	13	25	40	20
D6	112	3.59	0.94	2	11	29	43	15
D7	112	3.80	1.00	2	9	23	41	25
D8	111	3.86	0.92	3	6	14	55	22
				Sex				
Male								
D1	174	4.02	0.79	1	3	18	51	27
D2	174	4.22	0.75	0	3	11	48	38
D3	173	3.77	0.82	1	6	23	55	15
D4	173	3.77	0.81	0	7	26	50	17
D5	172	3.88	0.97	1	11	14	47	27
D6	173	3.75	0.97	1	13	17	47	22
D7	172	3.98	0.87	1	7	14	50	28
D8	171	4.09	0.75	1	3	10	58	28
Female								
D1	245	4.09	0.76	1	2	14	54	29
D2	245	4.24	0.73	1	2	6	53	38
D3	245	3.82	0.76	1	4	24	56	15
D4	245	3.95	0.77	1	2	20	54	23
D5	246	4.10	0.84	1	3	16	44	36
D6	246	3.98	0.85	1	4	21	45	29
D7	246	4.11	0.81	1	2	17	47	33
D8	245	4.07	0.81	1	3	12	55	29

Appendix 7-J

Number of Responses, Means, Standard Deviations and Percentage Responses by Demographic Subgroups for the PVOI Section F: For Parents in a Family Group

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Centre				
Centre B								
F1	111	4.72	0.45	0	0	0	28	72
F2	111	4.68	0.49	0	0	1	31	68
F3	112	4.51	0.59	0	0	5	40	55
F4	111	4.27	0.69	1	1	5	56	37
F5	112	4.06	0.85	3	3	9	57	28
F6	112	4.07	0.76	1	1	17	53	28
F7	111	4.05	0.85	1	4	17	47	31
F8	111	4.33	0.69	1	1	5	51	42
F9	111	4.64	0.55	0	1	1	32	66
F10	111	4.56	0.66	0	2	4	32	62
F11	111	2.94	1.30	13	34	14	24	15
F12	111	4.20	0.76	0	4	10	49	37
F13	111	2.85	1.32	16	31	21	17	15
Centre D								
F1	53	4.58	0.50	0	0	0	42	58
F2	53	4.60	0.49	0	0	0	40	60
F3	52	4.48	0.58	0	0	4	44	52
F4	53	4.30	0.57	0	0	6	59	35
F5	52	4.25	0.79	0	6	4	50	40
F6	52	4.15	0.80	0	4	14	46	36
F7	53	3.98	0.93	0	11	9	49	31
F8	53	4.42	0.57	0	0	4	51	45
F9	53	4.45	0.50	0	0	0	55	45
F10	53	4.47	0.50	0	0	0	53	47
F11	52	2.27	1.05	19	56	8	13	4
F12	52	3.87	1.01	0	8	35	21	36
F13	52	3.04	1.33	9	39	8	27	17
Centre E								
F1	95	4.64	0.48	0	0	0	36	64
F2	95	4.62	0.49	0	0	0	38	62
F3	95	4.58	0.52	0	0	1	40	59
F4	95	4.41	0.57	0	0	4	51	45
F5	95	4.23	0.82	0	2	18	34	45
F6	95	4.08	0.90	2	1	20	40	37
F7	95	4.14	0.79	0	3	16	45	36
F8	95	4.46	0.60	0	0	5	43	52
F9	95	4.69	0.51	0	0	2	26	72
F10	95	4.65	0.52	0	0	2	31	67
F11	95	2.86	1.22	13	34	18	26	9
F12	95	4.26	0.75	0	2	12	44	42
F13	95	2.99	1.14	10	25	34	20	11
				Age (years)				
18-25								
F1	6	4.33	0.52	0	0	0	67	33
F2	6	4.33	0.52	0	0	0	67	33
F3	6	4.33	0.82	0	0	17	33	50

Appendix 7-J (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Age (years)				
18-25								
F4	6	4.00	0.89	0	0	34	33	33
F5	6	3.67	0.82	0	0	50	33	17
F6	6	4.17	0.75	0	0	17	50	33
F7	6	4.00	0.89	0	0	34	33	33
F8	6	4.17	0.75	0	0	17	50	33
F9	6	4.33	0.82	0	0	17	33	50
F10	6	4.33	0.52	0	0	0	67	33
F11	6	3.50	1.38	0	33	17	17	33
F12	6	4.33	0.52	0	0	0	67	33
F13	6	2.83	0.75	0	33	50	17	0
26-35								
F1	64	4.69	0.47	0	0	0	31	69
F2	64	4.67	0.47	0	0	0	33	67
F3	65	4.55	0.56	0	0	3	39	58
F4	65	4.31	0.75	2	2	3	52	41
F5	65	4.17	0.84	3	0	9	52	36
F6	65	4.02	0.89	3	0	20	46	31
F7	65	4.09	0.84	2	3	12	51	32
F8	65	4.32	0.71	2	0	5	52	41
F9	65	4.62	0.60	0	2	2	30	66
F10	65	4.58	0.63	0	2	3	31	64
F11	65	3.02	1.41	20	22	11	32	15
F12	65	4.25	0.81	0	3	14	38	45
F13	65	3.06	1.29	14	23	20	29	14
36-45								
F1	142	4.70	0.46	0	0	0	30	70
F2	142	4.68	0.48	0	0	1	30	69
F3	142	4.54	0.57	0	0	4	39	57
F4	141	4.38	0.55	0	0	4	55	41
F5	142	4.20	0.77	1	3	9	51	36
F6	142	4.09	0.81	1	3	15	49	32
F7	142	4.03	0.87	0	7	15	46	32
F8	141	4.45	0.60	0	1	4	45	50
F9	141	4.67	0.47	0	0	0	33	67
F10	141	4.57	0.58	0	1	2	37	60
F11	141	2.63	1.17	14	44	15	19	8
F12	141	4.08	0.86	0	5	18	41	36
F13	141	2.87	1.26	12	36	21	16	15
46-55								
F1	23	4.65	0.49	0	0	0	35	65
F2	23	4.57	0.51	0	0	0	44	56
F3	23	4.52	0.51	0	0	0	48	52
F4	23	4.30	0.56	0	0	4	61	35
F5	23	4.17	0.89	0	4	17	35	44
F6	23	4.13	0.87	0	0	30	26	44
F7	23	4.26	0.75	0	0	17	39	44
F8	23	4.43	0.59	0	0	4	48	48
F9	23	4.52	0.59	0	0	4	39	57
F10	23	4.65	0.57	0	0	4	26	70
F11	23	2.87	1.36	14	39	13	17	17

(Appendix continues)

Appendix 7-J (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
46-55								
F12	23	4.30	0.82	0	4	9	39	48
F13	23	2.74	1.18	18	22	39	13	8
56^{+}								
F1	19	4.53	0.51	0	0	0	47	53
F2	19	4.47	0.51	0	0	0	53	47
F3	18	4.44	0.51	0	0	0	56	44
F4	19	4.32	0.58	0	0	5	58	37
F5	18	4.22	0.94	0	5	17	28	50
F6	18	4.28	0.67	0	0	11	50	39
F7	18	4.22	0.65	0	0	11	56	33
F8	19	4.42	0.51	0	0	0	58	42
F9	19	4.58	0.51	0	0	0	42	58
F10	19	4.68	0.48	0	0	0	32	68
F11	18	2.89	0.96	6	33	28	33	0
F12	18	4.28	0.57	0	0	6	61	33
F13	18	3.44	1.29	6	22	22	22	28
			Education level					
Primary								
F1	11	4.73	0.47	0	0	0	27	73
F2	11	4.45	0.69	0	0	9	36	55
F3	10	4.40	0.70	0	0	10	40	50
F4	11	4.18	0.75	0	0	18	46	36
F5	10	3.70	1.06	0	20	10	50	20
F6	10	4.10	0.32	0	0	0	90	10
F7	11	3.82	0.60	0	0	27	64	9
F8	11	4.00	0.63	0	0	18	64	18
F9	11	4.36	0.50	0	0	0	64	36
F10	11	4.36	0.50	0	0	0	64	36
F11	10	2.50	0.85	0	70	10	20	0
F12	10	4.10	0.88	0	0	30	30	40
F13	10	3.20	1.14	0	40	10	40	10
Secondary								
F1	139	4.69	0.46	0	0	0	31	69
F2	139	4.68	0.47	0	0	0	32	68
F3	140	4.56	0.54	0	0	2	40	58
F4	140	4.36	0.64	1	1	2	55	41
F5	140	4.20	0.84	1	3	10	46	40
F6	140	4.21	0.73	1	0	14	48	37
F7	140	4.13	0.88	1	6	11	44	38
F8	139	4.40	0.62	1	0	3	52	44
F9	139	4.59	0.56	0	1	1	36	62
F10	139	4.59	0.59	0	1	3	33	63
F11	139	2.85	1.27	13	38	14	22	13
F12	139	4.17	0.85	0	5	14	41	40
F13	139	3.00	1.27	12	30	20	23	15
TAFE / Polytechnic								
F1	28	4.50	0.51	0	0	0	50	50
F2	28	4.57	0.50	0	0	0	43	57
F3	28	4.54	0.58	0	0	4	39	57
F4	28	4.21	0.69	0	0	14	50	36

(Appendix continues)

Appendix 7-J (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Education level				
TAFE / Polytechnic								
F5	28	4.18	0.67	0	0	14	54	32
F6	28	4.00	0.67	0	0	21	57	22
F7	28	3.96	0.64	0	0	21	61	18
F8	28	4.25	0.70	0	0	14	47	39
F9	28	4.54	0.51	0	0	0	46	54
F10	28	4.43	0.57	0	0	4	50	46
F11	28	2.75	1.17	14	32	25	22	7
F12	28	4.25	0.60	0	0	7	57	36
F13	28	2.68	1.25	21	21	36	11	11
University								
F1	81	4.67	0.47	0	0	0	33	67
F2	81	4.63	0.49	0	0	0	37	63
F3	81	4.49	0.57	0	0	4	43	53
F4	81	4.34	0.57	0	0	5	56	39
F5	81	4.15	0.82	1	3	12	48	36
F6	81	3.91	1.00	3	5	25	34	33
F7	81	4.03	0.87	0	6	17	44	33
F8	81	4.51	0.61	0	1	3	41	55
F9	81	4.74	0.47	0	0	1	24	75
F10	81	4.63	0.58	0	1	1	31	67
F11	81	2.69	1.26	17	38	11	25	9
F12	81	4.10	0.85	0	4	20	39	37
F13	81	2.89	1.25	12	32	25	16	15
				Sex				
Male								
F1	98	4.53	0.50	0	0	0	47	53
F2	98	4.51	0.50	0	0	0	49	51
F3	98	4.43	0.57	0	0	4	49	47
F4	98	4.22	0.63	0	1	8	58	33
F5	98	4.00	0.91	1	6	16	45	32
F6	98	3.94	0.81	0	4	24	47	25
F7	99	3.86	0.82	0	7	20	53	20
F8	99	4.25	0.63	0	1	7	58	34
F9	99	4.55	0.56	0	0	3	39	58
F10	99	4.45	0.63	0	1	4	43	52
F11	98	2.60	1.16	14	44	16	19	7
F12	98	3.97	0.84	0	7	15	51	27
F13	98	2.80	1.14	12	32	29	19	8
Female								
F1	161	4.75	0.44	0	0	0	26	74
F2	161	4.72	0.46	0	0	1	26	73
F3	161	4.59	0.54	0	0	3	36	61
F4	161	4.39	0.61	1	0	3	52	44
F5	161	4.26	0.76	1	1	8	49	41
F6	161	4.19	0.81	2	0	14	46	38
F7	160	4.19	0.84	1	4	12	43	40
F8	160	4.49	0.62	1	0	3	42	54
F9	160	4.67	0.51	0	1	0	31	68
F10	160	4.65	0.54	0	1	1	31	67
F11	160	2.88	1.29	14	35	13	26	12
F12	160	4.27	0.79	0	2	16	36	46

F13	160	3.03	1.32	13	29	19	21	18

Appendix 7-K

Number of Responses, Means, Standard Deviations and Percentage Responses by Demographic Subgroups for the PVOI Section G: For School Students

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Centre				
Centre B								
G1	41	3.98	0.88	0	7	17	46	30
G2	41	3.80	0.95	0	15	12	51	22
G3	41	4.12	0.68	0	2	10	61	27
G4	39	3.18	1.02	5	15	49	18	13
G5	40	3.10	1.24	8	30	25	20	17
G6	41	3.00	0.95	5	22	49	17	7
Centre D								
G1	30	3.80	0.92	3	3	23	51	20
G2	30	3.70	1.18	7	7	26	30	30
G3	30	4.20	0.66	0	0	13	53	34
G4	29	3.00	1.07	10	14	52	14	10
G5	30	3.03	1.33	13	27	20	23	17
G6	30	2.07	0.98	37	27	30	6	0
Centre E								
G1	22	3.82	0.91	0	5	36	32	27
G2	22	3.86	0.99	0	5	41	18	36
G3	23	4.22	0.60	0	0	9	61	30
G4	22	3.32	0.95	5	5	59	18	13
G5	23	3.61	1.08	0	13	44	13	30
G6	23	2.96	1.07	13	13	44	26	4
				Age (years)				
11-12								
G1	33	4.12	0.99	3	3	15	36	43
G2	33	3.91	1.16	6	3	24	27	39
G3	33	4.33	0.60	0	0	6	55	40
G4	31	3.19	0.98	10	0	61	19	10
G5	32	3.62	1.24	6	9	34	16	35
G6	33	2.55	1.12	24	18	40	15	3
13-17								
G1	33	3.82	0.85	0	3	36	36	25
G2	33	3.82	1.01	0	12	24	33	31
G3	34	4.21	0.59	0	0	9	62	29
G4	33	3.30	1.07	3	18	43	18	18
G5	34	3.24	1.23	3	35	18	24	20
G6	34	2.91	1.11	9	29	32	21	9
18-25								
G1	5	3.20	0.84	0	20	40	40	0
G2	5	3.40	0.55	0	0	60	40	0
G3	5	4.00	0.71	0	0	20	60	20
G4	5	2.80	0.45	0	20	80	0	0
G5	5	3.00	0.71	0	20	60	20	0
G6	5	3.00	0.71	0	20	60	20	0
No details supplied								
G1	21	3.76	0.77	0	10	14	66	10
G2	21	3.62	0.97	0	19	14	53	14
G3	21	3.95	0.74	0	5	14	62	19

(Appendix continues)

Appendix 7-K (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Age (years)				
No details supplied								
G4	20	2.90	1.07	10	20	50	10	10
G5	21	2.57	1.16	19	33	24	19	5
G6	21	2.57	0.93	19	14	57	10	0
				Education level				
Primary								
G1	39	4.00	0.97	3	3	24	35	35
G2	39	3.85	1.09	5	3	28	31	33
G3	39	4.26	0.59	0	0	8	59	33
G4	38	3.16	0.95	8	5	58	21	8
G5	38	3.50	1.22	5	16	32	18	29
G6	39	2.62	1.07	21	18	43	15	3
Secondary								
G1	31	3.90	0.83	0	3	29	42	26
G2	31	3.87	1.02	0	13	19	36	32
G3	32	4.25	0.62	0	0	9	56	35
G4	30	3.37	1.07	3	13	47	17	20
G5	32	3.31	1.20	3	28	25	22	22
G6	32	2.81	1.18	13	31	28	19	9
No details supplied								
G1	21	3.76	0.77	0	10	14	67	9
G2	21	3.62	0.97	0	19	14	53	14
G3	21	3.95	0.74	0	5	14	62	19
G4	20	2.90	1.07	10	20	50	10	10
G5	21	2.57	1.16	19	33	24	19	5
G6	21	2.57	0.93	19	14	57	10	0
				Sex				
Male								
G1	42	4.19	0.80	0	2	17	41	41
G2	42	4.07	0.87	0	2	26	33	38
G3	42	4.21	0.65	0	0	12	55	33
G4	40	3.50	0.88	0	8	53	22	17
G5	41	3.59	1.12	0	20	32	19	29
G6	42	2.67	1.03	17	21	43	17	2
Female								
G1	30	3.53	0.97	3	7	40	33	17
G2	30	3.50	1.20	7	13	27	30	23
G3	31	4.26	0.58	0	0	7	61	32
G4	30	2.87	1.04	13	13	53	13	7
G5	31	3.13	1.28	10	26	26	19	19
G6	31	2.81	1.22	16	26	29	19	10
				Sex				
No details supplied								
G1	21	3.76	0.77	0	10	14	67	9
G2	21	3.62	0.97	0	19	14	52	14
G3	21	3.95	0.74	0	5	14	62	19
G4	20	2.90	1.07	10	20	50	10	10
G5	21	2.57	1.16	19	33	24	19	5
G6	21	2.57	0.93	19	14	57	10	0

Appendix 7-L

Number of Responses, Means, Standard Deviations and Percentage Responses by Demographic Subgroups for the PVOI Section H: For Teachers

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Centre				
Centre B								
H1	6	3.33	0.97	17	0	33	33	17
H2	6	4.17	1.00	0	0	0	83	17
H3	6	4.33	0.93	0	0	0	67	33
H4	6	3.83	0.67	0	0	17	83	0
H5	6	3.67	1.06	0	17	17	50	17
H6	6	3.83	1.00	0	0	17	83	0
H7	6	4.00	0.78	0	0	17	66	17
H8	5	4.40	1.31	0	0	0	60	40
Centre D								
H1	9	2.78	0.88	0	56	11	33	0
H2	9	3.00	0.83	0	44	12	44	0
H3	9	2.89	0.99	0	44	22	33	0
H4	9	2.78	0.93	0	33	56	11	0
H5	8	3.38	0.87	0	25	25	38	12
H6	9	3.33	1.32	0	22	33	33	11
H7	9	3.11	0.53	0	22	44	33	0
H8	8	3.50	0.65	13	13	0	62	12
Centre E								
H1	9	3.56	0.88	0	11	33	44	11
H2	9	3.22	0.83	0	22	33	44	0
H3	8	2.87	0.99	13	13	50	25	0
H4	8	3.00	0.93	13	0	63	25	0
H5	9	3.33	0.87	0	11	56	22	11
H6	9	3.00	1.32	22	11	11	56	0
H7	9	3.44	0.53	0	0	56	44	0
H8	9	4.45	0.69	0	0	9	36	54
				Age (years)				
18-25								
H1	2	2.50	0.71	0	50	50	0	0
H2	2	2.00	0.00	0	100	0	0	0
H3	2	2.50	0.71	0	50	50	0	0
H4	2	3.00	0.00	0	0	100	0	0
H5	2	3.00	0.00	0	0	100	0	0
H6	2	3.00	1.41	0	50	0	50	0
H7	2	3.00	0.00	0	0	100	0	0
H8	2	4.50	0.71	0	0	0	50	50
26-35								
H1	7	3.43	1.27	14	0	29	43	14
H2	7	4.00	0.58	0	0	14	71	14
H3	6	3.67	1.37	17	0	0	67	17
H4	7	3.43	1.13	14	0	14	71	0
H5	7	3.57	0.98	0	14	29	43	14
H6	7	3.43	1.13	14	0	14	71	0
H7	6	4.17	0.41	0	0	0	83	17
H8	6	4.33	0.52	0	0	0	67	33

(Appendix continues)

Appendix 7-L (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Age (years)				
36-45								
H1	10	3.00	0.94	0	40	20	40	0
H2	10	3.10	0.88	0	30	30	40	0
H3	10	3.20	1.03	0	30	30	30	10
H4	10	3.10	0.74	0	20	50	30	0
H5	10	3.00	0.82	0	30	40	30	0
H6	10	3.40	0.70	0	10	40	50	0
H7	10	3.10	0.57	0	10	70	20	0
H8	10	3.90	1.20	10	0	10	50	30
46-55								
H1	5	3.60	1.14	0	20	20	40	20
H2	5	3.60	0.89	0	20	0	80	0
H3	5	3.20	0.84	0	20	40	40	0
H4	4	2.75	0.50	0	25	75	0	0
H5	4	4.50	0.58	0	0	0	50	50
H6	5	3.20	1.64	20	20	0	40	20
H7	5	3.40	0.89	0	20	20	60	0
H8	5	4.00	1.22	0	20	0	40	40
				Education level				
Secondary								
H1	4	2.50	1.29	25	25	25	25	0
H2	4	3.50	0.58	0	0	50	50	0
H3	4	3.50	0.58	0	0	50	50	0
H4	4	3.50	0.58	0	0	50	50	0
H5	4	3.00	0.82	0	25	50	25	0
H6	4	4.00	0.00	0	0	0	100	0
H7	4	3.75	0.50	0	0	25	75	0
H8	3	3.33	2.08	33	0	0	33	33
University								
H1	20	3.35	0.99	0	25	25	40	10
H2	20	3.35	0.99	0	30	10	55	5
H3	19	3.21	1.13	5	26	21	37	11
H4	19	3.05	0.85	5	16	47	32	0
H5	19	3.53	0.96	0	16	32	37	15
H6	20	3.20	1.11	10	15	25	45	5
H7	20	3.40	0.75	0	10	45	40	5
H8	21	4.24	0.77	0	5	5	52	38
				Sex				
Male								
H1	9	3.00	1.32	11	33	11	33	11
H2	9	3.33	1.00	0	33	0	67	0
H3	9	3.22	0.97	0	33	11	56	0
H4	8	3.13	0.83	0	25	38	38	0
H5	9	3.44	1.24	0	33	11	33	22
H6	9	3.11	1.05	11	11	33	44	0
H7	9	3.22	0.67	0	11	56	33	0
H8	9	4.14	0.38	0	0	0	86	14
Female								
H1	15	3.33	0.90	0	20	33	40	7
H2	15	3.40	0.91	0	20	27	46	7

(Appendix continues)

Appendix 7-L (Continued)

Item	*n*	*M*	*SD*	SD	D	U	A	SA
				Sex				
Female								
H3	14	3.29	1.14	7	14	36	28	14
H4	15	3.13	0.83	7	7	53	33	0
H5	14	3.43	0.76	0	7	50	36	7
H6	15	3.47	1.06	7	13	13	60	7
H7	15	3.60	0.74	0	7	33	53	7
H8	15	4.12	1.17	6	6	6	35	47

Appendix 7-M

The Final Profile of Visit Outcomes Instrument

***P**rofile*
of
***V**isit*
***O**utcomes*
***I**nstrument*

We need your help to understand how well we at the **Centre** present science and technology experiences to our visitors. This questionnaire was developed using comments made by visitors soon after their visit.

All the questions relate to **your** recent visit.

Please complete every section which applies to you. There are special sections for *parents* [Section F], *school students* [Section G] and *teachers* [Section H]. Everyone should complete **all** the other sections.

(Appendix continues)

Most sections ask you to tick a box to show how much you agree with each visitor comment.

Example Only

Your visit to the centre.

	SA	A	U	D	SD
It was a very enjoyable experience.	☐	☐	☐	☐	☐

Tick the box:

SA	if you strongly agree
A	if you agree
U	if you can't decide whether you agree or disagree
D	if you disagree
SD	if you strongly disagree

For <u>all items in every Section</u> (unless directed otherwise) **please tick the box that best indicates your position about each statement.**

Section A

Your overall impression of your visit.

		SA	A	U	D	SD
1.	It is a good place for a family outing.	☐	☐	☐	☐	☐
2.	I intend to return.	☐	☐	☐	☐	☐
3.	I would recommend it as a place to visit.	☐	☐	☐	☐	☐
4.	Children are free to explore without being told "don't touch."	☐	☐	☐	☐	☐
5.	There was something to learn for all age groups.	☐	☐	☐	☐	☐
6.	The visit was "good value for money."	☐	☐	☐	☐	☐

(Appendix continues)

Appendix 7-M (Continued)

Section B

Your own learning and understanding as a result of your visit.

		SA	A	U	D	SD
1.	The "hands-on" activities helped me to remember scientific concepts after my visit.	☐	☐	☐	☐	☐
2.	I now know how some things work that I didn't understand before.	☐	☐	☐	☐	☐
3.	The element of discovery helped me learn.	☐	☐	☐	☐	☐
4.	I was challenged to think about "why" some things happened.	☐	☐	☐	☐	☐
5.	Learning was easy.	☐	☐	☐	☐	☐
6.	It was easy to understand because things were explained in everyday language.	☐	☐	☐	☐	☐
7.	I now think about scientific things more.	☐	☐	☐	☐	☐
8.	I learned that science is not always predictable.	☐	☐	☐	☐	☐
9.	I was able to relate scientific concepts to my everyday life.	☐	☐	☐	☐	☐
10.	I learned something new about myself.	☐	☐	☐	☐	☐
11.	I learned something new about the world around me.	☐	☐	☐	☐	☐

(Appendix continues)

Section C

Your thoughts and feelings as a result of your visit.

		SA	A	U	D	SD
1.	My interest in science and technology has been reinforced.	☐	☐	☐	☐	☐
2.	I am amazed by science and technology.	☐	☐	☐	☐	☐
3.	The unexpected results of some of the activities made them exciting.	☐	☐	☐	☐	☐
4.	I enjoyed finding out how and why some things work.	☐	☐	☐	☐	☐
5.	I would have been more interested in science if I had visited a place like this when I was a child.	☐	☐	☐	☐	☐
6.	At the centre scientific concepts are made understandable for people of all ages.	☐	☐	☐	☐	☐

If you were **confident about science and technology before your visit** to the centre please go straight to **Section D**. **Otherwise**, please complete the rest of **Section C** below.

Section C (Continued)

Your thoughts and feelings as a result of your visit.

		SA	A	U	D	SD
7.	I think that science and technology are within my capability.	☐	☐	☐	☐	☐
8.	I am not intimidated by science and technology.	☐	☐	☐	☐	☐
9.	I am not bored by science and technology	☐	☐	☐	☐	☐

(Appendix continues)

If you had very positive views about science and technology before your visit please skip Section D and go straight to Section E.

Section D

Your views about science and technology as a consequence of your visit.

		SA	A	U	D	SD
1.	I now realise how important science and technology are for my everyday life.	☐	☐	☐	☐	☐
2.	I now realise how much science influences modern technology.	☐	☐	☐	☐	☐
3.	I now have a better appreciation of the laws of nature.	☐	☐	☐	☐	☐
4.	I now have a better appreciation of some things that I have taken for granted.	☐	☐	☐	☐	☐
5.	I am now more aware of how fast science and technology change.	☐	☐	☐	☐	☐
6.	I am now more aware of advances in modern technology	☐	☐	☐	☐	☐
7.	I now realise there is a need to keep up with changes in current technology.	☐	☐	☐	☐	☐
8.	I appreciate that living standards can be improved through technology.	☐	☐	☐	☐	☐

(Appendix continues)

Section E

What did you do as a result of your visit?

Please indicate anything you have done by placing a tick in the appropriate box.

1. Bought a piece of scientific equipment. ☐
2. Bought a kit that demonstrates scientific principles. ☐
3. Bought a toy that clearly shows a scientific principle. ☐
4. Read an article about a scientific principle which was demonstrated by an exhibit. ☐
5. Watched more TV programs related to science. ☐
6. Read more science-related articles in newspapers or magazines. ☐
7. Suggested to other people that they visit the science centre. ☐
8. Conducted an experiment at home. ☐
9. Built something based on an idea I got from an exhibit. ☐
10. Changed my lifestyle. ☐
11. Started a new hobby. ☐
12. Started an exercise program. ☐
13. Became more energy conscious in my home. ☐
14. Influenced my decisions at work. ☐
15. Talked about my visit to people **other** than those who visited with me. ☐
16. If you answered **yes** to any of the above, would you please give details of what you did in the following space.
17. If there is anything else you have done that is a direct result of your visit, would you please give details in the space below.

(Appendix continues)

Section F

For parents in a family group.

		SA	A	U	D	SD
1.	Watching my children enjoy themselves was a joy to me	☐	☐	☐	☐	☐
2.	Being able to watch my children actively engaged with the exhibits was a pleasure to me.	☐	☐	☐	☐	☐
3.	It was a challenging and stimulating experience for my children.	☐	☐	☐	☐	☐
4.	It gave me an opportunity to discuss the displays with my children.	☐	☐	☐	☐	☐
5.	My children asked me questions about the exhibits.	☐	☐	☐	☐	☐
6.	I now encourage my children to question and find out things.	☐	☐	☐	☐	☐
7.	We talk as a family about what we did on our visit.	☐	☐	☐	☐	☐
8.	I believe my children learned something from their visit.	☐	☐	☐	☐	☐
9.	The fun aspect of a visit is an attraction for my children.	☐	☐	☐	☐	☐
10.	The way the centre presents science and technology has educational value for my children.	☐	☐	☐	☐	☐
11.	I was looking after my children so I didn't learn as much as I would have liked.	☐	☐	☐	☐	☐
12.	I look forward to a return visit as much as my children.	☐	☐	☐	☐	☐
13.	I would enjoy a visit without my children so I could be more free to experience the exhibits as I wish.	☐	☐	☐	☐	☐

(Appendix continues)

Section G

For school students.

As a result of my experiences during my visit to the science centre,

		SA	A	U	D	SD
1.	I understand more about my science lessons.	☐	☐	☐	☐	☐
2.	I have more interest in science lessons at school.	☐	☐	☐	☐	☐
3.	I have a greater awareness of some scientific ideas.	☐	☐	☐	☐	☐
4.	My grades in science have improved.	☐	☐	☐	☐	☐
5.	I was able to use some information for a school project.	☐	☐	☐	☐	☐
6.	I am considering a career in science or technology.	☐	☐	☐	☐	☐

7. If you tried an activity based on something you saw, please describe it in the space below.

8. If you have purchased a scientific game or experiment kit, please describe the game or kit in the space below.

9. Is there any other comment you can make about your school science classes after your visit to our science centre?

(Appendix continues)

Appendix 7-M (Continued)

Section H

For primary school teachers.

Please complete this section only if you have made any change, or intend to make any change, in your teaching as a result of your visit to the science centre.

		SA	A	U	D	SD
1.	I have used some ideas that I got from exhibits in my lessons.	☐	☐	☐	☐	☐
2.	I intend to make changes in my teaching program based on ideas from exhibits.	☐	☐	☐	☐	☐
3.	I include more "hands-on" activities in my science lessons.	☐	☐	☐	☐	☐
4.	I include more "hands-on" activities in lessons other than science.	☐	☐	☐	☐	☐
5.	I decided to try out new strategies in my classroom teaching.	☐	☐	☐	☐	☐
6.	I explain scientific concepts by using every-day examples.	☐	☐	☐	☐	☐
7.	I feel more confident about teaching science.	☐	☐	☐	☐	☐
8.	I have decided that my class would benefit from a visit to the science centre.	☐	☐	☐	☐	☐

9. Are there any other comments you can make about your teaching as a result of your visit to the science centre?

(Appendix continues)

Section I

Are there any other comments you would like to make about your visit to our science centre?

Section J

Respondent details

We would like to know some details about yourself so the data can be analysed. All information provided is strictly confidential.

- **Gender** (Please circle) Male Female
- **Age** (Please circle) 11-12 13-17 18-25 26-35 36-45 46-55 56+
- What is your **highest** level of education in **science**? (Please circle)

  None Primary School Secondary School TAFE University

- **I visited** (Please circle)

  by myself with my family with my friends with my family and friends

Thank you very much for your assistance!

Appendix 7-N

Letter to Potential Reviewers of the Final PVOI

7 March 1996

Dear

I am seeking your assistance with my research again. Last year you completed a questionnaire (the PVOI) following a visit to *Scitech* and you also added some constructive comment about the questionnaire. The comments of yourself and others have been taken into account and accordingly changes have been made to the questionnaire.

If you would be prepared to again assist by commenting on the amended questionnaire, please return this letter in attached reply paid envelope.

I thank you in anticipation of your further help.

Yours sincerely

David Johnston
Researcher
Curtin University of Technology
ph 3898437

Appendix 7-O

Number of Respondents, Means and Standard Deviations for Age x Sex Groupings the PVOI Section A: Your Overall Impression of Your Visit

		Age Group								
		School-age			Young Adult			Older Adult		
Sex	Item	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Male	A1	45	4.51	.79	44	4.50	.51	86	4.48	.55
	A2	45	4.20	.87	44	4.27	.66	84	4.24	.82
	A3	45	4.69	.51	44	4.48	.59	85	4.65	.48
	A4	45	4.64	.61	44	4.61	.49	85	4.74	.44
	A5	45	4.58	.54	44	4.45	.63	84	4.58	.50
	A6	45	4.13	.79	44	4.14	.73	85	4.13	.83
Female	A1	30	4.33	.48	82	4.54	.57	138	4.64	.50
	A2	30	4.20	.92	82	4.37	.76	138	4.34	.81
	A3	30	4.60	.56	82	4.60	.65	138	4.64	.51
	A4	30	4.80	.55	82	4.77	.48	138	4.75	.51
	A5	30	4.53	.73	82	4.63	.53	138	4.64	.56
	A6	30	4.37	.67	82	4.18	.96	138	4.42	.71

Appendix 7-P

Number of Respondents, Means and Standard Deviations for Age x Sex Groupings for the PVOI Section B: Your Own Learning and Understanding of Your Visit

		Age Group								
		School-age			Young Adult			Older Adult		
Sex	Item	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Male	B1	45	4.09	.76	44	3.93	.50	86	4.02	.67
	B2	45	4.33	.74	44	3.68	.71	86	3.88	.83
	B3	45	4.22	.67	44	3.86	.77	86	3.91	.73
	B4	45	4.29	.63	44	3.80	.59	86	4.05	.73
	B5	45	4.38	.78	44	3.89	.69	85	3.89	.64
	B6	45	4.36	.65	44	4.09	.68	86	4.01	.69
	B7	45	3.82	1.01	44	2.91	.83	85	3.02	.90
	B8	45	4.31	.82	44	3.36	.72	86	3.50	.85
	B9	45	4.04	.85	44	3.59	.66	85	3.66	.78
	B10	45	3.53	1.08	44	3.18	.72	85	3.05	.99
	B11	45	4.29	.82	44	3.77	.64	86	3.78	.80
Female	B1	30	3.93	.83	82	4.12	.66	136	4.06	.66
	B2	30	4.07	.83	82	4.00	.67	136	4.09	.67
	B3	30	4.03	.76	82	4.13	.64	136	4.09	.61
	B4	30	4.07	.83	82	4.13	.64	137	4.03	.71
	B5	30	4.03	.96	82	4.16	.68	136	4.12	.50
	B6	30	3.93	.93	82	4.23	.61	137	4.26	.63
	B7	30	3.13	1.01	82	3.32	.86	136	3.31	.85
	B8	30	3.90	.84	82	3.73	.74	136	3.84	.72
	B9	30	3.47	.97	82	3.70	.83	137	3.60	.72
	B10	30	3.20	1.06	82	3.45	.97	135	3.41	.87
	B11	30	4.13	.86	82	4.10	.64	136	4.03	.69

Appendix 7-Q

Number of Respondents, Means and Standard Deviations for Age x Sex Groupings for the PVOI Section C: Your Thoughts and Feelings as a Result of Your Visit

		Age Group								
		School-age			Young Adult			Older Adult		
Sex	Item	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Male	C1	45	4.27	.72	44	3.73	.76	85	3.88	.75
	C2	45	4.40	.75	44	3.82	.92	85	4.01	.75
	C3	45	4.42	.81	44	3.82	.81	85	3.88	.75
	C4	45	4.04	.77	42	3.55	.89	86	3.48	.93
	C5	45	4.53	.59	44	4.23	.52	86	4.21	.62
	C6	45	3.93	.89	42	3.33	.98	84	3.42	.89
	C7	45	4.27	.81	42	3.57	.99	84	3.60	.92
	C8	42	4.31	.84	44	3.84	1.14	86	3.93	1.06
	C9	45	4.36	.80	44	4.00	.81	86	4.05	.87
Female	C1	30	3.50	1.01	82	3.85	.79	137	3.86	.73
	C2	30	4.03	.85	82	4.01	.79	136	3.98	.68
	C3	30	4.47	.57	82	4.06	.85	137	4.14	.63
	C4	30	3.77	.77	80	3.70	.82	134	3.81	.77
	C5	30	4.27	.87	82	4.34	.53	137	4.36	.51
	C6	30	3.63	.85	82	3.55	.93	130	3.53	.86
	C7	30	3.87	.97	82	3.67	.88	129	3.71	.87
	C8	29	3.66	1.01	82	4.22	.82	134	4.29	.88
	C9	30	4.13	.86	82	4.28	.79	138	4.30	.68

Appendix 7-R

Number of Respondents, Means and Standard Deviations for Age x Sex Groupings for the PVOI Section D: Your Views About Science and Technology as a Consequence of Your Visit

		Age Group								
		School-age			Young Adult			Older Adult		
Sex	Item	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Male	D1	45	4.27	.75	44	4.00	.72	85	3.91	.83
	D2	45	4.49	.73	44	4.07	.76	85	4.15	.73
	D3	45	4.09	.87	44	3.68	.67	84	3.64	.82
	D4	45	4.04	.85	44	3.50	.73	84	3.76	.79
	D5	45	4.36	.86	44	3.66	1.03	83	3.73	.93
	D6	45	4.38	.68	44	3.45	1.07	84	3.57	.91
	D7	45	4.33	.74	44	3.86	.85	83	3.86	.90
	D8	43	4.44	.70	44	3.86	.67	84	4.04	.77
Female	D1	30	4.10	.83	134	4.13	.74	245	4.09	.76
	D2	30	4.16	.83	134	4.25	.68	245	4.24	.73
	D3	30	3.85	.76	134	3.77	.78	245	3.82	.76
	D4	30	4.02	.69	134	3.93	.76	245	3.95	.77
	D5	30	4.11	.88	135	4.07	.84	246	4.10	.84
	D6	30	3.94	.93	135	3.99	.80	246	3.98	.85
	D7	30	4.06	.84	135	4.15	.82	246	4.11	.81
	D8	30	4.01	.91	135	4.09	.78	245	4.07	.81

Appendix 7-S

Number and Percentage of Respondents for Age x Sex Groupings for the PVOI Section E: What Did You Do as a Result of Your Visit?

		Age Group					
		School-age		Young Adult		Older Adult	
Sex	Item	*n*	%	*n*	%	*n*	%
Male	E1	48	31	44	5	83	8
	E2	48	23	44	0	83	7
	E3	48	35	44	9	83	10
	E4	48	33	44	16	83	8
	E5	48	38	44	27	83	27
	E6	48	27	44	16	83	17
	E7	48	79	44	80	83	78
	E8	48	40	44	14	83	7
	E9	48	13	44	0	83	2
	E10	48	15	44	0	83	0
	E11	48	17	44	7	83	0
	E12	48	13	44	7	83	6
	E13	48	33	44	23	83	16
	E14	48	13	44	9	83	5
	E15	48	75	44	82	83	80
Female	E1	29	7	84	6	137	12
	E2	29	7	84	4	137	9
	E3	29	17	84	16	137	21
	E4	29	24	84	12	137	17
	E5	29	28	84	24	137	35
	E6	29	21	84	24	137	20
	E7	29	72	84	82	137	81
	E8	29	17	84	16	137	11
	E9	29	7	84	5	137	1
	E10	29	7	84	4	137	2
	E11	29	17	84	0	137	2
	E12	29	17	84	8	137	9
	E13	29	31	84	21	137	17
	E14	29	7	84	8	137	4
	E15	29	79	84	76	137	84

Appendix 7-T

Number of Respondents, Means and Standard Deviations for Age x Sex Groupings for the PVOI Section F: For Parents in a Family Group

		Age Group					
		Young Adult			Older Adult		
Sex	Item	*n*	*M*	*SD*	*n*	*M*	*SD*
Male	F1	24	4.46	.51	70	4.56	.50
	F2	24	4.42	.50	70	4.54	.50
	F3	25	4.36	.57	69	4.45	.58
	F4	25	4.12	.67	69	4.29	.60
	F5	25	3.96	.68	69	4.06	.94
	F6	25	4.00	.71	69	3.90	.86
	F7	25	3.88	.67	70	3.86	.87
	F8	25	4.24	.52	70	4.29	.64
	F9	25	4.40	.65	70	4.60	.52
	F10	25	4.52	.51	70	4.44	.67
	F11	25	2.64	1.38	69	2.62	1.10
	F12	25	4.16	.80	69	3.91	.85
	F13	25	2.64	1.11	69	2.88	1.14
Female	F1	46	4.76	.43	114	4.75	.44
	F2	46	4.76	.43	114	4.71	.47
	F3	46	4.63	.57	114	4.58	.53
	F4	46	4.37	.80	114	4.40	.53
	F5	46	4.22	.92	114	4.28	.70
	F6	46	4.04	.97	114	4.25	.74
	F7	46	4.20	.91	113	4.21	.78
	F8	46	4.35	.79	113	4.55	.53
	F9	46	4.70	.59	113	4.66	.47
	F10	46	4.59	.69	113	4.68	.47
	F11	46	3.28	1.38	113	2.73	1.22
	F12	46	4.30	.79	113	4.26	.80
	F13	46	3.26	1.27	113	2.92	1.33

Note. Five respondents, four males and one female from the school-age group were omitted from the analysis.

Appendix 7-I

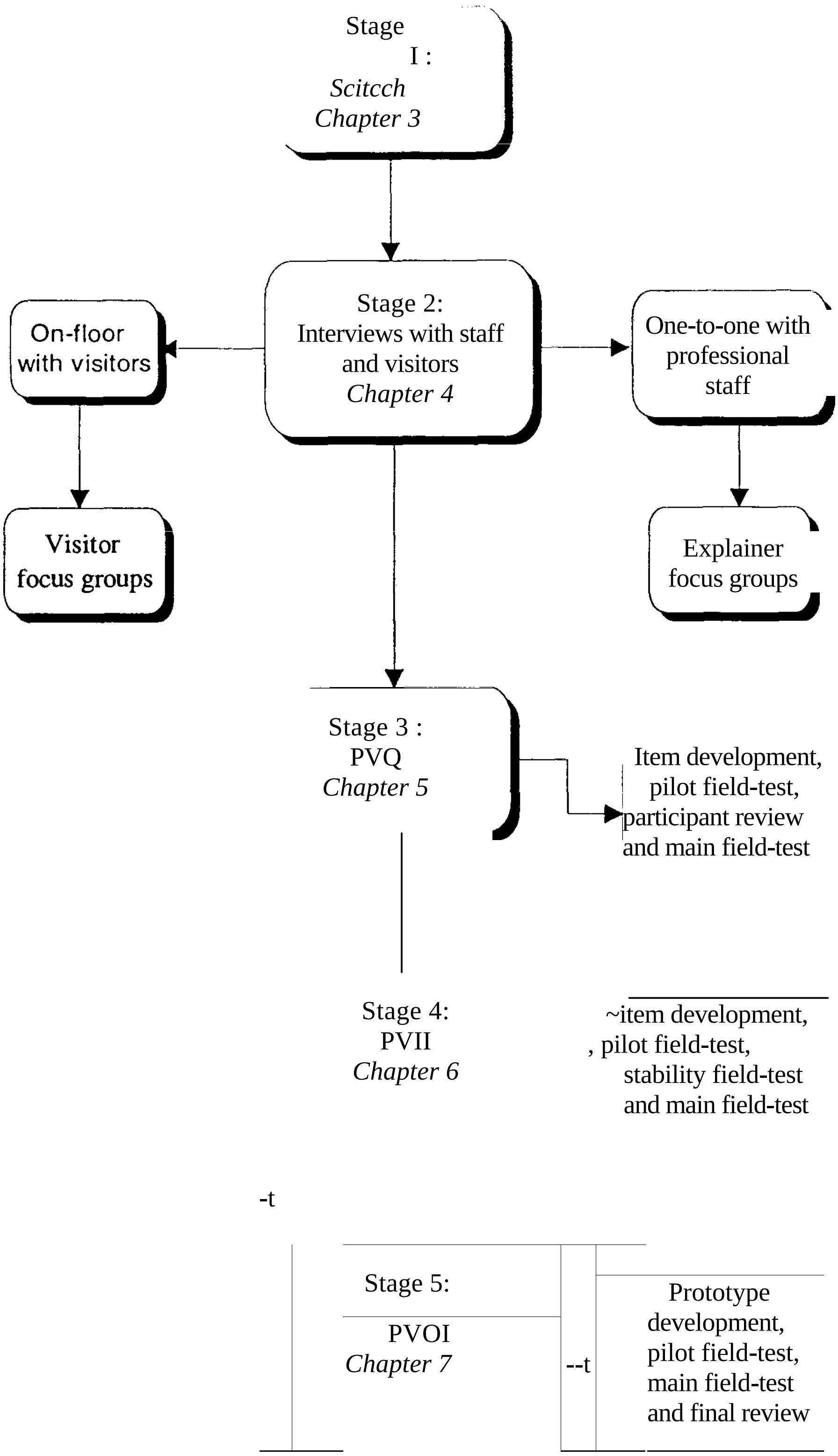
Number of Respondents and Percentage Responding Yes by Demographic Subgroups for the PVOI Section E: What Did You Do as a Result of Your Visit?

Demographic Subgroup	*n*	Item														
		E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15
Centre																
Centre B	152	15	12	20	18	40	23	80	14	3	53	5	13	30	5	78
Centre D	103	10	5	15	12	22	16	70	10	4	2	5	4	15	5	78
Centre E	170	9	7	18	18	27	21	85	19	4	2	4	8	17	10	83
Age (years)																
11-12	37	30	22	38	32	32	19	76	35	14	16	14	11	32	14	73
13-17	40	15	13	20	28	35	30	78	28	8	8	20	18	33	8	80
18-25	45	2	0	9	11	16	11	89	11	4	0	4	13	18	11	80
26-35	83	7	4	16	15	30	27	77	17	2	4	1	5	24	7	77
36-45	150	13	9	16	15	31	15	82	11	2	1	1	8	15	5	83
46-55	37	3	3	16	8	27	24	78	5	0	0	0	8	19	5	81
56^{+}	33	9	12	21	12	39	30	73	6	0	0	3	6	18	3	82
Education level																
Primary	52	17	17	25	23	39	25	73	31	10	12	12	12	29	10	73
Secondary	213	12	7	17	16	32	22	83	13	4	2	4	10	23	6	80
TAFE/Polytechnic	41	12	7	24	24	24	20	83	12	2	0	5	12	24	5	90
University	119	6	6	14	12	24	18	77	13	1	3	2	4	13	8	79
Sex																
Male	175	14	10	17	17	30	19	79	18	5	4	6	8	22	8	79
Female	250	9	7	19	16	30	22	80	13	4	3	3	10	20	6	81

Appendix 7-S

Number and Percentage of Respondents for Age x Sex Groupings for the PVOI Section E: What Did You Do as a Result of Your Visit?

		Age Group					
		School-age		Young Adult		Older Adult	
Sex	Item	*n*	%	*n*	%	*n*	%
Male	E1	48	31	44	5	83	8
	E2	48	23	44	0	83	7
	E3	48	35	44	9	83	10
	E4	48	33	44	16	83	8
	E5	48	38	44	27	83	27
	E6	48	27	44	16	83	17
	E7	48	79	44	80	83	78
	E8	48	40	44	14	83	7
	E9	48	13	44	0	83	2
	E10	48	15	44	0	83	0
	E11	48	17	44	7	83	0
	E12	48	13	44	7	83	6
	E13	48	33	44	23	83	16
	E14	48	13	44	9	83	5
	E15	48	75	44	82	83	80
Female	E1	29	7	84	6	137	12
	E2	29	7	84	4	137	9
	E3	29	17	84	16	137	21
	E4	29	24	84	12	137	17
	E5	29	28	84	24	137	35
	E6	29	21	84	24	137	20
	E7	29	72	84	82	137	81
	E8	29	17	84	16	137	11
	E9	29	7	84	5	137	1
	E10	29	7	84	4	137	2
	E11	29	17	84	0	137	2
	E12	29	17	84	8	137	9
	E13	29	31	84	21	137	17
	E14	29	7	84	8	137	4
	E15	29	79	84	76	137	84



<u>Figure</u> I An overview of the research design. 54

Table 3.1

Research Design Overview and Timelines

Timeline	Stage	Purpose	Data Sources
Feb 1993 to May 1994	1. Immersion in *Scitech* (Chapter 3)	To understand the educational context and daily working environment of a typical ISTC	Informal discussions; casual conversations; observations; document analysis; and attending of meetings, planning sessions and exhibition launches
Dec 1993 to Sept 1994	2. Interviews with staff and visitors (Chapter 4)	To obtain verbal data about staff and visitor perspectives of possible outcomes of visits for use in developing survey instruments	Focus groups and one-to-one sessions with both staff and visitors
Mar 94 to June 94	3. Development of PVQ and data collection (Chapter 5)	To collect written data for a bank of items as a source for developing instruments to measure outcomes of visits	Analysis of the responses to the interview questions and focus group questions
Sept 1994 to June 1995	4. Development of PVII and field testing (Chapter 6)	To obtain a simple measure of visitors' immediate reaction to the impact of a visit	Responses to PVQ items, randomly selected voluntary visitors to five ISTCs, *Scitech* staff, specifically targeted educators and members of the public.
Jan 1995 to Dec 1995	5. Development of PVOI and field testing (Chapter 7)	To obtain a multi-dimensional measure of visit outcomes in the form of a profile	Responses to PVQ items and interview questions, randomly selected voluntary visitors to three ISTCs, *Scitech* staff, specifically targeted educators and respondents who offered critical comment to the PVOI