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March 1997

A thesis submitted for the degree of Master of Scientific Communication of The Australian National University.
This thesis is my own work, and other people's work has been specifically acknowledged.

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22 February 1997
On the road with the

Shell Questacon Science Circus:

An investigation of its contribution to the public understanding of science.
Abstract

This study investigated the effectiveness of the Shell Questacon Science Circus (Science Circus), the major outreach program of Questacon–The National Science and Technology Centre in communicating science to the public.

The Science Circus' effectiveness in meeting its goals and objectives were evaluated, and improvements were suggested. Finally the new programs were developed and evaluated.

Both primary and high school students enjoyed the demonstration show put on at schools and primary school students were more positive in their attitudes toward the shows than the high school students. The vast majority of the visitors at the public venues thought their visit was very worthwhile. The data suggest that a majority of visitors at the Science Circus public venue were family groups who had found out about the Science Circus through the school sessions.

Teachers are very supportive of the Science Circus, believing it is a worthwhile experience for their students. Primary school teachers requested more resource material, related to the science curriculum, and high school teachers seem to prefer the more spectacular Science Circus shows and would like access to the Science Circus exhibits for their senior classes.

The Science Circus program that is offered to remote and Aboriginal and Torres Strait Islander communities was very well received. The development of portable exhibits and more resource material will enhance the current program.

The Science Circus had little effect in changing the existing attitudes toward science and scientists of primary and high school students' and teachers' attitudes. The primary school students have more positive attitudes toward science and scientists than the high school students. The data suggests that primary school students thought scientists were more 'normal' and more 'fun' after the Science Circus visit. The majority of high school students have negative attitudes toward scientists, both before and after the Science Circus
visits. The high school students were, however, supportive of science and scientists in society. Teachers have very positive attitudes toward the role of science in society and there was little change in their attitudes before and after the Science Circus visit.

The numbers visiting the Science Circus have been relatively stable over the past seven years. However, the use of the student free tickets to visit the public venue have been steadily decreasing. To address this problem a number of recommendations were made. The implementation of some of these recommendations are described.

That the Science Circus is a world class travelling program is clear, both from the tendency of overseas centres to emulate its programs and employ its graduates, and from the high level of acceptance by audiences within Australia.
Acknowledgements

There are many individuals that deserve special thanks.

Thank you to Chris Bryant, my supervisor, who encouraged me to produce something that I am proud of, and his instruction of the correct use of ‘however’.

I relied on a number of people for inspiration: Sandy Clugston, who always believed in me; Jenny Edwards, who seemed more confident in my ability than me; and Martin Fewings, who was always very encouraging of my undertaking this study.

Thanks to Simon Barry for his assistance with the data analysis and encouraging comments. Greg Hood introduced me to pivot tables, they changed my life, I am forever indebted.

The dedicated proof-readers: Simon Torok, Ilze Groves, Jenny Dettrick and Damon Shorter deserve thanks for their helpful (and numerous) comments!

Thank you to Ken and Margot Dredge: without the use of their dining table, overlooking the Indian Ocean, I would not have been nearly as inspired to complete this thesis. Thank you to my ‘adopted’ family in Canberra, Greg and Jenny Hoodwards, for providing me with regular meals, a bed, encouragement and a deck to relax on.

Finally, thanks to Questacon’s staff and the Graduate Diploma students. Without their assistance over the past two years, this project would not have been possible.
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Chapter One

Introduction

Background

Every year more people are experiencing the fun and excitement of interactive science centres, travelling science exhibitions and science museums. The numbers of interactive science centres and outreach programs are growing in Australia and throughout the rest of the world. Their role is to encourage and promote the public understanding of science through the use of hands-on exhibits\(^1\) that allow visitors to explore the wonders of science and technology. Science centres house many different exhibits and education programs which can be used by school, family and social groups; from the young to the old. Schools frequently use the facilities of such centres because informal interactive learning is seen to complement the formal learning process occurring in the classroom.

Semper (1990) supports science centres and museums as environments for learning.

They excel at presenting examples of natural phenomena, human and animal behaviour, and real world applications of science. They provide multiple opportunities for the public to broaden and deepen its knowledge and understanding of science, technology and nature (p. 50).

Although science centres are popular and their education potential is recognised (e.g. Wellington 1990; Feher 1990; Rennie and McClafferty 1996) there have been strong suggestions that science centres are merely places of fun and not learning. Ten years ago, Shortland (1987) suggested that children learnt little, if anything, at interactive science centres. He commented that the exhibit text panels were either too complicated or too simple, and that many of the analogies are inappropriate. In Shortland’s article he was very critical of science centres:

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\(^1\) Hands-on exhibits are commonly found in science centres and require some type of physical involvement of the visitor with the exhibit. Hands-on and interactive exhibits are further discussed in Chapter Three of this thesis.
When education and entertainment are brought together under the same roof, education will be the loser (p. 213).

...they (children) learn little science and may acquire a good many misconceptions which at the very least fail to match those offered in the captions (p. 214).

Shortland concluded, however, that science centres should strive to present science as exciting yet do so in a balanced and realistic fashion. In ten years perhaps science centres have found the balance to satisfy Shortland’s comments.

More recently Baggott (1995) suggests the science centre approach is damaging to the cause of science.

It can mislead people into thinking that science is simple and provides easy answers, only to disappoint when it is revealed to be horribly complicated and demanding (p. 47).

There has been extensive research on attitudes towards science (e.g. Ayers and Price 1975; Haladyna and Shaughnessy 1982; Wareing 1990; Woolcott 1995) and how attitudes towards science affect knowledge (e.g. Stronck 1983; Piburn and Baker 1993; Ebenezer and Zoller 1993; Germann 1994; Evans and Durant 1995). Germann (1994) reports that attitude has a significant effect with cognitive development and O’Brien and Porter (1994) found that a greater positive attitude toward physics attracts more girls to study the subject. It could be argued that if positive attitudes assist in the learning of science then science centres surely have an educational role, in assisting the promotion of positive attitudes towards science.

Both major Australian political parties are aware of the need to promote science and technology. Peter McGauran, Minister for Science and Technology, promotes the view that Australians need to develop a community that is scientifically aware, technologically literate and instinctively innovative; one that will be able to maximise the contributions of science, engineering and technology (DIST 1996a). The previous Minister for Industry, Science and Technology, Senator Peter Cook of the opposing party, also called for Australia to be a highly scientifically and technologically literate nation with a community able to absorb and adapt to technology and innovation (Cook 1994, Cook 1995).
This study focuses on the *Shell Questacon Science Circus* (*Science Circus*), a travelling outreach program of Questacon—The National Science and Technology Centre (Questacon) located in Canberra, Australia. The program reaches approximately 80,000 people a year throughout Australia. The main aim of the *Science Circus* is to promote a positive image of science and technology to people in regional areas of Australia, rather than teaching people science and technology concepts. The *Science Circus* also comprises the practical component of the Australian National University's Graduate Diploma in Scientific Communication which accepts 15 candidates each year.

In the recent review of Questacon and its travelling programs Beetlestone (1995) reports:

> ...few science centres world-wide operate travelling exhibitions but none of such a vast catchment area. It is an exemplar for other major centres to follow, particularly the linkage between the *Science Circus* and the graduate Diploma in Science Communication of the ANU (p. 10).

This study is centred around the importance of changing attitudes. It is based on the premise that a positive attitude toward science is a crucial step in developing a greater public understanding of science and technology. This study does not investigate how much a person learns from the *Science Circus* but if the *Science Circus* helps promote a positive image of scientists and science. If the *Science Circus* and all science centres have this effect then science centres can play an important role in enhancing our community's awareness of science and technology.

**The Shell Questacon Science Circus**

My experience as a Graduate Diploma student with the *Science Circus* in 1991 introduced me to the field of science communication and the growing interest in communicating a positive image of science and technology. After three years as Education Officer with the Queensland Museum Sciencentre in Brisbane, I returned to the *Science Circus* as a Coordinator/ANU Associate Lecturer with a much deeper appreciation of what other science centres were hoping to develop and achieve.
The *Science Circus* had been operating efficiently for seven years between 1988 and 1994, and the Graduate Diploma in Scientific Communication was well established. It was an ideal time to evaluate the program and implement any suggestions arising from the evaluation. The manager of the *Science Circus* was very receptive to the idea for two reasons: an injection of new ideas could only be beneficial, and any research conducted before the approaching sponsorship renewal from Shell Australia would be helpful.

Since its beginnings in 1988, the *Science Circus* has travelled to every State and Territory in Australia, visiting hundreds of thousands of people of all ages. During this time the *Science Circus* has updated its image with new exhibits and promotional materials, however, the format has changed little.

There is a continual need to evaluate and improve any program, even when it is perceived to be successful, if the program is to remain innovative and a leader in its field. In all of the years the *Science Circus* has operated, a formal evaluation has never been undertaken to determine if the *Science Circus* was indeed achieving its goals.

The goals of the *Science Circus*\(^2\) (unpublished goals, established in 1994) are:

- To promote a positive and personally relevant image toward science and technology to the people of regional Australia.
- To take a world class, touring, Science and Technology public program to the people of regional Australia.
- To assist teachers in regional Australian schools to enhance the quality of science and technology education they deliver to their students.
- To provide a diverse range of opportunities and audiences for the Graduate Diploma scholars to develop their skills in scientific communications.
- To be a well managed, cost recoverable program.

\(^2\) The goals and objectives of the *Science Circus* were redefined at the end of 1996. The goals and objectives evaluated as a part of this study are the initial working goals established in 1994 at a Questacon staff retreat.
The Science Circus’ objectives (unpublished objectives, established in 1994) are:

- To generate awareness of the Science Circus as a major program of Questacon.
- To optimise the number of people who will visit the Science Circus, both in schools and at venues, through generation of a broad interest base in the regions being visited.
- To assist in promoting the national profile of Questacon.
- To assist in promoting the national profile of the Shell Company of Australia.
- To provide opportunities for Graduate Diploma scholars to work with media and the general public and develop their science communication skills.

The mission statement of Questacon is: To be the national leader in promoting understanding and appreciation of science and technology through interactive exhibitions and programs (Questacon 1995). The Science Circus, as the major outreach program for Questacon, also strives to be the national leader in the promotion of science and technology through travelling exhibits.

There are science centres established in most States of Australia. Many of them have fully operational travelling programs or are in the process of developing them. Less than five years ago the Science Circus had the market to itself. For the Science Circus to maintain its current status it is essential that new exhibits, science demonstration shows and resource materials be developed.

**Purposes of the Study**

At the start of this project a group of Questacon staff members discussed how it would be possible to determine whether an organisation or an institution, such as the Science Circus, is a national leader. It was decided that a program would be a national leader if the program’s goals are achieved, if similar organisations seek advice from those involved in the program and if these similar organisations believe the program to be innovative. Therefore the group agreed that for the Science Circus to be a national leader it must have the following features:
• All goals and objectives are achieved.
• Other science centres, museums and travelling science shows seek the Science Circus’ opinion, guidance and advice.
• Other science centres, museums and travelling science shows believe the Science Circus to be innovative.

This research project focuses on the goals and objectives of the Science Circus. An evaluation of the Science Circus was undertaken initially, with an emphasis on seeking ideas, suggestions, improvements which will enable the Science Circus to achieve its goals and objectives more effectively. The second component of the thesis provides suggestions on the implementation of new programs to address the evaluation outcomes. Finally those new programs that were implemented were assessed.

The Science Circus attracts groups of all ages and sizes, but for the purpose of this study only the needs of particular target audiences including: pre-school students, primary school students, secondary school students, adults and Aboriginal community groups were addressed.

How the Purposes Were Achieved

There were a number of components devised for this project. They were needed to answer all of the above questions. The questions, their objectives and the methods used to answer the questions are detailed in Table 1.1. All the Science Circus’ goals and objectives are included in this study, except for the fifth one: To be a well managed, cost recoverable program. It was thought that this is a question for Questacon management to answer. Subsequently, it has transpired that this goal was not included in the new Science Circus goals, recently developed at the end of 1996.
Table 1.1: Research questions and methods related to the objectives of the project.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Research Question</th>
<th>Method</th>
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<tbody>
<tr>
<td>1. To examine if the SQSC is achieving its goals and objectives.</td>
<td>1a. Does the SQSC promote positive images towards science and scientists?</td>
<td>Questionnaire and attitudinal instruments with students and teachers</td>
</tr>
<tr>
<td></td>
<td>1b. Does the SQSC assist teachers?</td>
<td>Questionnaires and interviews with teachers</td>
</tr>
<tr>
<td></td>
<td>1c. Is the SQSC a world class touring program?</td>
<td>Questionnaires with teachers and students Review of literature</td>
</tr>
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<td></td>
<td>1d. Does the SQSC provide a range of opportunities for the Graduate Diploma students?</td>
<td>Review of tour information Interviews with Graduate Diploma students</td>
</tr>
<tr>
<td></td>
<td>1e. Does the SQSC optimise the number of people at schools and public venues?</td>
<td>Questionnaires with teachers and students Exit polls Review of tour statistics</td>
</tr>
<tr>
<td></td>
<td>1f. Does the SQSC promote Questacon and Shell?</td>
<td>Questionnaires with teachers Exit polls</td>
</tr>
<tr>
<td>2. To suggest and implement new programs for SQSC.</td>
<td>2. What programs can be developed to assist the SQSC achieve its goals?</td>
<td>Interviews with SQSC staff</td>
</tr>
<tr>
<td>3. To determine if the new programs are beneficial.</td>
<td>3. Are the new programs worthwhile additions to the SQSC?</td>
<td>Interviews with SQSC staff Exit polls Questionnaires with teachers Participant observation</td>
</tr>
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</table>

3 SQSC is the abbreviation for the Shell Questacon Science Circus
Significance of the Study

This study has implications for many areas of science communication, particularly interactive science centres, travelling science exhibitions and science education.

Questacon has many outreach programs and other exhibitions that travel to major cities and towns throughout Australia. This research will provide information which can be used to improve programs that are currently operating and also provide valuable insight for those people developing new outreach programs at both Questacon and other Australian science centres.

In evaluating and implementing new ideas the Science Circus must provide a program that better meets the needs of teachers, students and parents in regional areas of Australia. Particular emphasis must be placed on teacher’s need for more support in science education.

This thesis will assist in the development of a more culturally relevant science program for teachers in remote regions and Aboriginal students. In recognising the specific needs of remote aboriginal communities the Science Circus would have a greater chance of receiving funding to visit such areas.

There have been few attempts to measure attitudinal change arising from science awareness activities in Australia. This study will assist in determining if programs like the Science Circus have the ability to change school student and teacher attitudes toward science. In determining this it will provide further evidence for the science communication field on whether popularising science helps promote a positive image of science and scientists. In doing so it contributes significantly to the present body of science communication research.

Science communication is a relatively new field and few studies have been conducted on travelling science exhibitions. This research provides the first overall study of Australia’s largest travelling science exhibition the Science Circus.
At a broader level, the more the Science Circus improves, the greater the impact it will have on people and the more aware of science and technology members of the public will become.

**Thesis Structure**

Chapter Two investigates the background to the field of science communication addressing the aims and importance of science communication in today’s society.

Chapter Three discusses a number of factors affecting the public understanding of science, such as, formal science education, Aboriginal education, gender issues and the importance of attitudes towards science and technology.

Chapter Four investigates the role of science museums and science centres. The history and achievements of Questacon and the Science Circus over the past eight years are discussed.

Chapter Five provides details on the methods employed to achieve the objectives of this study.

Chapter Six is the first of the three results chapters. This chapter explores the attitudes revealed in the attitudinal questionnaire.

Chapter Seven presents the findings of the study that examines the first objective: whether the Science Circus achieves its goals.

Chapter Eight discusses the implementation of new ideas and the evaluation of the new ideas that were implemented.

Chapter Nine concludes the thesis by relating the findings from Chapter Six, Seven and Eight to the objectives established in Chapter One. Recommendations for future developments are also detailed.
Chapter Two

Public Understanding of Science

Introduction

Today's vocabulary is full of acronyms to the annoyance and hindrance of many people, because of the assumption that everyone is fully aware of their meanings. The acronyms below have raised a different issue: What are they all about? Do they all have the same meaning?

- PUS (Public Understanding of Science)
- POS (Popularisation of Science)
- PAS (Public Awareness of Science)
- PCST (Public Communication of Science and Technology)
- PUSET (Public Understanding of Science, Engineering and Technology)

Anyone embarking anew on the science communication field could be easily overwhelmed by the number of acronyms in the field!

This issue currently provides an interesting debate for people who subscribe to the PCST-L (Public Communication of Science and Technology List) on the Internet, monitored by Professor Lewenstein of Cornell University, USA. The PCST-L enables its subscribers throughout the world to comment on issues relating to public understanding of science. Below are examples of comments that people have contributed to the POS and PUS debate.

POS is in essence selling or marketing a product such as a book or a video, that touch on science... really has little to do with science but helps members of the non-scientific public feel some connection to science (Allen 1996).
POS is pretty clear. It is just teaching (not educating)...PUS also involves telling people about the way in which science works, how you do research, and what it means when scientists disagree (Kenward 1996).

POS is news about the latest breakthrough, while PUS is a longer term process which deals with scientific method as much as scientific discoveries (Smith 1996).

POS is done by people who don’t deserve respect and PUS is done by people who do. (Ban 1996).

POS aims to appeal to the imagination, while PUS aims to appeal to reason (Shimazu 1996).

PUS is supposed to be the result of POS (Jurdant 1996).

... the very acronym PUS is enough to drive the public away from ever wanting to understand science (Stutchbury 1996).

... that is the reason why I do prefer Public Communication on Science and Technology please lets drop PUS and the septicism, as against to scepticism, that it evokes and let PCST encompass the lot! (Fayard 1996).

... PUS ‘is an umbrella term to cover various activities to communicate and to interest the wider public in matters of science and technology’ isn’t that what the popularisation is suppose to do? (Taha 1996).

PUS is based on the notion that the public do not understand science... perhaps the public’s adverse reaction to science is often not due to ignorance but to objections to the wider social implications or content of that science... (let’s) reverse PUS to ‘the understanding of the public by the scientists’! (Lavau 1996).

At the forth international conference on public communication of science and technology (PCST), held in Australia in November 1996, the Australian organising committee adopted a ‘sexier’ name, SCICOMM, short for science communication.
Australia's first science communication centre at the Australian National University is referred to as CPAS, the Centre for the Public Awareness of Science. The French seem to prefer PCST, and the Britons are fond of PUS and now have a committee known as COPUS (Committee on the Public Understanding of Science). However, to be politically correct in the UK, any reference to science should always include engineering and technology, therefore PUS should really be PUSET, the public understanding of science, engineering and technology (Kenward 1996).

In this chapter the meaning of public understanding of science will be discussed along with the perceived need for it, what it hopes to achieve and how best to go about achieving its objectives.

Public Understanding of Science

In 1991 and 1995 the Department of Industry, Science and Technology commissioned Woolcott Research Pty Ltd to evaluate the understanding of, and attitudes to, science and technology. Both Woolcott reports (Woolcott 1991; Woolcott 1995) found that Australian Year Eight and Nine students regard scientists and enthusiastic science students as 'geeks', 'nerds' and 'dorks', with limited relevance to society and believe science based careers are risky.

In recent years, surveys of public scientific literacy have been conducted in Australia, Germany, China, the USA and the UK where the results show a low level of public knowledge (Durant et al. 1989; Zhang and Zhang 1993; BIE 1995; Woolcott 1995). Although Australians achieved a higher average score than all the other countries surveyed, whose data were included in the report, the findings still reinforce the need to increase the public's understanding of science and technology in Australia.

Ziman (1991) believes that the concern for the lack of public understanding of science is nothing new. In the early nineteenth century the British Association and other bodies were founded to bridge the gap between science and the public. He also states that the efforts made by these scientists and associations had little effect.
Durant *et al.* (1989) believe that there is a need to care about the public understanding of science for four reasons which they have identified as:

...science is arguably the greatest achievement of our culture
...science affects everyone’s lives and people need to know about it
...many public policy decisions involve science, and these can only be genuinely democratic if they arise out of informed public debate
...science is publicly supported, and such support is based on at least a minimal level of public knowledge (p. 11).

Durant (1990), in his address to the Science and Technology Communication conference, assigned them to cultural, practical and political categories. Shortland (1988) reviewed a number of different arguments that have been deployed in favour of promoting the public understanding of science. He is cautious of the distinctions he makes because it arbitrarily represents a very complex picture and conceals the overlap which exists between the different arguments. They are: scientific; economic; military; ideological; cultural; intellectual; aesthetic, and ethical. These arguments are similar to but differ slightly from Durant’s three categories. Shortland himself creates two others in favour of greater public understanding of science: individual and political arguments, believing that these two:

articulate and give expression to laypeople’s desires, aims and ambitions with respect to science and technology in today’s world (p. 312).

In total there seems to be 11 suggestions (or arguments as they are sometimes referred to) put forth. There are differing opinions for many of the arguments and this is investigated below.

**Cultural**

The cultural argument suggests that knowing about science and technology is inherently worthwhile. Other facets of culture such as art, literature and music are highly valued, so why not science? (Durant 1990). One should be able to marvel at the workings of science (Zen 1992) and appreciate the human endeavour (Boland 1991) within the science field.
Chapter Two  
Public Understanding of Science

Cossons (1993) believes that science is a central part of our culture and it is this, the social context of science that should be communicated to help people decode the culture in which they live. Attenborough (1992) believes that knowing about science enhances the enjoyment of life:

It is a positive pleasure to have some understanding of the processes of work in the sky above our heads that produce a thunderstorm... (p. 4).

Perhaps it is a pleasure for Attenborough: we are all well aware of his love of the wonders of nature. Can science communicators, however, be so sure that everyone else has an equal love of science? Durant et al. (1989) state that science is arguably the greatest achievement of our culture and people deserve to know about it. It is logical that people deserve to know about science if they choose, and this is a powerful argument. However, the argument that people must be made aware of science because scientists and science communicators believe science is awesome, can be interpreted as an elitist argument. Promoters of public understanding of science should be aware of individual choice; people may choose to be interested in science or they may not. Solomon (1993) concludes in her paper that choice includes the possibility of rejection, which is an important and complex issue. Miller and Barrington (1981) are aware of this:

Interest is the choice by an individual of an area or issue as one worthy of the time and effort necessary to become and remain informed about it (p. 180).

Practical

The practical argument implies that it is essential for a person to be aware of science and technology when living in a society where science and technology plays an important role in everyday operations, such as using a microwave. Durant et al. (1989) argue that science affects everyone’s lives and people need to know about it. It is assumed that an improved understanding of science and technology is useful to anyone living in a scientifically and technologically sophisticated society. Shortland (1988) believes that an individual would be able to negotiate through life more successfully, in terms of diet, health, safety and the fields of advertising.
The fruits of science and technology are very obvious in western society. But people have been using technology for many years without knowing the theories behind light properties, microwaves and electron transfer, and have successfully managed to survive and raise another generation of technology users. In the biological and medical sciences, there are many differing opinions on health and diet issues which may confuse people rather than assisting them through life.

**Political**

Politically there are many issues based on science and technology and it is believed that for people to make decisions they must be informed and educated about the topic. Durant (1990) has two arguments: public unease is linked to public ignorance and that the public do not need to be competent enough to make an expert judgement. A level of familiarity, however, combined with a confidence to listen to experts allows the public to know the range of options (Durant 1990). Miller (1993) has argued for over a decade that there are a growing number of public policy issues that are scientifically or technologically based, and there is a demand for a significant proportion of science literate citizens to participate in meaningful debates about these issues. He stresses that the health of democratic countries could be at risk if we fail to increase the public understanding of science.

Cossons (1993) suggests a move away from this argument would be beneficial as he believes that it will be listened to with politeness but little passion. He describes informed citizenship as the responsible exercise of individual democratic right, however argues that citizenship is linked with politics and therefore is removed away from the individual:

> Politics, by and large, is something remote and science policy is an even more obscure footnote that is difficult to find in any party political agenda. Except for politicians, the centre of people's lives is not politics... (p. 338).

**Scientific**

This argument is based on the grounds that understanding benefits science itself: science is publicly supported and the support should be based on a minimal level of public knowledge (e.g. Zen 1992). A theory is that as science knowledge increases so will public
support.

To understand something does not mean automatic approval. Shortland (1988) argues that:

... the relationship between understanding and approval is not necessary but rather contingent upon the nature of the particular understandings and the particular contexts in which they occur (p. 312).

**Economic, Military, Ideological**

The economic, military and ideological arguments are concerned with international competition with each suggesting that the public understanding of science contributes to a nation’s ability to have an advantage over its competitors. David Attenborough (1992) states:

If we are to maintain our position among the most prosperous nations of the world, we must maintain the technological skills that are at the heart of our industries... If illusions about the nature of science are not dispelled... then the economic prospects of this country will be gravely diminished. And so will the pleasures that should come from the privilege of being alive in the 21st century (p. 4).

**Intellectual**

This argument is in relation to an educated society, as science is an intellectually enabling and ennobling enterprise (Shortland 1988).

**Aesthetic**

The aesthetic argument is closely linked to the intellectual and cultural argument suggesting that a truly cultured mind is familiar with music, art, literature and science. It is suggested that without knowledge of science, life would be less worth living. Shortland and Gregory (1991) quote Carl Sagan:

Understanding the world is a kind of joy, and I find that every time people, ordinary people, understand some aspect of nature... they are delighted. This is a delight first in the joy of
knowledge itself and second because it gives them some intellectual encouragement; they
discover they’re not so dumb as they had been told they were (p.8).

This argument assumes that all people who reject science think they are ‘dumb’ and that
‘ordinary people’ are different from scientists and science communicators. These are
dangerous assumptions. It is important for science communicators to view the public as
intelligent, thinking beings.

Ethical

This argument suggests that a population of highly knowledgeable people will be a source
of an ethical society. Zen (1992) sees a scientifically literate society as one which will
police science research as it will have a better grasp of ethical issues that impinge on the
conduct and application of research.

Individual

The final argument is strongly supported by Shortland (1988), who considers that
individuals relate to science as they experience it. In this way an individual can become an
active and effective citizen.

Shortland (1988) warns that rehearsing the above 11 arguments may lead to more damage
than good, because they may lead to confusion. Cossons (1993) called for logical
intellectually definable, justification of the public understanding of science to be
articulated. He believes the argument should be culturally, not politically, based. He feels
that society’s view of science has little to do with the science itself, but views it as more
boring and sinister than it actually is. Cossons advocates the public understanding of
science should communicate the relationship between science, technology and industry, it
should not simply be about exciting children in science, and the movement needs to have
an agenda which society can understand and appreciate.

Fayard (1991) believes popularisation is causing the opposite effect to what the promoters
of public understanding of science desire. He cites a statement he previously made
confirming the divide between scientists and laypeople rather than reducing it:
Chapter Two

Public Understanding of Science

Popularisation results in the scientists being confirmed as scientists and... the lay person being confirmed as an ignoramus (p. 599).

Although there is little evidence for this statement, there is a likelihood of the erroneous assumption, among communicators, that laypeople have the same attitude toward science as they do. Fayard points out:

...(laypeople) freed from the constraints of (science in) the classroom, the non-captive layperson is in a position to say ‘No thanks, we’ve already done our bit!’ (p. 600).

An analysis of these arguments raises questions about the purpose of communicating science. There are many issues which have worried numerous people, including those mentioned above, in regards to the many arguments outlined. The public understanding of science is more complicated that merely ‘communicating to the public because it is good for them’. People have started to ask important questions, such as: ‘Does greater understanding of science lead to a greater sympathy for science and scientists?’

Zen (1992) argues that greater levels of scientific literacy would automatically lead to higher levels of public support for science. There is relatively little evidence that this is the case. In fact research is showing that people discriminate between different areas of science such as genetic engineering and nuclear testing. Evans and Durant (1995) found that measures of general attitudes were inadequate as guides to what the public may think about specific areas of science. They found that although there was a slight association between high levels of knowledge and more supportive attitudes towards science in relation to general science this was not the case for more morally contentious or non-useful areas of science. The well informed were more strongly opposed to funding than the less informed.

Recently, Fletcher (1996) concluded that although people were more likely to admit a lack of science knowledge they felt just as confident to speak about science issues as they were about an area in the arts. He suggests that this finding could be attributed to either the fact that the science background of science and technology is irrelevant to the public accepting and appreciating the science or that the move for civic literacy is based on a false argument. Perhaps, if people are interested in science and want to know more, then the role
of a science communicator is to present science as clearly as they can.

The phrase ‘public understanding of science’ has been picked to pieces to determine what the four words mean when linked together. Shortland has taken the meaning of all the words (excluding the ‘of’) in the phrase, in search of an understanding of the phrase. Silverstone (1991) reviews ‘communicating science to the public’ where he states there are four main assumptions: there is no such thing as the communication of science as everyone receives science in a different way; there is no such thing as the public, everyone understands, misunderstands, remembers and forgets in different ways; science cannot claim to be better than other fields, it has to compete with others for attention; the understanding of science does not come from one source but shares the role with local knowledge, practical understanding and common sense. Cossons (1993) thinks that the phrase ‘public understanding of science’ when taken literally means the understanding of science that takes place in public places, for example museums and libraries.

The meanings of the previously outlined acronyms and the ‘public understanding of science’ have raised a number a interesting debates, including those mentioned above. Little has been said of the opinion that there is no significant difference between the acronyms. Perhaps the science communication movement should focus its efforts on determining the best procedures in communicating science to the public.

The following chapter discusses a number of factors that influence the public understanding of science.
Chapter Three

Factors that Influence the Public Understanding of Science

This chapter reviews a number of factors that influence the task of increasing the levels of public understanding of science. The factors reviewed in this chapter are levels of scientific literacy, attitudes toward science and technology, the influences of formal science education, how people perceive scientists, cultural differences and gender issues.

Scientific Literacy

What is it to be scientifically literate? There are a number of views of what scientific literacy is; they are detailed below. In summary, it is when a person understands science and how science affects them in their day-to-day living.

Shortland (1988) believes it is when a person has the confidence to grasp a science issue, to solve a science problem, or answer a science question. It is when someone is able to cope with scientific matters as they arise in the course of life.

Miller (1993) suggests a citizen with a sufficient level of understanding of science should be able to: read a newspaper article on a public policy dispute and understand scientific terms and concepts; understand the approach taken by scientists and be able to distinguish between scientific and pseudo scientific judgements; and have an awareness of science and technology’s impact on society.

Zen (1992) believes a person is scientifically literate when she or he understands the importance of observation in science and that the observations are always subject to human errors. Zen argues against Shamos (1988) who claimed that increasing scientific literacy is futile as only a few need to use science, and the rest seem to get along fine without it. Zen insists that the people who will be making decisions in the future are current school...
students and they will vote on technology and science based decisions.

Studies conducted in Australia and elsewhere that surveyed the public’s scientific knowledge left a remarkable impression on the science communication community. More information was wanted: ‘Why do people have such low levels of understanding?’. Fayard (1991) encourages today’s science communicators to concentrate on ways and means of enabling lay people to acquire a level of scientific and technical literacy and to apply it in their everyday lives. Fayard is suggesting that it is up to the public to acquire these levels if they want. The science communicator’s role is to provide the information in a more accessible and readily available way and portray scientists and science in an accurate fashion.

Zen (1992) calls for a grass roots approach to increasing scientific literacy. At an Australian Academy of Science conference Zen invited the scientists to work with schools and teachers, assisting teachers in content, presentations, and activities. He stressed the importance of a partnership, suggested egos be left at the door and for scientists to learn from the teachers. Yearley (1994) encourages scientists to become involved in community groups and non-government organisation dealing with local issues.

Solomon (1993) and Fletcher (1996) both believe one reason for a lack of public understanding of science is that individuals have a choice in what they learn and what they are interested in. People should be able to reject science if they want, as that is their personal choice. This does not mean that they are ignorant or lead a less fulfilled life, it is a choice they have made.

Fayard (1991) and Cossons (1993) call for a strategic plan for promoting the public understanding of science. This could involve the coordination of all those working towards a greater awareness of science, combining the efforts of those in media, universities, science centres, school education systems and scientists. Although Fayard is promoting a plan of action, he believes science centres are not very productive as they preach to the converted minority (1991). This is an unfortunate view as all groups have different roles to play and without the support from everyone a strategic plan cannot develop to its full potential.
Chapter Three—Factors that Influence the Public Understanding of Science

There is much support for informing the public about how science works and what scientists do rather than just increasing scientific knowledge (e.g. Yearley 1994; Raina 1993; Maddox 1995). If familiarising the public about science is to work, then the whole picture needs to be painted: what science is, the different strands of science, those who work in the area and what scientists actually do. These issues are very difficult to portray in science centres, however it may not be their role. If science centres can enthuse people about science then the other partners in science communication can perhaps tackle those issues.

If science communicators remember that science is not the 'superpower' (Fayard 1991) and that it is a part of our culture, perhaps people will feel less inclined to reject science.

Attitudes Towards Science and Technology

Oppenheim (1992) states that most attitudes of an individual are usually dormant and are expressed in speech or behaviours only when the object of the attitude is perceived. Attitudes are reinforced by beliefs and often attract strong feelings which may lead to particular behavioural intent. There is no limit to the topics on which people may have attitudes. Most attitudes are given labels such as feminism, anti-science, strictness and vegetarianism. Attitudes do not necessarily hang together in a logical way.

What is an attitude toward science? Haladyna and Shaughnessy (1982) have developed a number of definitions defining the many aspects of science attitudes. Science attitudes relate to a student's approach to thinking about science; attitude toward scientists; perceptions about scientists; and attitudes toward science at schools.

Ayers and Price (1975) believe it is imperative that children develop a favourable attitude toward science at an early age, as a positive attitude is required for a person to develop scientific literacy.

Recently, interest has been directed to how attitudes toward science affect learning, career choices and abilities to deal with technological change. There is now widespread consensus
that the term ‘attitude toward science’ should be used to refer to a general and enduring positive or negative feeling about science which should not be confused with scientific attitude which is in relation to scientific attributes (Koballa and Crawley 1985).

A positive correlation between the attitudes of students to various subjects and their subsequent choice of school subjects was confirmed by Johnson and Bell (1987). O’Brien and Potter (1994) investigated the impact of a new physics project on girls’ attitudes to physics. O’Brien and Potter (1994) initially stated that a positive attitude would be an indication of the progress of the project. They indicated that a positive attitude on the part of the students did not itself guarantee the success of the project, although a positive attitude would seem to be necessary.

There tends to be a decline in positive attitude toward science from earlier to later grades (Piburn and Baker 1993) and research has shown that students’ attitude and interest in science learning tends to be formed and stabilised by the age of 10–14 (Hofstein and Welch 1984). Evidence is presented by Mullis and Jenkins (1988) of a strong positive relationship between science proficiency and attitude toward science. The outcome of their research also suggests that students come to feel less confident about their abilities in science and that this adversely affects their attitude toward the subject.

From these studies it could be concluded that by the time students are 14 years of age they have formed their opinion of science, would probably have a less positive attitude than when they were younger and may not be very confident with science. Therefore, targeting upper primary and lower high school students and providing rewarding experiences of science may assist the public communication of science.
Science Images

Haynes (1996) has identified six basic images of scientists that have been represented in society since the 1500s that appear to be recycled though the ages:

1. Evil alchemist—this scientist promises wealth, power and longevity e.g. Dr Strangelove, Dr Jekyll
2. Noble scientist—this scientist is not so common, but would be selfless and wise enough to be entrusted with the government e.g. Isaac Newton
3. Stupid scientist—this scientist is the absent minded professor who is so engrossed with their research that they wear odd socks and is oblivious to danger e.g. Albert Einstein
4. Inhuman researcher e.g. one who has rejected human relationships for science
5. Adventure hero—a space traveller or one on a wonderful adventure journey e.g. Dr Who, Indiana Jones
6. Out-of-control scientist—such a scientist refuses to foresee or accept responsibility for the disastrous results of their research e.g. Victor Frankenstein.

The method used to obtain scientists’ images usually involve Draw-A-Scientist-Test, where the researcher asks the students to draw their image of a scientist (e.g. Schibeci 1982). Jackson (1992) found that this test has limited potential in determining school children’s overall images of science and scientists. Jackson administered the Draw-A-
Scientist-Test and interviewed the same children. She found that the students demonstrated a greater knowledge of different types of scientists and science fields when interviewed.

Perhaps when children are asked to draw a scientist they are wanting to get the answer correct so they draw the image that is readily seen in television programs, advertisements, movies and cartoons. Another reason may be that the child’s limited drawing ability causes them to draw easily recognisable items.

Recently there have been two American blockbuster movies, Independence Day and Chain Reaction, both featuring scientists. Independence Day’s writers somehow managed to create an evil, stupid and inhuman male scientist. He had long grey wild hair, glasses, pants worn high on his waist, a very wide seventies-looking tie and was part of a conspiracy. In Chain Reaction there is a young male scientist, a female scientist and an old male eccentric scientist. Chain Reaction tackled the issue that science is moving too fast for society and its laws, and did not portray the scientists as part of the conspiracy. Although Chain Reaction relied on a number of stereotypical images, it did portray a more positive image of science and scientists. Chain Reaction provides evidence that even Hollywood is aware that scientists are ordinary people, even though most often filmmakers rely on the stereotypical images.

If you were to asked to draw an accountant, a lawyer, an artist, used-car salesman or a fruit shop owner, would you choose to include stereotypical features? Or perhaps an image doesn’t instantly appear but instead an overwhelming feeling. Initial research conducted by Mossop (pers comm 1995) indicated that students drew stereotypical images of artists with a paint palate and floppy hat standing beside an easel. McGauran (pers comm 1996), at a recent address to a Australian Science Communicators meeting, suggested that any reference to the stereotyped scientist, including the rejection of it, would only make people more familiar with the stereotype.

Perhaps ignoring the use of stereotypes is one way of helping improve the image of scientists. There is, however, a more innovative suggestion. Recently published in New Scientist’s Forum, Brookes (1997) argues that people frequently perceive scientists as eccentric loners because of the abnormal number of scientists that have beards. To rectify
the problem he suggests sending Richard Dawkins on a world tour to scientific establishments armed with razors!

**Formal Science Education**

Leon Lederman, who won a Nobel prize in Physics, seems to be approaching science communication from the angle of inspiring adolescent school aged children. Wolkomir (1993) investigated Lederman’s enthusiastic approach to science communication and education. Lederman believes his project may be the saving of America. It began in 1988 at some of the worst public schools in America. In Chicago over half of the high school class in 1991 failed to graduate. Lederman’s program focuses on primary school teachers and provides workshops on new teaching techniques which involve hands-on activities related to the curriculum, using inexpensive and easy to obtain equipment. Using this approach of enthusing and building confidence in teachers, the program is enhancing the teachers’, the students’ and parents’ understanding and appreciation of science. A principal of a school, whose teachers attended the two week program, was overjoyed with the response not only from the students, but also from their parents who attended mathematics and science workshops conducted by the newly trained staff.

Wolkomir quotes Lederman’s drive for the project:

> He (Lederman) argues that education is the best way to stop the inner-city poverty cycle. Academy officials cite studies showing that upgrading students’ science and math skills improves their abilities in other areas too, such as reading (p. 114).

It would seem that Lederman’s approach is not only to promote science and mathematics, but to use it as a tool to enhance quality of life for students and their parents. It is a focused project that is obtaining results, not just for the benefit of science but for society.

As communicating science is not a homogenous process, there are many communications about science (Silverstone 1991). The media, science centres, television, radio and print are involved in informal communications conveying scientific information. Schools and
universities engage in a formal education of science.

If students are to become scientifically literate, their teachers would be expected to understand how science works and demonstrate positive behaviours and attitudes toward science. In a recent study conducted by Woolcott (1995) it was found that Year Eight and Nine students perceived their teachers as dull, boring and failed scientists. The students need positive science role models, including their science teachers. Lederman (1992) reviews research in this area and states that teachers do not possess adequate conceptions of the nature of science. A study conducted by Abell and Smith (1994) showed that student teachers place little emphasis on the social or creative dimensions of science.

Science teachers’ views of science can affect how science is taught. A recent study conducted by Ritchie and Rigano (1996) found science teachers were preventing students from learning authentic science. During practical classes teachers were turning a blind eye to students fudging results, which sends a message to the students that cheating is okay. They advocate that many teachers need to change the emphasis in their science classes.

In order to address the problems with science education, enthusing teachers is the first step and this is the approach that Lederman and his team is taking.

**Aboriginal and Torres Strait Islander Education**

A number of educators encourage teachers to recognise the differences between the learning styles of Aboriginal children and non-Aborigines. They encourage learning styles that include informal settings, cooperative group work, observing, personal trial and error, repetition and a holistic approach to learning, modelling and imitation rather than through verbal instruction (e.g. Eibeck 1994; Potter 1994; Christie 1994).

As little research has been conducted into science teaching styles for Aboriginal and Torres Strait Islander students, general teaching styles are discussed below to provide a background of education in the Aboriginal and Torres Strait Islander communities.
In Australia Aboriginal and Torres Strait Islander people comprised 1.6% of the total population in 1991. The number of Aboriginal and Torres Islander people is increasing at about twice the rate of other Australians. Part of this increase can be explained by birth rates and part is the result of the increasing willingness of people to be identified as Aboriginal or Torres Strait Islander. Unlike other Australians who are concentrated in large cities and towns along the coast, Aboriginal and Torres Strait Islander people are more likely to be living in rural and remote parts of the country (DEET 1994).

In 1988 the Hughes Report (DEET 1994) concluded that Aborigines remained the most severely educationally disadvantaged people in Australia. In 1990 the National Aboriginal and Torres Strait Islander Education Policy (AEP) came into effect which attempts to recognise the diversity of Aboriginal and Torres Strait Islander people’s social, economic and political circumstances, cultural values and educational aspirations. It was seen that a national awareness and recognition of cultural diversity and the need to take these differences into account when developing educational programs for Aboriginal and Torres Strait Islander people was most important.

A review of education for the Aboriginal and Torres Strait Islander People was conducted, to reflect on the AEP (DEET 1994). In 1994 there were encouraging signs of progress. The gaps between educational outcomes between Aboriginal and Torres Strait Islander students and other Australian students were narrowing in most situations, however, in others the gaps were getting wider. Some people have criticised the goals of the AEP as being assimilationist, for overemphasising mainstream approaches and for assuming the education outcomes for Aboriginal and Torres Strait Islander students are the same as those for other Australians. There is a lively debate about the philosophy of education for Aboriginal and Torres Strait Islander people.

The review has shown a steady increase in Aboriginal and Torres Strait Islander primary school enrolments. Like other Australians, the vast majority of Aboriginal and Torres Strait Islander children will begin and complete primary school. However significant numbers of Aboriginal and Torres Strait Islander secondary school students do not complete the compulsory Years Eight and Nine. On average Aboriginal and Torres Strait Islander
students have lower levels of achievement in literacy and numeracy than other Australian students.

Aboriginal and Torres Strait Islander students tend to study similar subjects to other Australian secondary students and in much the same proportions, however, Aboriginal and Torres Strait Islander students are less likely to study physical sciences such as physics and chemistry, and are over represented in the arts, health and physical education (DEET 1994).

Separately identified Commonwealth funding for education for Aboriginal and Torres Strait Islander people is administered by the Department of Employment, Education, Training and Youth Affairs (DEETYA) and paid under a number of different programs including the Vocational and Educational Guidance for Aboriginal Scheme (VEGAS). It is the VEGAS scheme from which the Science Circus receives its funding to visit remote Aboriginal and Torres Strait Islander schools.

Mandawuy Yunnipingu, cited in Potter (1994), made the point that Yolngu learning methods are different to Western methods:

It (Yolngu method) is different in that it is centred on kinship; centred on a system that is governed in a social sense—how we relate to each other and how things are run, everyday normal sort of things. We learn and abide by the kinship system and it can be applied to Western areas where Yolngu people have traditionally had trouble grasping concepts such as mathematics and the science...by applying the recurring themes of our kinship system (p. 3).

Potter (1994) encourages teachers to use more personally empowering strategies when teaching to include active involvement, collaborative processes, experimental learning and problem solving and decision making skills. She believes it is the teachers’ responsibility to enthuse the students with the subject matter. However, there is evidence to suggest that many teachers do not attempt to help the students in this way (Eibeck 1994).

Mandawuy Yunnipingu referred to unity as the heart of Aboriginal learning. Learning in the Aboriginal way involves people working and learning together. Christie (1994)
suggests that the Western curriculum does not work well for Aboriginal students because children have little guidance from older Aboriginal students, they can’t learn at their own speed because of rigid timetables and they are told when to move from one activity to the next. He strongly supports the idea of workshops or activity based time blocks, where all ages of students can participate, and families and other Aboriginal community members being invited to help with the school activities which may make them feel welcome in the education environment. Von Sturmer (1994) reports that the community has little or no involvement with the schools. The school is viewed as outside the community and that parents may view teachers suspiciously.

Another issue of concern is the need for a high level of English in any area of study including mathematics and science. To communicate effectively with the teachers, the students also need to gain a clear understanding of maths and science meanings (Bucknall 1995).

It seems that for successful Aboriginal and Torres Strait Islander learning to occur a holistic approach is required. These children would be more suitable to activity based workshops where all ages of the community have some input. The Science Circus is a workshop based program that allows the students hands-on participation, group work and many other strategies mentioned above.

**Gender Issues**

Engineering has the lowest female share of any broad field of study with only 13% of total students enrolled in engineering in 1994 in Australia (Lewis and Harris 1995). Trankina (1993) in her reviews of USA surveys taken from 1972 to 1990 found that across all age groups from 20 to 79 years females had less confidence in science than males. More females believe that science breaks down people’s ideas of right and wrong and that science pries into things. Perhaps the reason for this gender disparity in attitudes may include: biological differences between the sexes with respect to quantitative skills and spatial visualisation; attitudes that females are ill-equipped to understand science, although incorrect, it may contribute to their lack of confidence; the perception that science is an
inappropriate career choice for females because it restricts family life; the likelihood of a less than supportive social climate for most women in science (Trankina 1993). Trankina supports affirmative action programs designed to recruit females, however, she believes this will have limited effects toward science attitudes. More appropriate strategies are required that focus on younger, school aged females.

Martinez (1992) reported that boys were more attentive to aspects of science experiments than elicit perceptions of control whereas girls were more attentive to social aspects. Teacher behaviour has been shown to play a role in the development of student attitudes toward science. When a teacher attends to the interest value of science students, especially females, they seem more likely to form positive attitudes toward science (Martinez 1992). It is vital that teachers are sensitive to the significant difference between male and female experiences.

Rennie and McClafferty (1996) reviewed a number of studies looking at gender-related behaviours towards science centre exhibits. Research findings indicate that children tend to behave in gender-stereotyped ways with boys and girls attracted to stereotyped play. For example boys were attracted to a Water Jet exhibit and girls to a Face Painting exhibit.

Kahle (1990) argues that both in-school and out-of-school experiences contribute to science knowledge, and that boys tend to have more science-based out-of-school experiences than girls. This then tends to foster success in in-school science.

The issues discussed above have implications for all aspects of science communication, including the outcomes of science centres and museums. The next chapter discusses a number of the above issues facing science centres and travelling science programs. The history and the components of the Science Circus are also discussed.
Chapter Four

Interactive Science Centres

This chapter reviews the role of interactive science centres in promoting the awareness of science and technology and takes an in depth look at the Science Circus and the research conducted on the Science Circus prior to this study.

Introduction

The first centre that contained interactive science exhibits originated in Paris at the Palais de la Découverte in 1937 (pers comm Groves 1997). In 1969 the first modern interactive science centre, The Exploratorium, opened its doors in San Francisco, California, USA (Shortland 1987). Since then many other centres have been launched throughout the world including Australia. These audiences of the science centres are encouraged to participate, discover and have fun.

Questacon–The National Science and Technology Centre, located in Canberra, is one such centre. In 1980, the original Questacon, the precursor to The National Science and Technology Centre, was established under the auspices of the Australian National University. Questacon had attracted a great deal of attention and this eventually resulted, in 1988, in its expansion to Questacon–The National Science and Technology Centre thanks to a Bicentennial gift from the Japanese Government. To be a truly national centre, as its title suggests, The National Science and Technology Centre (Questacon) has instigated many outreach programs one of which is the Science Circus (Questacon 1988).

Exhibits and Exhibitions

McManus (1992) has provided the following definitions to assist in distinguishing between a science museum and a science centre: science museum exhibits portray big concepts of science whereas science centres have a collection of interactive exhibits each representing a specific idea or concept. I would, however, tend to disagree with this interpretation of an
interactive science centre, as many today have exhibits based around themes which do portray a "big concept" of science, for example Questacon's *Environment* exhibition. A better distinction has been made by Danilov (1982) cited in Rennie and McClafferty (1996) that science museums emphasise cultural heritage through objects of intrinsic value while science centres aim to enlighten and entertain through contemporary and participatory exhibits. However, this is not altogether accurate as there are museums/science centres that have a combination of both. These centres are not just museums that have allocated an area to interactive exhibits but use cultural and contemporary exhibits. One such museum is Scienceworks in Melbourne, Australia.

Science centres are indeed very popular, as indicated by the number of people that visit them each year. Questacon reaches over one million people each year through its outreach programs, travelling exhibitions and its exhibits located in Canberra (Elsom per comm 1996). Science centres are fun, exciting and active environments; there are, however, those who feel that science is often short changed at these centres.

Fitzgerald and Webb (1994) quote Cossions, Director of the Science Museum in London:

...that museums would promote a critical understanding of science rather than promote science itself (p. 278).

As summarised by Rennie and McClafferty (1996) science centres are popular with the public; there are, however, accusations that the learning of science is a goal jeopardised, even trivialised, by concentrating on the visitors' enjoyment. They examined the role of science centres and their exhibits as potential learning places. Their findings are discussed later in this chapter.

**Exhibits and Exhibitions**

Interactive exhibits and hands-on exhibits are commonly thought of as the same thing; they have, however, one major difference. Hands-on exhibits require some physical involvement of the visitor with the exhibit, for example, to feel something or press a button
Chapter Four—Interactive Science Centres

to begin an audio-message. These hands-on exhibits are passive. Interactive exhibits are those that respond to action from the visitor and also invite a further response. Interactive exhibits can be hands-on because they rely on physical involvement. The main difference is that interactive exhibits offer feedback to the visitor provoking further interaction (Rennie and McClafferty 1996). Although this distinction has been made, many people are unaware of this.

Exhibits can either stand alone or be grouped. When there is a number of exhibits with a similar theme or style they are collectively referred to as an exhibition. An example of this is a recent exhibition at Questacon called BHP WildScience, where the common thread of the exhibits is the parallels between nature and science.

Semper (1990) recommends that the closer an exhibit is to the personal experiences of the visitor by using everyday objects and experiences the more interesting the exhibit. He also suggests that good educational exhibits are those where the learner is in control of the learning activity, the exhibits are attractive, easy to use and the environment in which the exhibits are located make the visitor feel comfortable to explore and learn. Kohlhagen (pers comm 1996) advocates that an exhibit should be designed on multiple levels to be beneficial to all visitors, young and old. If the exhibit allows all visitors to experience something then he feels he has designed a good exhibit. Semper (1990) looks favourably on museums and science centres as places where the exhibits provide a potential for meeting the comprehension levels of different people. In this way science centres are not just for children or school students but for adults also, although the playful atmosphere leads people to think that they are just for children.

Learning in Science Centres

Measuring learning in science centres is usually done by pre- and post-tests which are often very time consuming (Schibeci 1982; Stevenson 1991; Horvat 1996). Schibeci found that school children showed a measurable increase in knowledge, unlike adults, although he reported difficulties in obtaining both pre-test and post-test responses from adults.
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Stevenson (1991) found that there were long-term impacts of science centre on visitors. Several months after their visits, people were able to recall what they did with the exhibits and how they felt and thought about them. Visits to science centres are memorable (Stevenson 1991) and students’ attitudes are more positive after a visit (Finson and Enochs 1987). Horvat (1996) found a significant increase in student knowledge about whales after visiting the *Whales* exhibition at Questacon.

Feher (1990) strongly supports interactive exhibits as powerful learning tools. They are a teacher-free independent learning devices for the people using them and, in a secondary role, the exhibits allow researchers to study how the user learns. Feher describes the exhibits as teaching aids that provide four different levels of teaching: experiencing; exploring; explaining and expanding. The exhibit allows the user to experience the phenomenon by watching something happen. The user can then manipulate the exhibit and explore the science concept. The third level is conceptual. The fourth level involves the involvement of other related exhibits.

**Teachers’ Role Before and After Visit**

Teachers take their classes to visit science centres for many reasons: science enrichment, something different, a social experience for the students as well as to increase their exposure to science (Rennie and McClafferty 1996). It is important that teachers and students have a similar expectation for the visit.

Teachers who prepared pre-visit, in-visit, post-visit materials or combinations of these had their efforts reflected in more positive attitudes (Finson and Enochs 1987). In fact they indicated that students who did not visit the museum had more positive attitudes than the students who had an unstructured visit. Finson and Enochs accounted for this by relating it to Falk’s (1978) findings, that when students are subjected to novel environments such as those in museums they are concerned with adjusting to the environment rather than with learning, as often anxieties are developed.

Stronck (1983) compared the effects of a highly structured tour with a less structured tour
on children's attitudes and learning. He found that students learnt more on the guided tours but that students on the unguided tour had more positive attitudes:

Students on the unguided tours found the museum to be more exciting, less confusing, better, more useful and faster. (p. 288).

Stronck concluded that more positive attitudes occurred with less learning, confirming the findings of Falk (1978) that students learn less in novel settings.

Science centres can be used as educational resources. Teachers can make effective use of the visit by integrating the visit with their teaching program to complement the learning activities in the classroom. Rennie and McClafferty (1993) emphasise the importance of pre-visit preparation for both teachers and students, including making clear to students the nature of post-visit activities.

Generally science centres' exhibitions have some exhibits linked to relevant curriculum documents, and provide guidance and resource material for teachers organising the visit.

**Shell Questacon Science Circus**

The *Science Circus* is the major outreach program of Questacon. It is a travelling exhibition which provides opportunities for hands-on science throughout Australia's remote townships and regional cities. Yearly it attracts an audience of between 70,000 to 80,000 people. The *Science Circus* endeavours to communicate with all ages of school students, business people, university students, prisoners, hospital patients, aged people, remote Aboriginal communities and School of Distance Education (formerly known as School of the Air) students.

The original Questacon *Science Circus* began in 1985 and involved students from the ANU. In 1987 Shell Australia provided $750,000 in sponsorship over five years to ensure the *Science Circus* would take to the road on a permanent basis. Since then, Shell Australia has continued to fund this unique program. Since its inception the *Science Circus* has
visited every state in Australia (see Appendix I and II) and has been the learning environment for 105 graduates who have since been employed in a wide range of science, science education and science communication fields.

In 1988 the *Science Circus* was staffed by nine students studying for their Certificate in Scientific Communication at the Australian National University. In each of the following four years ten students were selected. In 1991, after requests from previous graduates of the certificate program, the course was upgraded to a Graduate Diploma in Scientific Communication and although there was an increase in the course work the *Science Circus* remained the integral part of the course.

Today the *Science Circus* is staffed by fifteen students studying for a Graduate Diploma in Scientific Communication. The coursework component of the course has adapted due demands from the students and changing employment opportunities. The *Science Circus* has become the ‘practical laboratory’ of the Graduate Diploma. The Graduate Diploma students perform many tasks enabling the *Science Circus* to operate. These tasks include packing and unpacking of the exhibits, performing science demonstration shows, training local high school students as Explainers, promoting the *Science Circus* in the media, explaining the exhibits to visitors, and operating the science shop and admission desk.

Much of the course work and the *Science Circus* work complement each other such as the Applied Project, the Research Project and the media component. The Applied Project allows the Graduate Diploma students to creatively design and develop and interactive science exhibition or a science demonstration show. The Research Project may involve an evaluation of an aspect of the *Science Circus* and the media component involves training for interviews, writing media releases and developing promotion strategies for the *Science Circus*.

The *Science Circus* has two main components when touring on the road. The first is the school session where the Graduate Diploma students go into schools to perform science demonstration shows, as shown in Plate 4.1. The second is the public venue where the general public can visit either during the evening or over the weekend. The interactive exhibits, shown in Plate 4.2, and the *Science Circus* shop are set up at the public venue.
Chapter Four—Interactive Science Centres

Plate 4.1: A Graduate Diploma student performing the ‘Up Up and Away’ science demonstration show, to a group of school children.

Plate 4.2: A Graduate Diploma student explaining an interactive exhibit, the Zoetrope, to a young visitor at the Science Circus public venue.
The school sessions are presented by a pair of the *Science Circus* Graduate Diploma students. A one-hour science show is presented in a fun and lively way to a school group of a maximum of 120 students. The same format is used for all ages, from lower primary to upper secondary school students. The general format consists of: a five minute introduction; a 20 minute science show; a ten minute session on an interesting aspect of science and scientists (allowing for the transition of props and presenters); a second 20 minute science show and a five minute conclusion and question time. This rigid format can be varied once the Graduate Diploma students are comfortable with performing to such large groups and have had experience in ‘reading’ audiences. Other formats are suggested usually during the second half of the year. Changes are not compulsory, but most Graduate Diploma students are very receptive to variety.

The science shows aim is to entertain. Basic scientific concepts are explored and everyday equipment and examples are used, allowing the audience to replicate many of the demonstrations for themselves at home. The shows are interactive through the use of friendly questions and calling upon audience members to assist with some of the demonstrations. Two examples of shows are the *Pressure Show* which explores atmospheric pressure and the *Up Up & Away Show* which considers many aspects of flight.

The school students pay $3 for the one hour performance and receive a free ticket to visit the public venue. This is a strategy of Questacon’s to encourage parents to visit the *Science Circus* with their children. The $3 charge is comparable to other travelling programs by both science and art performers, who do not offer a free ticket to an additional venue (pers comm Cooper 1995; Queensland Arts Council 1996).

At public venue sessions, adults and children can interact with over 50 hands-on exhibits and watch science demonstration shows. The hands-on exhibits rely on the physical interaction of the visitor. Like the shows, the exhibits explore scientific concepts enabling the visitor to explore through interaction. The Graduate Diploma students of the *Science Circus* perform shows, explain exhibits to the visitors as well as handle admissions and shop purchases.
Chapter Four—Interactive Science Centres

The tour coordinators, with one exception, are past students of the Scientific Communication course and can relate to the needs of their students and are very familiar with the format of the Science Circus. In a somewhat tiring tour the Graduate Diploma students perform consistently at a high level to entertain the public.

Prior Research

Falk and Dierking (1992) defined visits to institutions such as museums and science centres as a leisure time experience, meaning that these centres are competing with sport, television, reading or other leisure activities. From this perspective there are several factors which influence visitor’s decisions to attend: convenience, how far away is it and how long will we spend there?; money, is there an entrance price and is there a gift shop?; benefits, is it fun or educational?

Studies have shown that more than half the visitors to contemporary and interactive science centres in the United States are adults (Semper 1990). Similar figures are observed at Questacon (Datacol 1994). When these numbers are compared with those of the Science Circus, a difference is observed. Adults who visit the Science Circus public venue make up approximately 25% to 37% of the total number of visitors (unpublished tour data of 1993, 1994, 1995 and 1996). The lower percentage may be due in part to the fact that all school students visited by the Science Circus receive free tickets enabling them to attend the public venue.

In 1991 Peter Judge was commissioned to evaluate the Science Circus by two different surveys designed to seek the opinions and advice of first, the schools visited by the Science Circus and second, the adults who visited the Science Circus at the public venues. However the surveys were very general, brief, poorly worded and biased towards favourable responses. Judge sent out a total of 528 letters and questionnaires to schools contacted for visits by the Science Circus in 1990 and 1991. Of these, 284 completed forms were returned and analysed. The data were coded into a database and the results were displayed as percentages. There was no testing for statistical significance, as this was considered unnecessary. Almost all questions on the survey were closed questions allowing
the respondents to tick the correct box. Judge concluded that teachers enjoyed the Science School visit, particularly, due to the hands-on nature of the demonstrations (Judge 1991a).

To evaluate the visitors' opinion of the *Science Circus* the survey was conducted over one tour in NSW in September 1991. The questionnaire was presented on two sides of an A5 card. The cards were handed out to adults just as they were leaving, with the request that they complete them. Of the 471 cards collected, many were incompletely answered. This reflects the imprecision of a self-administered questionnaire compared with that of a structured interview. The data were coded into a data base and the results displayed as percentages. Possible differences in the results between the towns visited by the *Science Circus* were investigated. The main conclusion of this component of the study was that the *Science Circus* was very popular (Judge 1991b).

Anderson (1992) recorded many positive comments from primary school teachers when asked their perspective of the *Science Circus*. This study suggested the following improvements:

- minimise the number of students in a school session
- the use of a platform for large school sessions to elevate the presenters allowing greater visibility for students
- slow the rapid speech delivery of some presenters
- provide related follow-up activities and teacher resource material, particularly the *Science Toys and Activities* booklet and Questacon *Exsciter Packs*.

An attempt was made to implement these recommendations (Clugston pers comm 1995). Lowering the number of students in a session had an extreme effect on the income of the *Science Circus*, to the extent where it could not operate as a cost-recoverable program. Presenters are provided with training for voice delivery and projection. Consultants have been employed to produce follow-up materials and these can be purchased through the Science Shop of the *Science Circus*.

It has been demonstrated that lower primary school students benefit from the science shows, either remembering or both remembering and learning science concepts (Jones
Unfortunately, there are very few shows in the *Science Circus* which are tailored to such young audiences. The materials need adapting and the presenters require additional training to feel comfortable in performing to this age group.

The past experience of the *Science Circus* with Aboriginal children in remote communities has indicated an overwhelming response to very visual and hands-on science shows, enabling the students to participate rather than just listen (unpublished tour reports 1988, 1989, 1990, 1991, 1992, 1993, 1995 and 1996). The programs offered to these groups are adaptations of the science shows performed in school sessions.

Leow (1993) found that young adults, 18–25 years of age, and older adults, over 50 years of age, are under represented at the *Science Circus*. This may be due to its advertising campaign, which mainly targets school children and their parents, or perhaps the *Science Circus* doesn't appeal to these age groups. This study also suggested increasing the advertising in local newspapers.

In 1993, Purdie compiled 25 responses to a questionnaire from schools in the Kimberley region, visited by the *Science Circus*. This small evaluation collected mostly positive comments from all teachers.

Over (1994) researched the effect a science centre has on its visitors’ understanding of science. It was discovered that a visit to Questacon makes people more positive about science’s ability to solve problems. Over three quarters of surveyed visitors felt that their visit had increased their knowledge of science and technology. However the survey did not determine whether their belief was based upon an actual increase in knowledge. It was also found that a visit to Questacon did not increase the visitors’ desire to know more about science and technology. The study did not prove that Questacon increases understanding of science (Over 1994).

Vandermark (1995a and 1995b) concluded from her research that both school teachers involved in the *Science Circus* school visits and adult visitors to the public venues believed that the *Science Circus* was very effective in meeting its goals of generating interest in science and technology. Success was also found in the areas of publicity, operations and
style. Two questionnaires developed for the two different groups were divided into six sections surveying the following: demographics; publicity; operations; style/methodology; attitudes and follow-up. Closed questions and scaling were mostly used.

The data from schools were obtained by mailing out 296 questionnaire packages containing a letter of introduction, three copies of the questionnaire and three replied paid envelopes. From this mail out 267 responses were received, a response rate of 90% was recorded (Vandermark 1995a). Vandermark suggests the high response rate could be contributed to:

- sending three copies of the questionnaire to each school
- extending the time period for accepting responses
- offering a lucky draw prize as an incentive to return the questionnaire.

If the procedure of posting more than one questionnaire to each school were to be repeated it would be advisable to determine the number of completed questionnaires returned from any one particular school. This will help with reliability of the data.

The questionnaires for the public venues were administered to adults as they were leaving the Science Circus by four surveyors. A total of 141 questionnaires were completed over a three week period (Vandermark 1995b). All data for this component of Vandermark’s research were obtained from one area, which is not a true representation of the people in regional Australia.

Thus there have been numerous studies on the Science Circus, however, there has never been an evaluation determining if the Science Circus is achieving its goals.
Chapter Five

Methodology

Introduction

The methods adopted in this study are designed to generate an understanding of the effects the Science Circus has on the different groups it interacts with, namely primary and high school students, their teachers, community members, Aboriginal students and their teachers. While the people who come in contact with the Science Circus are the main focus of this study, schools that do not book Science Circus visits have been included to canvass teachers’ reasons as to why the Science Circus invitation was not accepted.

A number of methods were employed to obtain data from the sources mentioned above, including interviews, questionnaires, attitude tests and analysis of secondary data on the Science Circus.

This chapter is divided into three sections detailing the methods used in the study:

- Survey Research—this section provides a brief explanation of each method and its advantages and disadvantages.
- Application of Methods—this section discusses the reasons behind the choice of methods and participants used in the study.
- Collation, Coding, Analysis and Interpretation of Data.
Section One—Survey Research

Surveys include all observations that are capable of providing information about human actions occurring in non-laboratory environments. There are many methods available to the researcher and each method reveals slightly different facets of the same situation. By combining several of these methods the researcher obtains a better, more substantive picture of reality. This use of multiple methods is referred to as triangulation. Triangulation can be broken up into four categories:

- Data triangulation consists of three subtypes: time, space and person.
- Investigation triangulation consists of using multiple rather than single observers of the same object.
- Theory triangulation consists of using multiple rather than single perspectives in relation to the same set of objects.
- Methodological triangulation can entail within-method triangulation and between-method triangulation. (Berg 1995)

It is suggested that researchers, particularly novice researchers, use triangulation that include a multiple data collection procedures, multiple theoretical perspectives, and/or multiple analysis techniques. This use of multiple research strategies should increase the depth of understanding of the investigation data.

Survey research is one method of collecting, organising and analysing data. The relevant data can be collected by a variety of techniques and in many studies it may be appropriate to use a number of research methods. There have been many criticisms about surveys, but much research has been done to recognise the principal causes of error. De Vaus (1985) strongly states that surveys should only be used when they are the most appropriate method for the task, a variety of data collection techniques should be employed and different analyses used. In conclusion, de Vaus recommends that the method should suit the research problem rather than the problem being fitted to a set method.

Foddy (1993) investigates the main problems associated with survey procedures and reports on Belson’s (1986) conclusions of the five principal causes of error in the gathering
of data through survey procedure. The causes of error are:

- respondents' failure to understand questions as intended
- a lack of effort, or interest, on the part of respondents
- respondents' unwillingness to admit to certain attitudes or behaviours
- the failure of respondents' memory or comprehension processed in the stressed conditions of the interviews
- interviewer failures of various kinds (for example faulty recording procedures)

However, good survey research can be achieved with a thorough understanding of the method and being aware of the limitations of each of the methods of research (de Vaus 1985).

The techniques used in this study are briefly reviewed and described below. The five methods are:

- interviews
- questionnaires
- attitudinal instruments
- participant observation
- secondary data collection

**Interviews**

An interview can be described as a conversation with a purpose (Berg 1995). Interviews can take many forms and are usually classified according to the degree to which they are standardised. There are at least three major categories which can be identified: standardised, un-standardised and the semi-standardised interview. The standardised interview uses a formally standardised schedule of interview questions. This technique is used when the researcher can compare the answers of each respondent. The un-standardised interview is in complete contrast to the standardised interview, where the researcher does not use a schedule of questions. There is a defined topic and the interview
can be viewed as a ‘chat’. The semi-standardised interview is located somewhere between the extremes of standardised and un-standardised interview structure. The interviewer has a number of predetermined questions which are asked in a systematic order, however, there is the freedom to digress (Berg 1995).

Whilst interviews allow quick access to information and provide an avenue to obtain rich insights the method presents some difficulties. Some of these difficulties include potential problems with validity of responses, variation between interviews depending on context and interviewer’s sensitivity to answers, and the time consumed by the interview itself and the time required to transcribe the information collected (Berg 1995).

Questionnaires

Asking questions is widely accepted as a cost efficient and sometimes the only way of gathering information about past behaviour and experiences, private actions and motives, and beliefs, values and attitudes (Foddy 1993).

Foddy (1993) details ten problems associated with questionnaires and provides scope for finding solutions. The ten problems which have been found with much social research in the past are:

- factual questions sometimes elicit invalid answers
- the relationship between what respondents say they do and what they actually do is not always strong
- respondents’ attitudes, beliefs, opinions, habits and interests often seem to be extraordinarily unstable
- small changes in wording sometimes produce major changes in the distribution of responses
- respondents commonly misinterpret questions
- answers to earlier questions can affect respondents’ answers to later questions
- changing the order in which response options are presented sometimes affects respondents’ answers
• respondents' answers are sometimes affected by the question format
• respondents often answer questions even when it appears that they know little about the topic
• the cultural context in which a question is presented often has an impact on the way respondents interpret and answer questions.

Although there are problems with questionnaires, over the past 50 years few alternative techniques have been suggested (Foddy 1993).

Survey researchers attempting to identify views on issues are confronted with the problem of how to use open-ended or closed-ended questions. An open-ended question allows respondents the freedom to construct their own answers and a closed-ended question is one where respondents are obliged to select their response from a limited range of prescribed responses.

Advocates of open-ended questions argue that they allow respondents to say what is really on their minds without being influenced by suggestions from the researcher. Advocates of the closed-ended questions equally argue that they allow large scale surveys to be conducted quickly. Both question types have positive and negative features as shown in Table 5.1.

Open-ended and closed-ended questions are used for different purposes, can be used well together and are very appropriate in surveys of public understanding of science and technology (Bauer and Schoon 1993). Open-ended questions are, however, recommended for exploring new ideas, measuring sensitive issues and for measuring social attitudes (Foddy 1993). As quoted in Foddy, Schuman and Presser (1979) suggested:

differences (in response distributions for open and closed versions of the same questions) will be minimised if investigators begin with open questions on large samples of the target population and use these responses to construct closed alternatives that reflect the substance and wording of what people say spontaneously (p. 128).
Table 5.1: Advantages and disadvantages of open-ended and closed-ended questions (source: Foddy 1993; Bauer and Schoon 1993).

<table>
<thead>
<tr>
<th>Open-ended questions</th>
<th>Closed-ended questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>的优点</td>
<td>优点</td>
</tr>
<tr>
<td>• allow respondents the freedom to construct their own answers</td>
<td>• allow respondents to answer the same question so that answers can be meaningfully compared</td>
</tr>
<tr>
<td>• avoid bias by not suggesting response choices</td>
<td>• are easy to answer</td>
</tr>
<tr>
<td>• allow complex motivational influences and frames of reference to be identified</td>
<td>• are quick to answer</td>
</tr>
<tr>
<td>• are flexible to discover meanings and ideas</td>
<td>• produce less variable answers</td>
</tr>
<tr>
<td>• avoid format effects</td>
<td>• are easy to count and compute</td>
</tr>
<tr>
<td>劣点</td>
<td>劣点</td>
</tr>
<tr>
<td>• require great skill in formulating the questions and interpreting the results</td>
<td>• may not have catered for all possible answers and result in channelling and distorting responses</td>
</tr>
<tr>
<td>• are time consuming to fill in</td>
<td>• may elicit response even though respondents know nothing about issue</td>
</tr>
<tr>
<td>• are time consuming to process</td>
<td>• may not be relevant</td>
</tr>
<tr>
<td>• respondents differ in articulation so that differences in responses may reflect differences in articulation as much as differences in opinion</td>
<td></td>
</tr>
</tbody>
</table>

Questionnaires can be administered in different ways, of which the two most common are via the mail and face to face. However, response rates to questionnaires administered by the postal system are usually around 30–35%, which is considered quite low, after the initial mailouts. The response rates increase if follow-up procedures are used (de Vaus 1995). Mail questionnaires provide no control over the order in which people answer questions, which could obscure the answers. The order in which people read the questions could easily influence the way they answer them. They are not suited to many open-ended questions or long complex questionnaires. Identification numbers should be used on questionnaires, letters and envelopes.
To maximise the response rate de Vaus (1995) recommends the use of an incentive such as the promising respondents that they will enter a draw for free lottery tickets. Follow ups are often required to achieve response rates similar to those obtained using telephone or personal questionnaires.

**Attitudinal instruments**

There are a variety of methods which have been used for the assessment of attitudes (Ayers and Price 1975; Piburn and Baker 1993; O’Brien and Porter 1994; Gogolin and Swartz 1992; Finson and Enochs 1987; Haladyna and Shaughnessy 1982; Colless 1991; Harris 1995). From this research it became obvious that the measurement of attitudes requires a scaling system.

There are many different types of scales detailed in a number of social research text books, and the differences between the techniques and appropriateness of each scale are not immediately obvious. Examples of scales that have been used in the past are summated scales (rating scales), Likert scales, Thurstone scales, magnitude scaling and semantic scales.

De Vaus (1985) indicates there are five reasons why it is desirable to measure a concept by using multiple indicators rather than one. Scales assist in the investigations by:

- getting to the complexity of the concept
- assisting in developing more valid measures
- helping to increase reliability
- enabling more precision
- simplifying the analysis considerably by summarising the information conveyed by a number of questions into one variable.

Many attitude scales yield a single score to represent an attitude. Such instruments fail to distinguish between the aspects of the attitude (Foddy 1993; de Vaus 1985). Sandman and Swartz, cited in Gogolin and Swartz (1992), argue that the effects of one variable may
cancel or dilute another variable if combined in the assessment instrument.

Schibeci (1982) researched the reliability of two methods for the measuring of student attitudes, semantic differential scales and Likert instruments. He concluded that high school students’ general attitudes to science can be readily measured using a semantic differential scale and if more specific attitudes are to be assessed then Likert instruments would be more appropriate.

Oppenheim (1992) recommends that:

No amount of statistical manipulation will produce a good attitude scale unless the ingredients are right... the attitude statements... (they) are the raw material of attitude scales (p. 174).

A science attitude inventory was devised for this study, based on attitudinal questionnaires used in the past and as this study is assessing general attitudes toward science the semantic differential was chosen (Harris 1995; Gogolin and Swartz 1992; Colless 1991).

**Participant observation**

Participant observation is where the researcher is able to observe the naturally unfolding worlds of the population under study (Berg 1995). Unobtrusive data collection is where there is no interaction between the subjects an the investigator and the measures remain at the realm of the surface level. This data collection has little cost but is very time consuming.

**Secondary data collection**

At times it is extremely difficult to obtain samples that are sufficiently large and representative to allow adequate analysis. The problem may be compounded when data are needed for a whole nation rather than a local area. Often the solution is to either abandon the project or collect an inadequate sample so the study becomes only exploratory. There can be an alternative and that is the use of data collected by other people or agencies, and
this is called secondary analysis. There are disadvantages to secondary analysis as the data sets may not reflect the exact questions the researcher is asking. However, with a little creativity, ingenuity and compromise it is often possible to obtain satisfactory measures for the concepts required in one’s own research (de Vaus 1995).

Summary of methods used

The research methods chosen are further described within the description of the methods for each particular group of participants. A summary of each different method is presented in Table 5.2 and Figure 5.1.

Table 5.2: Methods used for the collation of data.

<table>
<thead>
<tr>
<th>Method</th>
<th>Group/Source</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionnaire</td>
<td>School teachers</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>School students</td>
<td>536</td>
</tr>
<tr>
<td></td>
<td>Remote school teachers</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>SQSC public venue visitors</td>
<td>693</td>
</tr>
<tr>
<td>Attitudinal instrument</td>
<td>School teachers</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>School students</td>
<td>536</td>
</tr>
<tr>
<td>Interviewing</td>
<td>School teachers</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Remote school teachers</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Parents</td>
<td>over 50</td>
</tr>
<tr>
<td></td>
<td>Graduate Diploma students</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Questacon staff</td>
<td>5</td>
</tr>
<tr>
<td>Secondary data analysis</td>
<td>SQSC reports</td>
<td>12</td>
</tr>
<tr>
<td>Participant Observation</td>
<td>School visits</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>SQSC public venue visitors</td>
<td>20</td>
</tr>
</tbody>
</table>
Figure 5.1: Summary of the evaluation methods and groups.

**SQSC Evaluation**

**Secondary Data**

**School Visits**
- Teacher Interviews
- Student Observation
- Questionnaire
- Grad. Dip Students Interviews
  - Booked Schools
  - Non-booked Schools
  - Control Schools

**Public Venue**
- Exit Polls
  - Teacher Interviews
  - Student Interviews
  - Visitor Observation
    - Adult
    - Staff

**Remote Visits**
- Teacher Interview
- Teacher Questionnaire
- Grad. Dip Students Interviews
- Student Observation
Section Two—Applications of Method

The study has been broken up into three components: the school visits, the public venues and remote community visits indicated in Figure 5.1. Each of these three components were investigated using a number of the methods detailed below. Some of the methods were used more than once in the different stages of the study. The techniques used for each component are described below. First, the background provided by the secondary data analysis will be discussed.

Secondary data

There have been many studies conducted by Australian National University students, studying for the Graduate Diploma in Scientific Communication, who have undertaken small research projects on various aspects of the Science Circus (Colless 1991; Barbagallo 1991; Jones 1992; Anderson 1992; Leow 1993; Tennant 1995; McIntyre 1996). In previous years Questacon has contracted two consultants to evaluate the Science Circus: Judge in 1991 and Vandermark in 1995. An independent teacher, Purdie, from a school in the Northern Territory reviewed the Science Circus visit to his area in 1993. The results from these various evaluations were summarised and the outcome of the collated data influenced the nature of this research project.

The research projects mentioned above have included general evaluations of the Science Circus, explorations of the perspectives of primary school teachers, assessment of the effectiveness of science shows for young children, investigation of the lack of adult visitors to the public venues and the effects of volunteers during a science demonstration show.

Public venue and school statistics from Science Circus tours over the past seven years have been recorded for the Science Circus budget reconciliation, reports and reviews for supporters and sponsors. These data were collated and trends were calculated to determine differences between the years, including numbers of schools visited, numbers of student returns, numbers of venue hours. These data were used to show the many differences between each year including whether the Science Circus visited remote areas, communities suffering from drought, major towns or cities and lengths of tours.
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The collated statistics and the results from the many research projects conducted on the *Science Circus* were discussed with many members of the Questacon staff. Informal meetings were held with the three coordinators of the *Science Circus* and the Manager of the Outreach Program, to discuss the significance of the data and their implications. The gatherings were semi-standardised; there was, however, enough flexibility to allow new ideas to be discussed. Future directions of the *Science Circus* were discussed, as were new formats and new programs which could assist the many people in regional and remote areas of Australia. Ideas ranged from new exhibit concepts to new demonstration shows, and new programs for high school students to students in remote community schools.

These informal meetings were usually held away from the office to provide a relaxed atmosphere. From these meetings ideas were generated which were followed up on tours to enhance the overall experience of the *Science Circus*.

**Component one—School visits**

This is the main component of this study. Teachers were interviewed, students were observed, teachers and students answered questionnaires to determine their impressions of the *Science Circus* and their attitudes were sought before and after the *Science Circus* had visited their school. Activity sheets were developed from the initial interviews and the evolution of the activity sheets is discussed.

**Teacher interviews**

Many opportunities were made available to me to interview teachers in many regions of Australia when travelling with the *Science Circus*. Both un-standardised and semi-standardised protocols were used throughout the project. Un-standardised interviews were initially used to determine the important issues that the teachers wanted to raise. The results obtained from the un-standardised interviews provided questions to be asked in the semi-standardised interviews.
The questions were designed to obtain a general impression of the teacher’s thoughts on the Science Circus’ presentation and philosophy. The questions which were asked are listed below:

- Was the presenters’ language appropriate for the age group?
- Did you enjoy the show?
- Do you think the hands-on nature assisted the presentation?
- How could the performance be improved?
- What other things could the Science Circus do to help teachers?

Most of the interviews with teachers were carried out whilst visiting the school with the Science Circus. They were usually conducted just after the one hour presentation, or occasionally during the end of the presentation if the teacher indicated they had little time after the presentation. The length of the interviews was dependent on the time the teacher had and her or his level of interest. Most of the teachers were very happy to engage in the discussion. The length of the interviews ranged from an estimated 5 to 15 minutes, with the majority of the interviews lasting approximately 10 minutes. Out of all the teachers interviewed nine teachers were very keen to chat and either stayed to talk during the lunch break, at the public venue or, in one case, at the pub over a beer and a game of pool. Some teachers were difficult to approach as they seemed displeased with the fact their class lesson was disrupted. An effort was made to interview these teachers for their views and I generally found they were willing to help.

The information obtained from these discussions was noted on the Graduate Diploma students’ feedback sheets during the discussion, in point form. The writing of these notes did not hinder the discussions, as the notes were brief to avoid losing eye contact. It should also be noted that some of the information was relevant to individual show performers and when this was the case the comments were passed on to the Graduate Diploma students, for encouragement or for further improvement, during their feedback session on their show performance.

A lot of data were collected using this method. On average, 20 schools were visited each tour to assess each of the Graduate Diploma student’s show performance and to talk with
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teachers. Over 100 teachers were interviewed in the two year period. In some cases, where the teacher had a more than usual involvement with the *Science Circus*, a more in depth discussion came about. For example, the teacher may have organised clusters of smaller schools, assisted with the organising of the public venue location, provided local high school students as Explainers, or just had a keen interest in science. These discussions were very beneficial as these teachers openly discussed their needs in science education and ways in which the *Science Circus* could help them and their students.

**Student observation**

Whilst visiting the school during a *Science Circus* science demonstration the school students were observed in order to determine their enjoyment and interest levels. I was undertaking a purely observational role. When observing the students I sat towards the back of the room to one side where I could see students’ facial expressions. My observations were mainly unnoticed unless one of the Graduate Diploma performers mentioned my presence, but this was only at the end of the performance and the reason given was in relation to their own assessment not the student observation. For example, at the end of a show one Graduate Diploma student was in the habit of requesting a loud round of applause as this would “show his marker/teacher up the back how much you enjoyed the show and I’ll get a good mark”. Notes were recorded at all times on Graduate Diploma student feedback sheets. Although this was a very time consuming exercise it provided a valuable insight to the levels of enjoyment and interest.

Levels of enjoyment were determined by laughter, looks of amazement, as shown in Plate 5.1, and whether the audience was attentive. It was very easy to determine whether the students were enjoying the show by the amount of disruption in the class.

It must be noted that particular Graduate Diploma presenters were able to hold the audiences attention more than others, particularly with high school audiences. Difficulty arose when there was one exceptional presenter who could easily build a rapport with their audience and one presenter who did not have this ability. This created a situation where the students may have only enjoyed half of the presentation. As previously mentioned this study was not looking at individual performances but at the *Science Circus* as a whole.
Plate 5.1: A school group enjoying a Science Circus demonstration show. The obvious signs of enjoyment are the audiences’ laughter, looks of amazement and attentiveness.
Great Ocean Road tour evaluation

This component of the study was conducted in schools in the Great Ocean Road region in southern Victoria, Australia, during a typical tour of the Science Circus. All schools in this region were contacted by written correspondence requesting their involvement in the evaluation, whether they were to be visited by the Science Circus or not. The final sample consisted of 546 students and 40 teachers from 19 schools. The schools included a mix of primary and secondary schools, Catholic, private, independent and state schools.

The questionnaire assessed student and teacher opinions on the Science Circus and as part of the questionnaire the attitudes of teachers and students were assessed before and after the Science Circus visits using a attitudinal instrument.

Selection of participants

The schools were those in the Great Ocean Road region, which was the area that the Science Circus was visiting for three weeks in November 1996. The procedure for organising a Science Circus tour is similar each time, once the region has been decided. The coordinator obtains a listing of school addresses and contact names for the region. All schools are sent information on the Science Circus, including the dates of the intended visit, and booking sheets. The information is posted approximately six months in advance to allow schools enough time to organise the visit. Schools are informed that all bookings are mandatory. Schools that request a visit are recorded and there is further correspondence between the coordinator and the school. If there are vacancies in the bookings those schools that did not respond to the first mail-out receive a second invitation.

Once all of the above correspondence had been sent and the bookings were almost full for the Great Ocean Road tour, the questionnaires were posted. Of the 228 schools in the region, 52 schools booked a visit with the Science Circus. These 52 schools (which will be referred to as ‘booked’ schools) were sent a ‘booked’ evaluation package and the remaining 176 schools (‘non-booked’ schools) were sent a ‘non-booked’ evaluation package, both described in the instrumentation section below. In addition five schools not being visited by the Science Circus were randomly chosen as control groups and were also
given ‘booked’ evaluation packages.

Both the teachers and students of the ‘booked’ schools were requested to fill out questionnaires while only the teachers of the ‘non-booked’ schools participated in the evaluation. Both the students and the teachers of the control groups were requested to complete the questionnaires, where the students were also requested to participate in the evaluation.

The participants from the ‘booked’ schools and the control groups were requested to complete a pre-test approximately one to two weeks before the Science Circus visit and to complete a post-test approximately three to five days after the visit. The control groups conducted the pre-test at the same time as the ‘booked’ schools and administered the post-test to a similar time as the ‘booked’ school, approximately two weeks after the pre-test.

The teachers of the ‘non-booked’ schools were asked to complete one questionnaire, which was posted the same time as the ‘booked’ evaluation packages.

**The questionnaires**

Three questionnaires were developed for this evaluation in the Great Ocean Road region for teachers from ‘booked’ schools; students from ‘booked’ schools (also used for the control group students) and teachers from the ‘non-booked’ schools (also used for the control group teachers). The questionnaire tool discussed in this section refers to the ‘booked’ schools. The questionnaire employed for the ‘non-booked’ school is further discussed in the ‘non-booked’ schools section.

A Likert-type scale consisting of six statements for the students and nine statements for the teacher was used to determine the respondents’ opinions of the Science Circus visit. To minimise the effects of unthinking responses two statements from each of the questionnaires were stated negatively. For example, one of the negative items was ‘The length of the show was too long’. The respondent was asked to indicate whether she or he thought the show was definitely not, probably not, unsure, probably yes or definitely yes, too long; the response was then scored one, two, three, four or five, respectively. The
scores for the negatively stated items were reversed in the summation. The teacher questionnaire statements had two main concepts; the Science Circus presentation and the Science Circus as a valuable teaching resource. All six of the student questionnaire statements were in regards to the Science Circus presenters and the actual Science Circus presentation. These were summed to give one response for their enjoyment of the Science Circus visit. It was found that one of the statements was not answered very well as it was poorly worded. This question, ‘I didn’t learn any science’, was left out of the summation.

The before and after teacher questionnaires consisted of open-ended questions which sought demographics, opinions on the Science Circus resource kits and activity sheets, the Science Circus public venue and further suggestions on how the Science Circus and Questacon can assist teachers in the teaching of science.

**Attitude assessment instruments**

The second part of the questionnaire consisted of an attitude assessment instrument. The respondent was asked to provide reactions to the concepts by means of a set of bipolar adjective pairs and phrases. Each adjective pair/phrase is separated by a five-point scale, consisting of a horizontal line with five vertical dividers. The respondent was asked to mark the line which was then assigned scores of one, two, three, four and five respectively, with zero being counted for no response being recorded.

The teacher attitudinal inventory sought teachers’ reactions to four concepts: attitude to science, science in society, attitudes to scientists and scientists in society. Representative statements used for each of the four concepts are shown in Table 5.3. A total of 22 adjective pairs and phrases were used.

The students attitudinal inventory sought student reactions using 18 adjective pairs and phrases for the same four concept as the teachers. The adjective pairs and phrases used were chosen to be accessible for both primary students and high school students, rather than a formal approach, after trialling various wording with a group of students. Examples of the pairs and phrases are given in Table 5.4. The instrument was appropriate for students between Years Four and 12.
**Table 5.3: Representative items contained in the Teacher Science Attitudinal Inventory.**

### Attitude to Science

I think science is:

- Interesting - Boring
- Monotonous - Full of variety
- Relevant to me - Irrelevant to me

### Science in Society

We should encourage science research - We should stop science research

Science contributes to society’s well-being - Science doesn’t contribute to our standard of living

Science offers equal opportunities for women - Science does not offer equal opportunities

### Attitudes to Scientists

Scientists are:

- Humble - Arrogant
- Eccentric - Normal
- Socially inept - Socially adequate

### Scientists in Society

Scientists:

- Try to be useful - Don’t care about the relevance of their work
- Are only interested in their results - Try to spread their work for the greater good
- Are good communicators - Are poor communicators
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Table 5.4: Representative items contained in the Student Science Attitudinal Inventory.

<table>
<thead>
<tr>
<th>Attitude to Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think that science is:</td>
</tr>
<tr>
<td>Interesting - Boring</td>
</tr>
<tr>
<td>Fun - Painful</td>
</tr>
<tr>
<td>Easy - Difficult</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Science in Society</th>
</tr>
</thead>
<tbody>
<tr>
<td>We should encourage science research - We should stop science research</td>
</tr>
<tr>
<td>Science helps us - Science doesn't help us</td>
</tr>
<tr>
<td>I notice science in my daily life - Science never comes to mind outside school</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attitudes to Scientists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientists are:</td>
</tr>
<tr>
<td>Cool - Nerdy</td>
</tr>
<tr>
<td>Normal - Weird</td>
</tr>
<tr>
<td>Good looking - Ugly</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scientists in Society</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientists are:</td>
</tr>
<tr>
<td>Useful to have - Not useful to have</td>
</tr>
</tbody>
</table>

'Booked' schools

Of the 52 schools that were sent the ‘booked’ evaluation packages, 32 schools (25 primary schools and seven high schools) responded to both the teacher and student questionnaires. Of these 32 schools which were then send the post-test evaluation packages, 19 schools responded. The final sample consisted of 16 Primary schools with a total of 429 students and 35 teachers and three high schools, with 127 students and five teachers.

The ‘booked’ evaluation package consisted of a cover letter detailing the request (Appendix III), one class set (32) of students pre-test questionnaires (Appendix IV), three
teacher pre-test questionnaires (Appendix V), an instruction sheet (Appendix VI), and a reply-paid-self-addressed envelope, to assist with the return rate.

The teachers were asked to assign each student in their class a number between 1 and 32 (or the number of students in their class) and to retain a copy of the allocated numbers until the post-test had been completed. The corresponding numbered pre-tests were administered by the teacher to the students prior to the Science Circus visit. If a child was absent the teacher was instructed to write absent on student’s survey to ensure the numbers were not confused between the pre-test and post-test. It was indicated that student names should not be included on the test instrument.

The teacher was asked to fill in the teacher pre-test and pass on another two pre-tests to any other interested teachers. If the teacher was not willing to involve their students in the evaluation the teacher had the option of just completing the teacher pre-test and faxing the questionnaire back to Questacon on a toll free fax number. The teachers’ pre-test took a maximum of 10 minutes to fill out and the students’ pre-test took approximately five minutes.

The teacher was asked to collate all the surveys and post them back to Questacon in the supplied reply-paid-self-addressed envelope. The teacher of a class could then be identified with her or his class. When the pre-tests were received at Questacon a post-test package was posted directly to this contact teacher. The post-test package consisted of a cover letter (Appendix VII), class set (32) of student questionnaires (Appendix VIII), one teacher survey (Appendix IX), instructions (Appendix X) and a reply-paid-self-addressed envelope. The contact teachers were instructed to hand out the student post-test questionnaires three to five days after the Science Circus visit. The delay in the post-testing was designed to avoid students’ test familiarity and to provide adequate time for the activity sheets to be used by those teachers desiring to do so (Stronck 1983; de Vaus 1985; Finson and Enochs 1987; Oppenheim 1992; Harris 1995). When the post-test questionnaires were sent back the dates of the pre-tests and post-tests were noted to screen for consistency of the entire set of data.
Any teachers who had filled in one of the two additional teacher questionnaires were directly sent a post questionnaire. The teachers were informed that these post-tests could be faxed to Questacon on a toll free fax number.

It should be noted that the responsibility of assigning the numbers of the individual questionnaires to the students for the pre- and post-tests was entirely the teachers. This was decided because of the extreme difficulty in hand delivering all questionnaires due to geographical spread of schools. From the initial planning of this survey it was realised that this could be problematic so plans were put in place to check for any errors. A detailed instruction sheet was included in each of the pre- and post-survey packages and an example of a class roll (Appendix VI) was included. Each student was asked to write their class and teachers’ name on both the pre- and post-questionnaires. This enabled the handwriting to be compared for each student. All surveys were checked and aligned before being accepted as valid data. Using this technique two groups were rejected as there was a great variation of the pre-test and post-test class numbers and the students’ handwriting.

The school visits made by the Science Circus for the evaluation were not altered in any way from the regular Science Circus visit. Even though the Science Circus team consisted of ten performers each with their own individual presentation style and ability, the entire Science Circus, individual performers were being evaluated. However, a record was kept of which individual presenters performed at each of the schools that the Science Circus visited over the three week period, to take into account the variation in the presentation quality.

Letters of appreciation were posted to each of the schools that participated in the evaluation (Appendix XI).

The teachers were informed that each complete pre-test and post-test evaluation would be included in a lucky draw for six Exsciter Packs produced by Questacon valued at $55. A coloured flyer (Appendix XII) detailing the contents of the science kits was included in the pre-test evaluation package. The school that received the Exsciter Packs was St Patrick’s Primary School: they must have had that luck of the Irish.
'Non-booked' schools

Of the 176 questionnaires that were posted to science coordinators who did not request a Science Circus visit, only 29 teachers responded, from 23 primary schools and six high schools. Two reasons, perhaps account for the low return rate: the schools were not interested in science-type events, or there was a lack of an incentive such as a lucky draw prize. The teachers were requested to fill in a questionnaire and fax it back to Questacon on the toll free fax number. These teachers were included in the study to determine why schools do not book the Science Circus and how the Science Circus could address those reasons.

The ‘non-booked’ teachers were sent a cover letter detailing the request (Appendix XIII), and a questionnaire (Appendix XIV). The questionnaire used in this component contained both open-ended and closed-ended questions, where the responses of the open-ended questions were coded when all responses were received. The subjects were tested with an attitude assessment instrument, which was identical to the pre-test for the ‘booked’ and control schools.

Control groups

Five schools were chosen from the schools that had not booked the Science Circus. These schools were all located in Warrnambool and its surrounding region, part of the Great Ocean Road tour. As I was in this region at the time of the evaluation, the control questionnaires were hand-delivered to the schools in the hope that personal contact would inspire the school to assist in the evaluation. Two out of the five obliged; one high school and one primary school.

The students of the control groups were pre-tested and post-tested with identical questionnaires as the ‘booked’ schools and in the same time frame as used for the treatment groups. The only difference to the ‘booked’ schools was that the control schools were not being visited by the Science Circus in between the two tests. The students were asked to fill out the pre-test and two weeks later asked to fill out the post-test. The teacher questionnaires were identical to the ‘non-booked’ school and the attitudinal instrument the
same as the 'booked' schools. The teachers were sent a cover letter (Appendix XV), an instruction sheet (Appendix XVI), and provided with a reply-paid-self-addressed envelope. The teachers were requested to post the pre-test and post-tests together, detailing the times that each of the questionnaires were filled in. The control groups were used to see if there were any other influences between the pre-test and post-test, other than the Science Circus, that may have changed students and teachers' attitudes towards science and scientists.

Those teachers that responded as controls were also eligible for the draw of the six Exsciter Packs.

**Validity**

Validity is the degree to which the scale measures what it intends to measure. It is often impossible to find a sufficiently reliable and valid external criterion against which to validate an attitude scale (Oppenheim 1992). Schibeci (1982) indicates that the development of a semantic differential scale is simpler than a Likert scale because there is a large amount of research on adjective pairs. The 'good-bad' scale has been firmly established as an evaluative scale. Schibeci quotes Maguire (1973) indicating that attention should be given to the representations of attitudes for the population of interest. In this study the adjective pairs and phrases were adapted from others published. The language of the adjective pairs was tested on a representative sample of the final population. The questionnaire was also seen by a trained primary school teacher and a high school teacher, staff of the Science Circus and other staff of the Questacon and a parent of two children at primary school who is interested in science education. It has been suggested by O'Brien and Porter (1994) that there should also be a high correlation between similar items under each of the concepts.

**Activity sheets**

The need for activity sheets detailing hands-on science activities for teachers to use in the classroom was a particularly strong suggestion among the initial feedback received from all teachers. Initially a general activity sheet (Appendix XVII) was developed which incorporated many science activities not based on any particular theme. The sheets contained a pot pourri of Questacon's popular activities. This activity sheet was included.
with the Teacher Resource Kit given to the schools at the end of a *Science Circus* visit. In the Great Ocean Road questionnaire the teachers were asked for their suggestions and feedback. From these comments recommendations have been made regarding the future format of the activity sheets.

**Graduate Diploma student interviews**

The Graduate Diploma students, who perform the one hour demonstration shows at schools, were asked for their opinion on the variety of audiences they presented to in regard to school visits. These interviews were semi-standardised where the interviewer determined the amount of variety and reasons behind their answers. This method was deployed as there was no need to compare answers of all respondents. The length of the interview depended upon the students' opinion of school visits however the questioning was typically completed within 5 minutes.

**Component two—Public venues**

**Interviews with parents**

Parents at the *Science Circus* were pleased to inform me of their views of the *Science Circus*, perhaps because it gave them an opportunity to talk with another adult. These interviews were of a very general nature and the conversations were only recorded when suggestions were made. Typically these parents were very pleased that the *Science Circus* had visited their area but they had little else to say. The interview questions were designed to get an overall impression of the *Science Circus* and to find out what else the *Science Circus* could do for them.

**Graduate Diploma student interviews**

The Graduate Diploma students were asked for their views on the variety of audiences they interacted with during the public venues. These opinions were determined with semi-standardised interviews.
Exit polls

At the end of the Public Venue sessions, approximately half an hour before closing time, many of the Science Circus Graduate Diploma students administered the questionnaires (exit polls) (Appendix XVIII) to the visitors. People were chosen randomly, both male and female and of all ages. Many questionnaires were left at the table at the entrance/exit door with pens for people to fill out. The reason for getting the Graduate Diploma student to ask the people to fill them in was to capture those that would not complete them on their way out. All the questions, except two, were closed-ended questions, which enabled the questionnaire to be completed in a few minutes. Often families filled them out together. The participants were asked if they enjoyed the Science Circus, who they visited with, how they found out about the Science Circus, who is the Science Circus' sponsor and what part they enjoyed the most. The interviewers were instructed not to lead the respondent.

Participant observation

Visitors to the Science Circus public venue were observed when interacting with two of the new exhibits: Speed Ball and Totspot, an area specifically designated for parents and their children under the age of five. As these two exhibits were new to the Science Circus, the visitors were observed to see if the exhibits were being used correctly, if at all, and if they were a popular addition to the Science Circus.

Component three—Remote community visits

Interviews

Un-standardised interviews were used to determine the needs of teachers and students in remote communities and remote Aboriginal and Torres Strait Islander communities in relation to science and how the Science Circus could assist in providing resources. The interviews which covered many issues were conducted very informally usually over lunch or dinner with a number of teachers and Graduate Diploma student of the Science Circus. There was time to have in depth talks about many of the issues relevant to teachers and the communities whilst being driven from the airstrip to the school or when shown the local
sights. The teachers were incredibly obliging and were happy to provide as much insight as they could—perhaps this is a reflection on the appreciation of new company!

The success of integration of the ‘white’ teachers and the communities determined the nature of the discussions. Many of the teachers identified with the problems in preserving the Aboriginal culture and the consequent conflict of having ‘white’ teachers in Aboriginal communities. These teachers were of the opinion that it was their job to teach the children to the best of their professional ability with current teaching methods. In these situations the discussions were very fruitful with regard to the Science Circus in determining how best the program could assist these teachers in such remote communities. Other teachers had little tolerance for the Aboriginal culture and didn’t have many constructive things to say with respect to the Science Circus. In some situations it was an amazing transition from one community to another, depending on the success of the community and the dedication of the teachers. Two communities which stand out are Tjukula in the Warburton Ranges of Western Australia and Mornington Island, Queensland. The teachers at these communities provided insight to the working conditions, the needs of the school and how the Science Circus could help provide more resources.

The information obtained from these interviews was either written down during the discussions in point form or written from memory recall within a few hours after the conversations had taken place. I remember one lengthy discussion with the Principal and the teacher of the Burketown State School, Queensland, during a sight-seeing trip out to salt pans. It was a bumpy ride in the back of the van and the information obtained from this spontaneous conversation could not be written down until we had returned from the excursion.

Many issues were raised regarding the politically sensitive issue of the ‘white’ education system educating Aboriginal children, the importance of teaching science and the issues that faced teachers in such remote areas. The general questions asked were:

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5 The reference to ‘white’ teachers includes all non-Aboriginal teachers from the State Education Departments. This wording is within context used in the Aboriginal communities.
• Was the (amount of) language appropriate?
• Do you think the students enjoyed the show?
• Do you think the hands-on format is appropriate?
• Do you think the *Science Circus* will help you with future science lessons?
• What other things can the *Science Circus* do to help you?
• How can the performance be improved to relate more to the Aboriginal people?

A total of 35 Aboriginal and remote communities were visited during the past 2 years. Unfortunately, I was only able to visit seven of these communities due to time and budget restrictions. At all of the seven communities the principals and teachers (if greater than a one teacher school) were interviewed either individually or in a group. The Graduate Diploma student members were provided with interview questions and were asked to interview the teachers if the chance became available. The Graduate Diploma student provided details of the information required and had many interesting conversations with teachers and community adults. These conversations proved to be very similar to the ones I had.

**Ideas for new programs**

To develop new exhibits and ideas for remote community visits, interviews were conducted with Linda Cooper and William Inveen, who have experience with interactive science programs travelling to remote areas.

Linda Cooper, Deputy Director, The Investigator Science and Technology Science Centre in Adelaide, has had extensive experience in offering interactive science to Aboriginal communities and was pleased to assist in this investigation. Her experience provided new ideas and suggestions which meant the direction of the new projects changed paths as the investigation continued. All conversations were recorded during and after the conversations. Many notes were read and summarised before coming back to Canberra.

William Inveen, Project Officer for the South Pacific Science on the Move Project provided much guidance in terms of researching new exhibit ideas for the Aboriginal and Torres Strait Islanders Communities. These discussions were carried out with the main aim
of developing new and relevant exhibits for the communities. Extensive notes were taken during these interviews.

**Questionnaires**

Follow-up questionnaires were sent to all remote schools visited by the *Science Circus*. The questionnaires (Appendix XIX) contained only open-ended questions searching for suggestions on how to improve the visits. The questionnaires were faxed to the Principals or the Science Coordinator of each school once the *Science Circus* returned to Canberra. The teachers were requested to fax the questionnaire to Questacon’s toll free fax number. Of the ten questionnaires which were returned the comments reflected the outcomes of the interviews, however in less detail.

**Participant observation**

The students were observed to determine if the show was appropriate and if the students participated in and enjoyed the performance. Plate 5.2 is an example of students participating in one of the activities.

**Graduate Diploma student interviews**

On return from the remote community visits the Graduate Diploma students were asked to think about their most memorable event in terms of personal experience and science communication experience. Meetings were held with all Graduate Diploma student and each person shared their views with the group. This served two purposes, data collection and the opportunity for all students to hear about their team members’ experiences.
Plate 5.2: A small group of children eagerly participating in a workshop activity, the Cartesian Diver, at a remote community school.
Chapter Five—Methodology

Section Three—Collation, Coding, Analysis and Interpretation of Data

It has been suggested that the overlapping of observation and analysis, by undertaking two activities concurrently, produces more reliable results than conducting the two activities in isolation (Foddy 1993). The interpretation of data should occur throughout the majority of the project to allow ideas to be continually formulated and tested throughout the data collection stage.

This suggestion was easily adopted throughout the study. The initial data collection allowed ideas to develop and these ideas were tested on the numerous people involved with the Science Circus. In turn the study continually developed and the direction of research was constantly evolving. In some of the initial stages of the study, unexpected results were obtained and influenced the project. It was necessary to withdraw from the dynamic environment of the Science Circus and reflect on the findings. As pointed out in de Vaus (1995) the mark of a good researcher is not the ability to formulate hypotheses that turn out to be correct but the ability to make sense of data and to analyse them intelligently. The opportunity to discuss the results and ideas with other members of staff at Questacon provided new perspectives. This procedure and data collection occurred until the final tour of the Science Circus in 1996. After this, time was spent combining all aspects of the study and synthesising the main conclusions from the research.

Analyses of interviews with teachers, public venue visitors and Graduate Diploma students is discussed below.

Analysis of school visits

Demographics

The results from the demographic questions were compiled, coded and examined to give a profile of the teachers involved and those not involved with the Science Circus. These results were analysed in a straightforward manner.
Chapter Five—Methodology

Teacher interviews

Data derived from the interviews were indexed according to date and topic. To preserve the confidentiality of participants the data have been coded and no other persons have had access to the codings.

Attitude assessment instrument

The attitudes of the students and the teachers who had booked the Science Circus were given pre- and post-scores between one and five, one corresponding to the left-most mark and 5 the right-most mark. All questions were aligned between the pre-test and post-test and all the positive responses were moved to the left hand side. When all questions were aligned the difference between the pre-test and post-test scores were taken to represent the participants' changes in attitudes after the Science Circus had visited. The questions were grouped to determine the four overall attitudes toward science, science in society, scientists and scientists in society. Means were obtained for before and after the visit and the subtraction scores determined for primary school students and teachers, high school students and teachers, and for individual classes. Teacher attitudes were matched with classes and correlation in attitudes were investigated. General trends were established and the results are described in simple summaries.

There was a great variation in how these attitude questions were answered, both within classes and between schools: ranging from circles, dots, strokes, bars or ticks on the marks, between the marks, as a sliding scale and across two or three marks or on the text. To smooth out this variation to the nearest mark using the zero to five scale the questionnaire was first scanned to obtain a feel of how the questions had been answered and to find the best fit to 'definitely' (one or five), 'sort of' (two or four) or 'half' (three). In the database that was initially set up a column labelled 'rounded' has a 'zero' when answers are clearly on the marks, and 'one' when an approximation was given. This column also indicates those students who were absent. The data were handled by one person only to ensure consistency of scoring method.
The attitude responses for the control groups were treated in the same way as the data were for the ‘booked’ schools. The data were analysed and trends were compared to the ‘booked’ schools data. The attitudes for the ‘non-booked’ school were grouped and means were obtained. As there was no post-test, the attitude score could not be subtracted.

The data were difficult to analyse because of the clustered nature of the response. This occurred because we sampled children within classes within schools. This clustering results in a lack of independence between responses and the appropriate analysis method is complicated. In addition the moderate sample involved made it hard to detect significant outcomes, except for the most obvious features of the data. As we are only interested in detecting simple trends in the data we have not pursued complicated statistical techniques (Barry pers comm 1996).

**Enjoyment**

The level of enjoyment was calculated by grouping questions and determining the means for students, teachers of primary school and high school, and then for individual schools. Standard deviations and confidence intervals were calculated.

**Teacher resources and activity sheets**

These questions were coded and treated in a straightforward manner.

**Analysis of public venues**

**Exit polls**

The results only required a straightforward examination. There was no need for a statistical package to be used to analyse the data.
Participant observation

Data derived from participant observation were indexed according to theme and date. General trends were obtained from this data.

Interviews

The data derived from interviews with adult visitors were indexed according to date and topic.

Analysis of questionnaires from Aboriginal communities and remote areas

Teacher interviews

Data derived from the interviews were indexed according to date and topic. To preserve the confidentiality of participants the data have been coded and no other persons have had access to the codings.

Questionnaires

The results from the questionnaires were compiled to provide a profile of the needs of teachers in these remote areas and the teachers' thoughts on the Science Circus visit. Due to the small data set and the straightforward examination required no statistical package was necessary to analyse the data.
Chapter Five—Methodology

Experience

There is no doubt that my experience with the *Science Circus* played a major part in the selection of topic. Whilst completing my Honours degree in Molecular Biology I was very interested in communicating my research. My supervisor was well aware of this and when he discovered there was a course which was about science communication he knew I would be very interested. In 1991 I travelled with the *Science Circus* as part of the Graduate Diploma in Scientific Communication with nine other people. That year provided me the chance to find out what I enjoyed: science and communicating science.

After working in other science communication areas I started work with the *Science Circus* in 1995 and was interested in further study.

My previous experience with the *Science Circus* provided me with the insight of school visits from a presenter’s view as well as a coordinator’s role. After three years of working in science centres as an Education Officer I was aware of the many aspects of school visits and had much experience in talking with teachers, parents and children about the role of science centres and what they have to offer, aware of the delicate issues in remote Aboriginal communities and towns. From this experience I found it easy to build a rapport with groups of students, teachers and parents.

Being involved with the *Science Circus* whilst undertaking the study allowed me to visit many areas of Australia, which were crucial to providing me with a large sample of teachers who represented all of Australia. I had the opportunity of talking with many useful contacts for this project. Without these opportunities this study could never have attempted and completed.
Chapter Six
Attitudes Toward Science and Scientists

Introduction

This chapter addresses the first associated research question of the first objective set out in Chapter One: ‘Does the Science Circus promote positive images toward science and scientists?’.

Chapter Three discussed the importance of positive attitudes toward science. Evidence suggests that there is a relationship between science proficiency and attitudes toward science (Mullis and Jenkins 1988). For example, Wareing (1990) found a significant correlation between students’ science report card grades and their attitudes toward science suggesting that a more positive attitude toward science could indeed facilitate the learning process. The first Science Circus goal is to promote a positive image toward science and scientists.

It is important, therefore, to investigate the change in attitudes toward science and scientists immediately after a Science Circus visit. To determine the effect of the Science Circus, primary and high school students and teachers completed an attitude inventory before and after the Science Circus visit. Table 5.3 and 5.4 list the adjective phrases and pairs used in the teacher and student attitude inventory, respectively.

Primary and high school students’ attitude scores are compared and discussed, including the control groups, for each of the adjective pairs and phrases. The primary school teacher responses are briefly reviewed. While results from the primary and high school control groups are discussed, the pre-test and post-test adjective pairs and phrases are not summed due to the low response rate.
High school test and control groups are difficult to compare because of the variation in their pre-test scores. It appears that the high school control group have more mature attitudes than the test group, even though the groups of students are of similar ages. The 'non-booked' teacher attitudes are reviewed and a comparison is made between the pre-test of the 'booked' teachers and the attitudes of the 'non-booked' teachers. The summation scores for attitudes toward science, science in society, scientists, and scientists in society are analysed in relation to age, gender and school.

There were three high school teachers that completed both the pre-test and post-test and due to the low response rate the attitude scores are not discussed. Responses of the high school teachers are investigated in Chapter Seven.

**Individual Adjective Pairs and Phrases**

Each adjective pair and phrase was separated by a five-point scale. Respondents were asked to mark the scale and their response was assigned a score of one, two, three, four or five, with one being the most positive and five being the most negative response. A score of zero was recorded when there was no response. Although the adjective pairs and phrases are clearly bipolar, often a neutral response is preferred, not the most positive response. For example, take the pair 'scientists are good looking—ugly'. All possible responses would be somewhere between 'all scientists are ugly' and 'all scientists are good looking'. Neither of the two extreme answers are the right response, although the latter is considered more positive. The 'optimal' response would be neither good looking nor ugly, but somewhere in between; a score of three; or what is termed the neutral zone in this study.

To determine if the respondents have positive or negative attitudes and in which direction their attitudes changed, if at all, two types of analyses were used: a direct comparison of the pre-test and the post-test scores, and the calculation of a difference score determined from the pre-test and post-test scores. The distinguishing feature of the methods are described below.
Comparing the before and after scores

The frequency of responses for each adjective pair and phrase was determined for the pre-test and post-test. Comparing the before and after attitudes in this way, represents the number of students that scored each attitude as positive, negative or neutral. The before and after scores do not represent identical groups. For example a student that was absent on the day of the pre-test and hence did not complete it, may have been present on the day of the Science Circus visit and hence was eligible to complete the post-test.

Calculation of the difference score

The second analysis is the subtraction of individual scores for the pre-test and post-test. This score represents the change of the attitudes of an individual after the Science Circus visit. Those students who did not fill in either the pre-test or post-test were not included in this analysis.

Results for each phrase or pair have been graphically displayed using both the before and after comparison and the difference method. Both graphs are on one page, allowing them to be compared easily. The primary school students’ results are displayed first and followed by high school students’ results, for the same adjective pair or phrase. For example Figure 6.1a and Figure 6.1c show the pre-test and post-test comparisons for primary school students and high school students respectively. Scores one and two are added to give an overall positive score and scores four and five added to give an overall negative score. Score three has been termed a neutral score.

The second figure represents the difference method, for example Figure 6.1b and Figure 6.1d. A positive change in attitude is represented by one, two, three or four, with four being the greatest positive attitude change and -1, -2, -3, -4 with -4 as the greatest negative change in attitude. A change of zero represents no change for the individual, that is the respondent scored the same on both the pre-test and the post-test. A sum of change was calculated by adding all the positive change to give an overall positive attitude changes and the negative scores were added to give an overall negative attitude change.
I think science is interesting – boring

Primary school students
A large majority of the students rate science as interesting and few students think science is boring, as shown in Figure 6.1a. After the Science Circus visit there was a small increase in positive responses and a reduced number of neutral scores. There was little change in the frequency of negative responses. Figure 6.1b shows that the majority of the students did not change their attitude after the Science Circus visit, however, there are indications that more positive attitude changes occurred than negative.

The control students were less positive in the post-test, with more students scoring scientists as neither interesting nor boring. Approximately half of the students did not change their attitude. The test group showed less variation in their attitudes than the control group and a greater percentage of test students had positive attitude changes after the Science Circus visit.

High school students
These students were not nearly as positive as the primary school students both before and after the Science Circus visit. There was a trend toward answering that scientists are boring and the number of students who thought that science is interesting equalled the number who thought science is neither interesting nor boring, as shown in Figure 6.1c. There is evidence that more students had a negative attitude change after the Science Circus visit than a positive change, however, approximately a third of the students did not change their attitudes, as shown in Figure 6.1d. The high school control group answered this question more positively than the test group for both the pre-test and post-test results, making it difficult to relate the two populations. The control group showed similar attitudes to the primary school students. The difference method indicated that more individual students had a positive attitude change.

Summary
The data suggest that more primary school students had a positive change in attitude than a negative change in attitude after the Science Circus visit. The high school results show that the Science Circus had the opposite effect.
Science attitude: *Interesting* – *Boring*

Primary school students

**Figure 6.1a:** Frequency of ‘interesting’ (positive) and ‘boring’ (negative) scores for primary school students’ attitudes toward science before and after the Science Circus visit.

**Figure 6.1b:** Frequency of primary school students’ changes in attitude toward science (interesting - boring) after the Science Circus visit.
Science attitude: *Interesting – Boring*

**High school students**

![Bar chart](image)

**Figure 6.1c:** Frequency of 'interesting' (positive) and 'boring' (negative) scores for high school students' attitudes toward science before and after the Science Circus visit.

![Bar chart](image)

**Figure 6.1d:** Frequency of high school students' changes in attitude toward science (interesting - boring) after the Science Circus visit.
I think science is fun – painful

Primary school students
The results for this question, shown in Figure 6.2a, are very similar to the question above. Most students thought that science is fun, with very few students thinking that science is painful. There is a small change in attitude before and after the Science Circus visit, Figure 6.2b, however, shows that an equal number of students underwent a positive and negative attitude change. Approximately half of the students did not change their attitudes. The control group was less positive with over half the students having a negative change in attitude.

High school students
These students gave a mixed response, being that science is neither fun nor painful, as shown in Figure 6.2c. The post-test results indicate that more students thought science is painful after the Science Circus visit. This is confirmed in Figure 6.2d which shows that a greater percentage of students had a negative attitude change than positive. The majority of the control students thought that science was fun, and they showed an increase in positive attitudes toward science.

Summary
Primary school children think science is more fun than high school students. The Science Circus had little effect on the primary school attitudes and more high school students had a negative attitude change than positive, after the Science Circus visit.
Science attitude: *Fun – Painful*

**Primary school students**

![Bar chart showing frequency of 'fun' (positive) and 'painful' (negative) scores for primary school students' attitudes toward science before and after the Science Circus visit.]

**Figure 6.2a:** Frequency of 'fun' (positive) and 'painful' (negative) scores for primary school students' attitudes toward science before and after the Science Circus visit.

![Bar chart showing frequency of primary school students' changes in attitude toward science (fun -painful) after the Science Circus visit.]

**Figure 6.2b:** Frequency of primary school students’ changes in attitude toward science (fun -painful) after the Science Circus visit.
Science attitude: *Fun – Painful*

High school students

![Bar chart showing frequency of scores for high school students' attitudes toward science before and after the Science Circus visit.](image)

**Figure 6.2c:** Frequency of 'fun' (positive) and 'painful' (negative) scores for high school students' attitudes toward science before and after the Science Circus visit.

![Bar chart showing frequency of changes in attitude toward science for high school students after the Science Circus visit.](image)

**Figure 6.2d:** Frequency of high school students' changes in attitude toward science (fun - painful) after the Science Circus visit.
I think science is easy – difficult

Primary school students
Figure 6.3a shows a greater variation in the students’ responses to this question than with the first two questions. Less than half of the students thought that science was neither easy nor difficult and more students thought that science was easy compared to difficult. Figure 6.3b indicates that a large number of students had a change in attitude compared with the previous two statements. Slightly more students have a positive attitude change than a negative change. Half of the control students had a negative change in attitude, with more students thinking science was neither easy nor difficult.

High school students
Again these students had mixed responses. Neutral was the most common response, shown in Figure 6.3c. Figure 6.3d shows that approximately half of the students did not change their attitude, however, there were both positive and negative attitude changes. The control students were more positive than the test students, both in the pre-test and post-test, making comparison difficult.

Summary
For both primary and high school students there is a mixed response for this question, neutrality is the most common. The data suggests that the Science Circus had a positive effect on primary school students and no effect on high school students.
Science attitude: *Easy – Difficult*

Primary school students

Figure 6.3a: Frequency of ‘easy’ (positive) and ‘difficult’ (negative) scores for primary school students’ attitudes toward science before and after the Science Circus visit.

Figure 6.3b: Frequency of primary school students’ changes in attitude toward science (easy - difficult) after the Science Circus visit.
Chapter Six—Attitudes Toward Science and Scientists

Science attitude: *Easy – Difficult*

High school students

![Bar chart](image)

**Figure 6.3c:** Frequency of 'easy' (positive) and 'difficult' (negative) scores for high school students' attitudes toward science before and after the Science Circus visit.

![Bar chart](image)

**Figure 6.3d:** Frequency of high school students' changes in attitude toward science (easy - difficult) after the Science Circus visit.
I think science is worthwhile – a waste of time and money

Primary school students
Figure 6.4a clearly shows that a vast majority of students think that science is worthwhile and not a waste of money, both before and after the Science Circus visit. Figure 6.4b shows that over half of the students did not change their attitude and that more students had a positive change in attitude than negative. The control group showed very little change in attitude for this question, scoring science as a worthwhile venture in both the pre- and post-test.

High school students
The high school students showed a similar trend to the primary school students, though not as strong, as shown in Figure 6.4c. After the Science Circus visit there were more students that had a positive attitude change than negative, shown in Figure 6.4d. The control group again was more positive than the test population, however, there was little indication of any student having a change in attitude for this question.

Summary
Both primary and high school students believe that science is worthwhile. The Science Circus does not appear to have altered the primary school students' opinion, however, a small positive change was recorded for the high school group.
Science in Society attitude: *Worthwhile – A waste of time and money*

**Primary school students**

*Figure 6.4a:* Frequency of ‘worthwhile’ (positive) and ‘a waste of time and money’ (negative) scores for primary school students’ attitudes toward science in society before and after the Science Circus visit.

*Figure 6.4b:* Frequency of primary school students’ changes in attitude toward science in society (worthwhile - a waste of time and money) after the Science Circus visit.
Science in Society attitude: Worthwhile – A waste of time and money

High school students

Figure 6.4c: Frequency of ‘worthwhile’ (positive) and ‘a waste of time and money’ (negative) scores for high school students’ attitudes toward science in society before and after the Science Circus visit.

Figure 6.4d: Frequency of high school students’ changes in attitude toward science in society (worthwhile - a waste of time and money) after the Science Circus visit.
I think science is all around us – not all around us

Primary school students
Figure 6.5a and 6.5b show that primary school students thought that ‘science is all around them’ both before and after the Science Circus visit and there were approximately equal numbers of positive and negative attitude changes. The control group was very positive that ‘science is all around us’. However, there are a lot of positive and negative changes, with less than a quarter of the control students having no attitude change. It is difficult to conclude that the Science Circus had an effect due to the variation of the control group.

High school students
These students were positive in their response to this question, as shown in Figure 6.5c. Approximately two thirds of the students had a change in attitude, see Figure 6.5d, with slightly more students having a positive attitude change. Although the control group answered slightly more positively, there is a great number of students who changed their attitude. Perhaps this question doesn’t provoke strong feelings and the students do not relate to it very well.

Summary
A majority of primary and high school students think that ‘science is all around us’; there is, however, little evidence of any effect by the Science Circus.
Science in Society attitude: *All around us – Not all around us*

**Primary school students**

*Figure 6.5a:* Frequency of ‘all around us’ (positive) and ‘not all around us’ (negative) scores for primary school students’ attitudes toward science in society before and after the Science Circus visit.

*Figure 6.5b:* Frequency of primary school students’ changes in attitude toward science in society (all around us - not all around us) after the Science Circus visit.
Science in Society attitude: *All around us – Not all around us*

**High school students**

*Figure 6.5c:* Frequency of ‘all around us’ (positive) and ‘not all around us’ (negative) scores for high school students’ attitudes toward science in society before and after the Science Circus visit.

*Figure 6.5d:* Frequency of high school students’ changes in attitude toward science in society (all around us - not all around us) after the Science Circus visit.
We should encourage science research – we should stop science research.

Primary school students
This question was answered consistently before and after the Science Circus visit. Figure 6.6a shows that an equal number of students think positively towards science in the pre-test and post-test. However, Figure 6.6b indicates that there was a small number of attitude changes with approximately equal negative and positive changes occurring. Over half of the students had no attitude change. The control group was very positive in both the pre-test and post-test with few students changing their attitudes.

High school students
Figure 6.6c shows that approximately half the students thought that ‘we should encourage science research’. Again there was a lot of attitude change in the test population, as shown in Figure 6.6d, unlike the control group, who were very consistent with their positive attitudes.

Summary
Both the primary and high school students thought that ‘we should encourage science research’. However, both test populations showed more attitude change, negative and positive, than the control groups. This may suggests that the Science Circus stimulates the students to think about science research and its consequences.
Science in Society attitude: *We should encourage science research* – *We should stop science research*

**Primary school students**

![Bar chart showing frequencies of scores](image)

**Figure 6.6a:** Frequency of ‘we should encourage science research’ (positive) and ‘we should stop science research’ (negative) scores for primary school students’ attitudes toward science in society before and after the Science Circus visit.

![Bar chart showing changes in scores](image)

**Figure 6.6b:** Frequency of primary school students’ changes in attitude toward science in society (we should encourage science research - we should stop science research) after the Science Circus visit.
Science in Society attitude: *We should encourage science research – We should stop science research*

High school students

![Graph showing frequency of scores](image)

**Figure 6.6c:** Frequency of ‘we should encourage science research’ (positive) and ‘we should stop science research’ (negative) scores for high school students’ attitudes toward science in society before and after the Science Circus visit.

![Graph showing frequency of changes](image)

**Figure 6.6d:** Frequency of high school students’ changes in attitude toward science in society (we should encourage science research - we should stop science research) after the Science Circus visit.
Science helps us – science doesn’t help us

Primary school students
An overwhelming response from the students indicates that they think science is useful in helping society. Figure 6.7a shows little change overall, however, Figure 6.7b shows that there were both a small number of positive and negative attitude changes, with these attitude changes being the smallest possible change, a difference score of one. The control group again, indicated a strong support for science with over half the students not changing their attitudes.

High school students
Figure 6.7c indicates that over half of the students think that science helps society. Little attitude change was detected in Figure 6.7d with over half the population having no attitude change. The control group showed a greater amount of change in attitude, both negative and positive change. However there were no negative scores in the pre-test or post-test for the control group.

Summary
The results for this adjective phrase are very similar to the previous one. Both primary and high school students believe science can help society and there appears to be little evidence suggesting that the Science Circus had an effect.
Science in Society attitude: *Science helps us* – *Science doesn’t help us*

Primary school students

![Bar chart showing frequency of scores](image)

**Figure 6.7a:** Frequency of ‘science helps us’ (positive) and ‘science doesn’t help us’ (negative) scores for primary school students’ attitudes toward science in society before and after the Science Circus visit.

![Bar chart showing frequency of change](image)

**Figure 6.7b:** Frequency of primary school students’ changes in attitude toward science in society (science helps us - science doesn’t help us) after the Science Circus visit.
Science in Society attitude: *Science helps us – Science doesn’t help us*

**High school students**

![Bar chart showing frequency of scores for high school students' attitudes toward science in society before and after the Science Circus visit.]

**Figure 6.7c:** Frequency of ‘science helps us’ (positive) and ‘science doesn’t help us’ (negative) scores for high school students’ attitudes toward science in society before and after the Science Circus visit.

![Bar chart showing frequency of changes in attitude toward science in society before and after the Science Circus visit.]

**Figure 6.7d:** Frequency of high school students’ changes in attitude toward science in society (science helps us - science doesn’t help us) after the Science Circus visit.
I notice science in my daily life – science never comes to mind outside school

Primary school students
Figure 6.8a shows the mixed response for this question. More students answered that they ‘notice science in their daily life’ than not. This question did not provoke as strong a reaction as the previous four, with students scoring right across the range. Figure 6.8b shows that an equal number of students had positive and negative attitude changes. The control group also showed a mixed response for this question and the students were more negative in the post-test. Due to the amount of change in both the control and test groups it is difficult to conclude if the Science Circus had any effect.

High school students
Figure 6.8c shows that this question had a full range of responses, with more students thinking that ‘science doesn’t come to mind outside of school’. This question does not appear to provoke strong feelings, and there were equal numbers of students who underwent positive and negative attitude changes, as well as no attitude change, as shown in Figure 6.8d. The control group was much more positive in answering this question, with not nearly as many students changing their attitude. It would appear that the Science Circus provokes a change in attitude, however, in both positive and negative directions.

Summary
Primary school students thought they ‘notice science in their life’ more than high school students. There appears to be little evidence that the Science Circus has either a positive or negative effect on both primary and high school students.
Science in Society attitude: *I notice science in my daily life – Science never comes to mind outside school*

Primary school students

Figure 6.8a: Frequency of ‘I notice science in my daily life’ (positive) and ‘science never comes to mind outside school’ (negative) scores for primary school students’ attitudes toward science in society before and after the Science Circus visit.

Figure 6.8b: Frequency of primary school students’ changes in attitude toward science in society (I notice science in my daily life - science never comes to mind outside school) after the Science Circus visit.
Chapter Six—Attitudes Toward Science and Scientists

Science in Society attitude: *I notice science in my daily life* – *Science never comes to mind outside school*

High school students

**Figure 6.8c:** Frequency of 'I notice science in my daily life' (positive) and 'science never comes to mind outside school' (negative) scores for high school students' attitudes toward science in society before and after the Science Circus visit.

**Figure 6.8d:** Frequency of high school students' changes in attitude toward science in society (I notice science in my daily life - science never comes to mind outside school) after the Science Circus visit.
Chapter Six—Attitudes Toward Science and Scientists

**Girls like science – girls don’t like science**

*Primary school students*

There was little change in the overall positive and negative scores between the pre-test and post-test, however, there is a trend that more students responded in the neutral category in the post-test, as shown in Figure 6.9a. Figure 6.9b shows that there were more students who had a negative attitude change, which is not an increase in the attitude that ‘girls don’t like science’, but a move toward the neutral zone. The control group showed a large negative change in attitude as more students scored in the neutral zone in the post-test than the pre-test. A majority of the test and control students gave a neutral score of three in the post-test.

*High school students*

Figure 6.9c shows a much higher response rate for the neutral zone compared with the primary school children. Approximately half of the students had no change in attitude, with more students having a negative change than positive, as shown in Figure 6.9d. The control group again, answered more positively than the test group in the pre-test, with many students scoring a neutral response. The *Science Circus* had little effect on changing attitudes in high school students, however the students were aware that girls may or may not like science.

*Summary*

It is reassuring to see a large number of students answering this question with a neutral score of three. Both control and test groups had an increase of students responding in the neutral zone, making it difficult to conclude whether the *Science Circus* had any effect.
Gender attitude: *Girls like science – Girls don’t like science*

**Primary school students**

![Graph showing frequency of 'girls like science' (positive) and 'girls don’t like science' (negative) scores for primary school students' attitudes toward girls and science before and after the Science Circus visit.]

**Figure 6.9a:** Frequency of ‘girls like science’ (positive) and ‘girls don’t like science’ (negative) scores for primary school students’ attitudes toward girls and science before and after the Science Circus visit.

![Graph showing frequency of primary school students’ changes in attitude toward girls and science (girls like science - girls don't like science) after the Science Circus visit.]

**Figure 6.9b:** Frequency of primary school students’ changes in attitude toward girls and science (girls like science - girls don't like science) after the Science Circus visit.
Gender attitude: *Girls like science – Girls don’t like science*

**High school students**

![Graph showing frequency of 'girls like science' (positive) and 'girls don’t like science' (negative) scores for high school students' attitudes toward girls and science before and after the Science Circus visit.](image)

**Figure 6.9c:** Frequency of 'girls like science' (positive) and 'girls don’t like science' (negative) scores for high school students' attitudes toward girls and science before and after the Science Circus visit.

![Graph showing frequency of high school students' changes in attitude toward girls and science (girls like science - girls don’t like science) after the Science Circus visit.](image)

**Figure 6.9d:** Frequency of high school students' changes in attitude toward girls and science (girls like science - girls don’t like science) after the Science Circus visit.
I would like to be a scientist – I don’t want to be a scientist

Primary school students
Figure 6.10a indicates that over half of the students do not want to be scientists. There seems to be an increase of neutral responses after the Science Circus visit. Figure 6.10b shows that there is a negative trend after the Science Circus visit, however this can be explained by the decrease in positive attitudes and the increase in neutral responses. Over half of the students had no change in attitudes toward science careers. The control group also indicated a large number of students not wanting to be scientists, with approximately half the students not changing their attitudes.

High school students
These students have a strongly held opinion that they will not pursue a science career, as shown in Figure 6.10c. A large majority of students do not want to be scientists, and little attitude change was recorded, as shown in Figure 6.10d. The control group has a greater percentage of students that want to be scientists, however there was a greater number of students who had a negative change in attitude than positive.

Summary
There is a strong indication that the majority of students, both primary and secondary, do not want to be scientists. There is little evidence to suggest that the Science Circus has an effect on students.
Chapter Six—Attitudes Toward Science and Scientists

Career attitude: *I would like to be a scientist* –
*I don’t want to be a scientist*

Primary school students

![Graph showing frequency of scores and sum of scores for primary school students' attitudes toward science careers before and after the Science Circus visit.]

**Figure 6.10a:** Frequency of ‘I would like to be a scientist’ (positive) and ‘I don’t want to be a scientist’ (negative) scores for primary school students’ attitudes toward science careers before and after the Science Circus visit.

![Graph showing frequency of changes in attitude after the Science Circus visit.]

**Figure 6.10b:** Frequency of primary school students’ changes in attitude toward science careers (I would like to be a scientist - I don’t want to be a scientist) after the Science Circus visit.
Career attitude: *I would like to be a scientist* – *I don’t want to be a scientist*

High school students

**Figure 6.10c:** Frequency of ‘I would like to be a scientist’ (positive) and ‘I don’t want to be a scientist’ (negative) scores for high school students’ attitudes toward science careers before and after the Science Circus visit.

**Figure 6.10d:** Frequency of high school students’ changes in attitude toward science careers (I would like to be a scientist - I don’t want to be a scientist) after the Science Circus visit.
Scientists are interesting – boring

Primary school students
A majority of students think that scientists are interesting compared to boring, as shown in Figure 6.11a. Although there appears to be little change in attitudes before and after the Science Circus visits, Figure 6.11b shows that over half the students had either a positive or negative change in attitude. The majority of the control group think that scientists are interesting in the pre-test, however over half of the students had a negative change in attitude in the post-test. The control group's attitude changes appear to be more negative than the test group suggesting that the Science Circus had a positive effect on the students.

High school students
The high school students were not nearly as positive toward scientists as the primary school students. Figure 6.11c indicates that the most common response is neutral or boring. After the Science Circus visited there was a trend that the students thought scientists are even more boring, as shown in Figure 6.11d. The control group were more positive than the test group, however there is a high number of students who had positive or negative changes of attitude. There is little evidence suggesting the Science Circus had a positive effect, due to the large change in attitudes in the control group scores and the negative responses for the test group.

Summary
The primary school students are much more positive, thinking that scientists are more interesting than high school students. There is little evidence suggesting that the Science Circus had a positive or negative effect on the primary and high school students’ attitudes.
Chapter Six—Attitudes Toward Science and Scientists

Scientist attitude: *Interesting – Boring*

Primary school students

![Bar chart showing frequency of 'interesting' (positive) and 'boring' (negative) scores for primary school students' attitudes toward scientists before and after the Science Circus visit.]

**Figure 6.11a:** Frequency of 'interesting' (positive) and 'boring' (negative) scores for primary school students’ attitudes toward scientists before and after the Science Circus visit.

![Bar chart showing frequency of primary school students' changes in attitude toward scientists (interesting - boring) after the Science Circus visit.]

**Figure 6.11b:** Frequency of primary school students’ changes in attitude toward scientists (interesting - boring) after the Science Circus visit.
Scientist attitude: *Interesting – Boring*

**High school students**

![Bar chart](image)

**Figure 6.11c:** Frequency of 'interesting' (positive) and 'boring' (negative) scores for high school students' attitudes toward scientists before and after the Science Circus visit.

![Bar chart](image)

**Figure 6.11d:** Frequency of high school students' changes in attitude toward scientists (interesting - boring) after the Science Circus visit.
Scientists are outgoing – shy

*Primary school students*

The results from this question are very similar to the question above, with Figure 6.12a showing that a majority of students, both before and after the *Science Circus* visit, think that scientists are outgoing. Figure 6.12b shows that there are changes in attitudes, approximately equal number of students having a positive and negative attitude change. The control group indicated a large number of students think scientists are outgoing, however more students had negative or positive attitude changes than no change. It is difficult to suggest the effect of the *Science Circus* due to the high attitude changes with the control students.

Three students, from different classes indicated that they could not answer the question as they did not want to stereotype scientists. For example:

*Depends on the individual’s personality* (Year Six student).

*Depends on the scientist* (Year Five/Six student).

*High school students*

The students showed quite a high neutral response for this question, with a reasonable amount of attitude change toward both negative and positive attitudes, as shown in Figures 6.12c and 6.12d. The control students gave similar responses, with a high number of students ranking scientists as neither outgoing nor shy and a high variation in attitude between the pre-test and post-test. Due to this high variation it is difficult to draw any conclusions.

*Summary*

The majority of primary school students think that scientists are outgoing, unlike the high school group where the most common response was a neutral score. There is little to suggest that the *Science Circus* has any effect due to the variation in control groups’ responses.
Scientist attitude: Shy – Outgoing

Primary school students

Figure 6.12a: Frequency of 'shy' (positive) and 'outgoing' (negative) scores for primary school students’ attitudes toward scientists before and after the Science Circus visit.

Figure 6.12b: Frequency of primary school students’ changes in attitude toward scientists (shy - outgoing) after the Science Circus visit.
**Scientist attitude: Shy – Outgoing**

**High school students**

![Graph](image)

**Figure 6.12c:** Frequency of 'shy' (positive) and 'outgoing' (negative) scores for high school students' attitudes toward scientists before and after the Science Circus visit.

![Graph](image)

**Figure 6.12d:** Frequency of high school students' changes in attitude toward scientists (shy - outgoing) after the Science Circus visit.
Scientists are fun – serious

Primary school students
The scores for pre- and post-tests were very different, as shown in Figure 6.13a. There is a definite increase in the number of students that think scientists are fun and a decrease in the number of students that think scientists are serious, in the post-test. Figure 6.13b indicates a large positive attitude change. There were negative changes in attitudes which could be due to more students changing their attitude to a more neutral category. The control group had an equal number of students thinking that scientists were serious and fun, in the pre-test. The results for the post-test show a large swing toward negative attitudes with over half the students thinking that scientists are serious.

High school students
The majority of high school students do not think that scientists are fun, as shown in Figure 6.13c. This figure also suggest that after the Science Circus visit, more students thought of scientists as neither fun nor serious. Figure 6.13d shows that equal numbers of students had a positive change in attitude, a negative change in attitude and no change in attitude. The negative change in attitude may be explained by the increase in the number of students who had a neutral score in the post-test. The majority of the control students thought that scientists are neither fun nor serious and in the post-test there are more students that gave a neutral answer. It is difficult to suggest an overall effect of the Science Circus due to the large number of control students changing their attitudes; both positive and negative attitude changes.

Summary
More primary school students think that scientists are fun than high school students.
There is evidence suggesting that the Science Circus has a positive effect on primary school students, indicating that the Science Circus promotes a fun image of scientists. There is no evidence to suggest that the Science Circus has the same effect on high school students. It would appear that the primary school students view the Graduate Diploma students as scientists, as the style of presentation is fun and entertaining, influencing the school students’ views.
Chapter Six—Attitudes Toward Science and Scientists

Scientist attitude: *Fun – Serious*

Primary school students

![Graphs showing frequency of scores before and after the Science Circus visit.]

*Figure 6.13a:* Frequency of 'fun' (positive) and 'serious' (negative) scores for primary school students’ attitudes toward scientists before and after the Science Circus visit.

![Graphs showing frequency of change before and after the Science Circus visit.]

*Figure 6.13b:* Frequency of primary school students’ changes in attitude toward scientists (fun - serious) after the Science Circus visit.
Chapter Six—Attitudes Toward Science and Scientists

Scientist attitude: *Fun – Serious*

High school students

![Bar chart showing frequency of 'fun' (positive) and 'serious' (negative) scores for high school students' attitudes toward scientists before and after the Science Circus visit.]

**Figure 6.13c:** Frequency of ‘fun’ (positive) and ‘serious’ (negative) scores for high school students’ attitudes toward scientists before and after the Science Circus visit.

![Bar chart showing frequency of high school students' changes in attitude toward scientists (fun - serious) after the Science Circus visit.]

**Figure 6.13d:** Frequency of high school students’ changes in attitude toward scientists (fun - serious) after the Science Circus visit.
Scientists are only as smart as you or me – extremely intelligent

Primary school students
There is clear indication that students think that scientists are extremely intelligent both before and after the Science Circus visit, as shown in Figure 6.14a. There appears to be a larger number of students who had a positive attitude change than negative, as shown in Figure 6.14b. The control groups also thought that scientists were extremely intelligent, however, there was little attitude change between the pre-test and post-test. This suggests that the Science Circus may have had a positive influence on children's views of how intelligent scientists are.

High school students
These students also felt that most scientists are extremely intelligent and there was a tendency for students to have a positive change in attitude toward scientists, shown in Figures 6.14c and 6.14d. The control group also felt that scientists are extremely intelligent with the majority of students having a small positive attitude change towards scientists somewhere between extremely intelligent and neutral. As both groups had a small positive attitude change in the post-test there is little evidence suggesting that the positive effect is due to the Science Circus.

Summary
Both the primary and high school students think that scientists are extremely intelligent. There is evidence suggesting that the Science Circus has a positive effect on primary school students, however, not with high school students.
Scientist attitude: *Only as smart as you or me* –
*Extremely intelligent*

**Primary school students**

*Figure 6.14a:* Frequency of ‘only as smart as you or me’ (positive) and ‘extremely intelligent’ (negative) scores for primary school students’ attitudes toward scientists before and after the Science Circus visit.

*Figure 6.14b:* Frequency of primary school students’ changes in attitude toward scientists (‘only as smart as you or me - extremely intelligent’) after the Science Circus visit.
Scientist attitude: *Only as smart as you or me* –
*Extremely intelligent*

**High school students**

*Figure 6.14c:* Frequency of 'only as smart as you or me' (positive) and 'extremely intelligent' (negative) scores for high school students' attitudes toward scientists before and after the Science Circus visit.

*Figure 6.14d:* Frequency of high school students' changes in attitude toward scientists (only as smart as you or me - extremely intelligent) after the Science Circus visit.
Scientists are good looking – ugly

Primary school students
Approximately half of the students think that scientists are neither good looking nor ugly which is the optimal result, as scientists can be either. Unfortunately, Figure 6.15a shows that there are a greater number of students who view scientists as ugly than good looking. There is some change in attitudes both positive and negative, however only small changes, as shown in Figure 6.15b. The control group had similar results to the test group in the pre-test with approximately half of the students scoring scientist as neither good looking nor ugly, with more students scoring scientists as ugly compared to good looking. However, the post-test showed a greater number of students having a negative change in attitude. Five students, from different classes wrote comments on their questionnaires to indicate that they could not generalise, for example:

Depends on your taste (Year Four student).

This is a dumb question (Year Six student).

High school students
The high school students were more negative that the primary school students. These students were pretty adamant that scientists are not good looking, with over half the number of students rating scientists as ugly. Most of the remaining students thought scientists were neither ugly nor good looking, as shown in Figure 6.15c. Figure 6.15d indicates that more students had a positive attitude change than a negative change, with more students scoring scientists looks as neither good looking nor ugly. Almost all of the control group students responded neutrally and there was very little change in attitude.

Summary
High school students think that scientists are more ugly than as thought by primary school students. However, there is some evidence that suggests the Science Circus has a positive effect on high school students. There is little evidence to suggest that the Science Circus has a positive effect on primary school students.
Chapter Six—Attitudes Toward Science and Scientists

Scientist attitude: Good looking – Ugly

Primary school students

Figure 6.15a: Frequency of ‘good looking’ (positive) and ‘ugly’ (negative) scores for primary school students’ attitudes toward scientists before and after the Science Circus visit.

Figure 6.15b: Frequency of primary school students’ changes in attitude toward scientists (good looking - ugly) after the Science Circus visit.
Scientist attitude: Good looking – Ugly

High school students

Figure 6.15c: Frequency of 'good looking' (positive) and 'ugly' (negative) scores for high school students' attitudes toward scientists before and after the Science Circus visit.

Figure 6.15d: Frequency of high school students' changes in attitude toward scientists (good looking - ugly) after the Science Circus visit.
**Scientists are normal – weird**

*Primary school students*

Figure 6.16a shows a positive increase in the number of students thinking that scientists are normal after the *Science Circus* visit. Figure 6.16b shows that there were more students who had a positive change in attitude than a negative change. The control group showed a mixed response for this question, however there tended to be a negative change in attitude. This evidence suggests that the *Science Circus* provides a normal image of scientists to the students.

*High school students*

Figure 6.16c shows that approximately half of the high school students think that scientists are weird, a more undesirable view than primary school students. Two thirds of the students had either a positive or negative change in attitude, with more students having a negative change, as shown in Figure 6.16d. The majority of the control students thought that scientists are neither normal nor weird but somewhere in between. Over half of the control students had no attitude change, with the remainder of the students having a positive attitude change. These results suggest that the *Science Circus* had a small negative effect on the high school students.

**Summary**

More primary school students think that scientists are normal than high school students. There is evidence suggesting that the *Science Circus* has a positive effect on primary school students, however, it appears the opposite for high school students.
Scientist attitude: *Normal – Weird*

**Primary school students**

![Graph A](image1.png)

*Figure 6.16a:* Frequency of 'normal' (positive) and 'weird' (negative) scores for primary school students' attitudes toward scientists before and after the Science Circus visit.

![Graph B](image2.png)

*Figure 6.16b:* Frequency of primary school students' changes in attitude toward scientists (normal - weird) after the Science Circus visit.
Scientist attitude: *Normal – Weird*

**High school students**

*Figure 6.16c:* Frequency of ‘normal’ (positive) and ‘weird’ (negative) scores for high school students’ attitudes toward scientists before and after the Science Circus visit.

*Figure 6.16d:* Frequency of high school students’ changes in attitude toward scientists (normal - weird) after the Science Circus visit.
Scientists are cool – nerdy

Primary school students
Before the Science Circus visit there was a range of responses, as shown in Figure 6.17a. After the Science Circus visit there was an increase in the number of students thinking that scientists are cool, and a small decrease in the number of students thinking that scientists are nerdy. Figure 6.17b shows that there was a large increase in positive attitudes and a similar number of students that did not change their attitudes. The majority of the control students think that scientists are neither cool nor nerdy in the pre-test, however the post-test had almost half the number of students thinking that scientists were nerdy.

This adjective pair and ‘scientist are fun or serious’ show similar trends.

High school students
Figure 6.17c clearly shows that half the number of students think that scientists are nerdy, both before and after the Science Circus visit. Figure 6.17d shows a greater number of students have a negative change in attitude. Again these students are more critical than the primary school students.

The majority of the control students responded that scientists are neither cool nor nerdy. There was a large number of control students who had a positive change, as more students moved from a negative response to a more neutral response. It would appear that the control group had a positive change and the test group had a negative change in attitude suggesting that the Science Circus did not promote a cool image of scientists.

Summary
Primary school students have a more positive image of scientists than the high school students. There appears to be evidence suggesting that the Science Circus visit causes more primary school students to think that scientists are cool and more high school students to think that scientists are nerdy.
Scientist attitude: Cool – Nerdy

Primary school students

Figure 6.17a: Frequency of 'cool' (positive) and 'nerdy' (negative) scores for primary school students' attitudes toward scientists before and after the Science Circus visit.

Figure 6.17b: Frequency of primary school students' changes in attitude toward scientists (cool - nerdy) after the Science Circus visit.
**Chapter Six—Attitudes Toward Science and Scientists**

**Scientist attitude: Cool – Nerdy**

**High school students**

![Graph showing frequency of 'cool' (positive) and 'nerdy' (negative) scores for high school students' attitudes toward scientists before and after the Science Circus visit.]

**Figure 6.17c:** Frequency of 'cool' (positive) and 'nerdy' (negative) scores for high school students' attitudes toward scientists before and after the Science Circus visit.

![Graph showing frequency of high school students' changes in attitude toward scientists (cool - nerdy) after the Science Circus visit.]

**Figure 6.17d:** Frequency of high school students’ changes in attitude toward scientists (cool - nerdy) after the Science Circus visit.
Scientists are useful to have – not useful to have

Primary school students
There is a large majority of students that strongly believe that ‘scientists are useful to have’, shown in Figure 6.18a. Over half of the students’ attitudes did not change, which indicates that students have a clear idea of scientists in society. Few students changed their attitudes either positively or negatively, as shown in Figure 6.18b. The control group had strong views that ‘scientists were useful to have’, and the majority of students had no attitude change toward this question. There is little evidence suggesting the Science Circus has a positive or negative effect on students.

High school students
Over half of the population thought that scientists are useful to have, and after the Science Circus visit more students had a positive view, as shown in Figures 6.18c and 6.18d., unlike the primary school students. The high school test and control groups have very similar patterns in the pre-tests, however there was a large percentage of control students that did not change their attitude. This suggest that the Science Circus has a positive effect on high school students in terms of how useful scientists are.

Summary
Both the primary and high school students think that scientists are ‘useful to have’. Primary school students showed little change in attitudes after the Science Circus visit, unlike the high school students. There is evidence to suggest that the Science Circus has a positive effect on high school students.
Scientists in Society attitude: Useful to have – Not useful to have

Primary school students

**Figure 6.18a:** Frequency of 'useful to have' (positive) and 'not useful to have' (negative) scores for primary school students’ attitudes toward scientists in society before and after the Science Circus visit.

**Figure 6.18b:** Frequency of primary school students' changes in attitude toward scientists in society (useful to have - not useful to have) after the Science Circus visit.
Scientists in Society attitude: *Useful to have – Not useful to have*

**High school students**

![Graph](image)

**Figure 6.18c:** Frequency of ‘useful to have’ (positive) and ‘not useful to have’ (negative) scores for high school students’ attitudes toward scientists in society before and after the Science Circus visit.

**Figure 6.18d:** Frequency of high school students’ changes in attitude toward scientists in society (useful to have - not useful to have) after the Science Circus visit.
Attitude Summation

Primary and high school students' summation and difference scores are summarised in Tables 6.1 and 6.2, respectively. The Figures 6.19a, 6.19b, 6.20a and 6.20b represent the calculated means and difference scores for each of the four attitude responses for primary and secondary school students, respectively.

Attitude toward science

The data suggests that the Science Circus has a small positive effect on primary school student attitudes toward science. On a scale of -4 to 4 there was a small positive increase of +0.11 ± 0.04. The Science Circus did not have such a positive effect on high school students, where a small negative change in attitude was recorded of -0.18 ± 0.10. The high school students were not nearly as positive before or after the Science Circus visits, compared to the primary school students. One a scale of one to five, with one being the most positive, the primary school students' post-test score is 2.1 ± 0.0, compared to 3.2 ± 0.1 for the high school students. Somewhere between primary and secondary school, students' attitudes toward science become more negative. These findings correspond to those of Hofstein and Welch (1984) who found that students had a negative change in attitudes toward science classes when in senior high compared to junior high.

Attitude toward science in society

The results for all each of the adjective pairs and phrases that were used to produce an overall score for science in society were very similar for primary school students. There was no change in attitude for this age group with a summed value of 0.00 ± 0.04. Although little change had occurred, the scores are very positive both before and after the Science Circus visit. The post-tests scores for primary and high school students are 1.8 ± 0.0 and 2.5 ± 0.1, respectively. High school students showed a very small positive increase in their attitudes toward science in society with a score of 0.04 ± 0.08.
Attitude toward scientists

The primary school students showed an overall positive change in attitude toward scientists of $+0.17 \pm 0.05$, with large increases in positive attitudes for the ‘fun - serious’ and ‘cool - nerdy’ adjective pairs. The primary school students had a more positive view of scientists that high school students with post-test scores of $2.5 \pm 0.1$ and $3.6 \pm 0.1$ respectively. The older students had a negative increase in their response of $-0.10 \pm 0.10$. Unlike the primary school students the high school group had a negative image of scientists both before and after the Science Circus visit. Unfortunately it appears that the Science Circus did not help improve their image.

Attitude toward scientists in society

The Science Circus had opposite effects for primary schools students and high school students in terms of scientists in society. The data suggests that the high school students showed an increase in positive attitudes of $+0.31 \pm 0.16$ compared to the negative change in attitude of $-0.23 \pm 0.07$ for primary school students. Both primary and high school students started out with positive attitudes toward scientists in society with pre-test scores of $1.4 \pm 0.0$ and $2.5 \pm 0.1$ respectively.

In all of the four attitudes high school students scores were less positive than the primary school students. There also appears to be evidence that the younger the age of the primary school students the more positive their attitudes. This supports the findings of others who found that older students had more negative attitudes toward science (e.g. Ayers and Price 1975; Piburn and Baker 1993).
Table 6.1: Primary school student attitudes toward science, science in society, scientists and scientists in society (mean ± standard error of the mean).

<table>
<thead>
<tr>
<th></th>
<th>Science</th>
<th>Science in Society</th>
<th>Scientists</th>
<th>Scientists in Society</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before</strong></td>
<td>2.2 ± 0.0</td>
<td>1.8 ± 0.0</td>
<td>2.7 ± 0.0</td>
<td>1.4 ± 0.1</td>
</tr>
<tr>
<td><strong>After</strong></td>
<td>2.1 ± 0.0</td>
<td>1.8 ± 0.0</td>
<td>2.5 ± 0.0</td>
<td>1.7 ± 0.1</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>0.11 ± 0.04</td>
<td>0.00 ± 0.04</td>
<td>0.17 ± 0.05</td>
<td>-0.23 ± 0.07</td>
</tr>
</tbody>
</table>

Table 6.2: High school student attitudes toward science, science in society, scientists and scientists in society (mean ± standard error of the mean)

<table>
<thead>
<tr>
<th></th>
<th>Science</th>
<th>Science in Society</th>
<th>Scientists</th>
<th>Scientists in Society</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before</strong></td>
<td>3.1 ± 0.1</td>
<td>2.5 ± 0.1</td>
<td>3.4 ± 0.1</td>
<td>2.5 ± 0.1</td>
</tr>
<tr>
<td><strong>After</strong></td>
<td>3.2 ± 0.1</td>
<td>2.5 ± 0.1</td>
<td>3.6 ± 0.1</td>
<td>2.3 ± 0.1</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>-0.18 ± 0.10</td>
<td>0.04 ± 0.08</td>
<td>-0.10 ± 0.10</td>
<td>0.31 ± 0.16</td>
</tr>
</tbody>
</table>
Figure 6.19a: The mean of primary school students' attitudes toward science, science in society, scientists and scientists in society.

Figure 6.19b: The mean of change in primary school students' attitudes toward science, science in society, scientists and scientists in society.
Figure 6.20a: The mean of high school students' attitudes toward science, science in society, scientists and scientists in society.

Figure 6.20b: The mean of change in high school students' attitudes toward science, science in society, scientists and scientists in society.
Gender differences

There is little evidence to suggest that males and females have different attitudes toward science and scientists, which supports the findings of Ayers and Price (1975). Table 6.3 summarises the results for primary and high school students, before and after the Science Circus visit. There is more variation between the sexes with the high school students, particularly their views on science in society. It appears that females have a more positive attitude toward science in society. Although Trankina (1993) found that more females than males agreed with the negative statement ‘science pries into things’ and ‘science breaks down people’s ideas of right and wrong’, the age groups are very different to those used in this study. Trankina’s study was determining attitudes of adults, aged between 20 and 79 years of age.

Table 6.3: Gender differences between primary and high school student attitudes toward science careers, girls and science, science, science in society, scientists and scientists in society (mean ± standard error of the mean).

<table>
<thead>
<tr>
<th>School</th>
<th>Test</th>
<th>Sex</th>
<th>Career</th>
<th>Girls &amp; science</th>
<th>Science</th>
<th>Science in society</th>
<th>Scientists</th>
<th>Scientists in society</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>Before</td>
<td>F</td>
<td>3.6±0.1</td>
<td>2.2±0.1</td>
<td>2.2±0.1</td>
<td>1.8±0.1</td>
<td>2.6±0.1</td>
<td>1.4±0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>3.5±0.1</td>
<td>2.2±0.1</td>
<td>2.1±0.1</td>
<td>1.8±0.1</td>
<td>2.7±0.1</td>
<td>1.5±0.1</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>F</td>
<td>3.7±0.1</td>
<td>2.4±0.1</td>
<td>2.1±0.1</td>
<td>1.8±0.1</td>
<td>2.5±0.1</td>
<td>1.7±0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>3.9±0.1</td>
<td>2.4±0.1</td>
<td>2.0±0.1</td>
<td>1.8±0.1</td>
<td>2.5±0.1</td>
<td>1.7±0.1</td>
</tr>
<tr>
<td>High</td>
<td>Before</td>
<td>F</td>
<td>4.4±0.2</td>
<td>3.2±0.2</td>
<td>3.0±0.1</td>
<td>2.4±0.1</td>
<td>3.3±0.1</td>
<td>2.3±0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>4.3±0.2</td>
<td>3.2±0.2</td>
<td>3.2±0.1</td>
<td>2.8±0.1</td>
<td>3.6±0.1</td>
<td>2.8±0.2</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>F</td>
<td>4.3±0.2</td>
<td>3.2±0.2</td>
<td>3.1±0.1</td>
<td>2.4±0.1</td>
<td>3.5±0.1</td>
<td>2.1±0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>4.3±0.2</td>
<td>3.4±0.2</td>
<td>3.3±0.1</td>
<td>2.7±0.2</td>
<td>3.7±0.1</td>
<td>2.4±0.2</td>
</tr>
</tbody>
</table>
Both males and females have little desire to become scientists, particular the high school students. There is little difference between males and females on the view that 'girls like or dislike science'.

Individual school class scores were compared to the respective teacher scores, however, there was little correlation between the two. All primary school teachers had very positive attitudes toward science and scientists, both before and after the Science Circus visit.

Primary school teachers

The majority of primary school teachers had very positive attitudes toward science and science in society, as shown in Table 6.4. Little attitude change occurred after the Science Circus visit. The only question which had a range of responses was 'is science easy or difficult'. Approximately half of the teachers responded in the neutral zone. There was very little change before and after the Science Circus visit.

The question 'does science offer equal opportunities for women' was answered positively and approximately a quarter of the respondents answering neutral. There was little change in attitude between the pre-test and post-test.

Attitudes toward scientists were all in the neutral range except for the 'extremely intelligent' question where the population was divided between neutral and extremely intelligent. Again there was little attitude change found before and after Science Circus visit. A number of teachers wrote comments on their questionnaires indicating that scientists should not be stereotyped, examples of comments are below:

(Scientists are) just like everyone else, they come in a variety of styles and colours!!

(Scientists are) like anyone else.

Can't generalise for all scientists.

Could be all of these depending on the individual.
Attitudes toward scientists in society differed for each question. Most teachers felt that 'scientists tried to be useful', however, teachers were less positive about 'scientists try to spread their work for the greater good'. There were mainly positive scores and only a small number of teachers felt that 'scientists were only interested in their results'. When asked if they thought 'scientists were good or bad communicators' the majority of teachers responded in the neutral zone.

When the questions are summed to give an attitude score for science, science in society, scientists, scientists in society the teachers have a more positive response compared with high school students. Although negative attitude changes are shown in Table 6.4 this can be explained by the fact that a few teachers moved from very positive to positive or to neutral. Few teachers ever recorded a negative response.

From the above results is would seem that the Science Circus had little or no effect on teacher attitudes. Adults tend to have formed their opinions and a one hour performance would have little influence on adults' attitudes unlike young children. This is another indication of the importance to promote positive images of science and scientists to school students, before their attitudes are formed.

Table 6.4: Teacher attitudes toward science, science in society, scientists and scientists in society (mean ± standard error of the mean)

<table>
<thead>
<tr>
<th></th>
<th>Science</th>
<th>Science in society</th>
<th>Scientists</th>
<th>Scientists in society</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>1.7 ± 0.1</td>
<td>1.2 ± 0.1</td>
<td>2.4 ± 0.1</td>
<td>2.2 ± 0.1</td>
</tr>
<tr>
<td>After</td>
<td>1.8 ± 0.2</td>
<td>1.3 ± 0.1</td>
<td>2.7 ± 0.0</td>
<td>2.3 ± 0.1</td>
</tr>
<tr>
<td>Difference</td>
<td>-0.10 ± 0.08</td>
<td>-0.12 ± 0.07</td>
<td>-0.20 ± 0.06</td>
<td>-0.04 ± 0.07</td>
</tr>
</tbody>
</table>

'Non-booked' teachers

The teachers who did not request the Science Circus to visit their school were asked to complete the attitudinal inventory before the Science Circus visited their region. These
teachers were not asked to complete a post-test. The results of the ‘non-booked’ teachers are shown in Table 6.5. The two teacher groups, the ‘booked’ and ‘non-booked’, show very similar attitudes toward science and scientists. This suggests that teacher attitudes toward science has little effect on the teachers’ decision to not book a Science Circus visit.

**Table 6.5: ‘Non-booked’ teacher attitudes toward science, science in society, scientists and scientists in society (mean ± standard error of the mean)**

<table>
<thead>
<tr>
<th></th>
<th>Science</th>
<th>Science in society</th>
<th>Scientists</th>
<th>Scientists in society</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.8 ± 0.1</td>
<td>1.3 ± 0.1</td>
<td>2.6 ± 0.1</td>
<td>2.3 ± 0.2</td>
</tr>
</tbody>
</table>

**Summary**

- The data suggests that primary school students have a positive attitude change toward scientists, believing scientists are more ‘fun’ and more ‘normal’ after a Science Circus visit.

- High school students have more negative attitudes toward science and scientists than primary school students.

- Teachers have very positive attitudes toward science and scientists.

- Generally the Science Circus has little effect on students’ attitudes toward science and scientists.

- There is little evidence to suggest that there are differences between male and female attitudes toward science and scientists.
Chapter Seven

Results from the Evaluation of the Science Circus

Introduction

This chapter is divided into five sections, each of which addressed the remaining research question of the first objective outlined in Chapter One. The questions are:

- Does the Science Circus assist teachers in regional areas of Australia?
- Is the Science Circus a world class travelling program?
- Does the Science Circus provide a diverse range of opportunities for the Graduate Diploma students?
- Does the Science Circus optimise the numbers of people at schools and public venues?
- Does the Science Circus promote Shell and Questacon?
Section One—Assisting Teachers in Regional Areas of Australia

Introduction

Teachers play a vital role in all Science Circus school visits. Without their cooperation and assistance the Science Circus school bookings would not run smoothly and the visits would not occur. During the school visit many teachers contribute to the one hour presentation by volunteering, encouraging students and introducing and thanking the Graduate Diploma students. Often teachers sit at the back of the room taking notes on the demonstrations. It is important that the Science Circus provides a format that suits teachers and provide the information they request.

More importantly teachers are probably one of the first science role models for students, and the teachers need to be positive and confident in their science teaching style to provide the initial stimulus for their students. Koballa and Crawley (1985) report on the influence teachers have in changing attitudes toward science, for better or worse. Ebenezer and Zoller (1993) argue that emphasis must be placed on the science teachers’ role to help increase the image of science.

Questacon recognises the importance of the teacher role, indicated by the third goal of the Science Circus: To assist teachers in regional Australian schools to enhance the quality of science and technology education they deliver to their students. The Science Circus’ effectiveness in meeting this goal was measured by:

- interviews with teachers who watched the Science Circus show
- questionnaires to ‘booked’ teachers
- interviews with teachers in remote areas
- questionnaires to teachers in remote areas
- secondary data analysis.
Chapter Seven—Results from the Evaluation of the Science Circus

Interviews

Interviews were conducted with primary and high school teachers, and the suggestions that were made are summarised in Table 7.1.

A majority of primary school teachers requested that the Science Circus supply teachers with activities in a written form, for example either a resource booklet or an activity sheet which they could photocopy. Many teachers preferred the activities be linked to the science curriculum in some way. There was a strong emphasis placed on way the teacher could learn from the Science Circus presentation and how they could use that as a basis for conducting similar hands-on activities in their classroom.

High school teachers had different requests. These teachers were not as interested in follow-up material, although they would use them if supplied, but more concerned with the content of the presentation. The teachers requested shows that were more complicated, with equipment and demonstrations that they could not do because of the expense and/or availability of equipment.

For example, a high school teacher, whose class saw the Liquid Nitrogen Show and the Pressure Show, thought the Liquid Nitrogen Show was 'terrific' but was not as impressed with the Pressure Show as he demonstrated a lot of the experiments to his class earlier in the year. He wanted something more spectacular, 'for example a show on electricity' and when it was mentioned that the Science Circus had a Laser Show, he nodded his head in agreement. A few of the Science Circus show ideas are now being demonstrated by the teachers, enabling hands-on science to reach a greater number of students. However, it is very important that the Science Circus continues to introduce new ideas to teachers and students to maintain its originality and uniqueness.

The seven teachers that assisted in the coordination of the Science Circus supported these views. The three primary school teachers thought that many primary teachers found it difficult to teach science, even though there are many books of science activities and ideas. All three teachers mentioned that the teachers need confidence to teach science, and felt that the Science Circus increased their level of confidence. One teacher commented:
When they see your people perform, they see how the experiment works and they will be able to repeat the activities if they have written instructions.

**Table 7.1: Teacher interview: suggestions on how to further assist teachers.**

<table>
<thead>
<tr>
<th>Suggestion</th>
<th>Frequency of suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity sheets/notes on hands-on activities</td>
<td>56</td>
</tr>
<tr>
<td>Pre- and/or post-activities related to the shows and curriculum</td>
<td>29</td>
</tr>
<tr>
<td>Allow teachers to choose shows</td>
<td>19</td>
</tr>
<tr>
<td>In-service for teachers</td>
<td>18</td>
</tr>
<tr>
<td>Come back next year</td>
<td>8</td>
</tr>
<tr>
<td>Access to exhibits</td>
<td>7</td>
</tr>
<tr>
<td>More briefing material</td>
<td>6</td>
</tr>
<tr>
<td>Take my science class</td>
<td>3</td>
</tr>
<tr>
<td>Stay longer</td>
<td>3</td>
</tr>
</tbody>
</table>

Of the four high school teachers, three were disappointed that their students did not see the exhibits of the *Science Circus*, instead of the one hour performance. Even though the teachers liked the performance they felt they could do the same experiments, except for a couple including the use of liquid nitrogen and demonstrations from the *Chemistry Show*. They thought the exhibits would have been a wonderful resource for the students. One teacher who had watched the one hour performance with his Year 11’s, and visited the public venue with his young children the next night, thought that his physics students would have learnt more from the exhibits than the demonstration show. At the public venue he indicated that the *Rotating Platform* would have been great for all his students to feel the effects of inertia. It was something he didn’t have at his school.

In its first two years the *Science Circus* program included a science show and time to interact with the exhibits during the day. The format was changed due to the intense
workload for the Graduate Diploma students and the small numbers of school students that could be seen at any one time.

The positive aspect of the Science Circus presenters travelling to the school rather than the school travelling to the venue is the reduced cost for the school students, as the school would have to hire a bus or arrange some other transport. Also less time is required for the students to be away from school as the students can quickly assemble in, for example, the school hall. However, one teacher with her class, had travelled 45 minutes to a school for the one hour performance and was very disappointed when she realised it was “just” the show and that the students would not see the exhibits as “that was the only reason why the class travelled all that way”.

Although it would be more expensive for the Science Circus to have the exhibits set up for a longer period of time, due to the hall costs, it could be arranged for schools to visit the exhibits between the public venues. This would need to be organised when the tour coordinator initially hires the public venue hall.

It seems that primary school teachers are happy with the one hour performance, and would be more so if the Science Circus were to provide pre- and post-visit resources. A trial activity sheet was developed as part of this project, which is discussed in more detail in Chapter Eight.

A number of high school teachers have requested access to the Science Circus exhibits and more complicated science demonstrations for their students. If a program could be offered to high school groups, similar to the one requested above, the Science Circus could attract a greater number of senior classes, for example physics students, whose teachers could use the exhibits to explain physics concepts. Perhaps the Science Circus could supply these teachers with a list of the exhibits prior to the Science Circus visit, allowing teachers to be familiar with what the Science Circus has to offer them and their students.
Chapter Seven—Results from the Evaluation of the Science Circus

Questionnaires

The teachers who responded to the 'booked' questionnaires were asked seven questions in relation to how the Science Circus could assist teachers. Each of these questions will be addressed separately.

I have incorporated a more hands-on style of teaching since the Science Circus visit.

A majority of teachers thought they had incorporated a more hands-on teaching style after the Science Circus visit, shown in Table 7.2. This provides some evidence that teachers are looking for new ideas and ways of teaching science in their classes. If the Science Circus were able to provide more assistance to the teachers on how to incorporate hands-on activities into their classroom, it would be viewed a more worthwhile program by teachers. The level of response for this question was poor, which may indicate that the question was more difficult to answer.

Table 7.2: The frequency of teacher responses to the statement 'I have incorporated a more hands-on style of teaching since the Science Circus visit'.

<table>
<thead>
<tr>
<th></th>
<th>Definitely not</th>
<th>Probably not</th>
<th>Unsure</th>
<th>Probably yes</th>
<th>Definitely yes</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>2</td>
<td>7</td>
<td>4</td>
<td>12</td>
<td>4</td>
<td>11</td>
</tr>
</tbody>
</table>

Vandermark (1994a) found a similar result with approximately half the number of teachers using a more hands-on style of teaching after the Science Circus visit.

There was sufficient briefing material provided prior to the visit.

Teachers were provided with this statement before and after the Science Circus visit. It appears that a greater percentage of teachers thought they needed more briefing material after the Science Circus than before, as shown in Table 7.3. However, when individual teacher comments are compared, there were more teachers that thought there was sufficient
briefing material when asked after the *Science Circus* visit. Of those teachers who indicated what other briefing material they would like, only 8% of teachers, before the *Science Circus* visit, requested more information on shows/activities compared to 23% of teachers once the *Science Circus* had visited. A quarter of the teachers who responded to both the before and after questionnaires would like more information on the types of shows and activities.

*Table 7.3: Percentage of teacher responses to the statement 'There was sufficient briefing material provided prior to visit'.*

<table>
<thead>
<tr>
<th></th>
<th>Definitely not</th>
<th>Probably not</th>
<th>Unsure</th>
<th>Probably yes</th>
<th>Definitely yes</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=68)</td>
<td>7%</td>
<td>7%</td>
<td>25%</td>
<td>50%</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td><strong>After</strong></td>
<td>10%</td>
<td>17%</td>
<td>17%</td>
<td>29%</td>
<td>17%</td>
<td>10%</td>
</tr>
<tr>
<td>(n=40)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Leading up to a *Science Circus* tour the coordinator receives numerous telephone calls from teachers requesting more detailed information on the shows, than what is detailed in the briefing notes. The current *Science Circus* briefing notes provide examples of show titles, however, this is not an exhaustive list and there are no details of the shows' content. The coordinator would explain a number of the different shows and often these teachers would request particular shows which corresponded to what the class was learning at that time. When a teacher requests a show, the coordinator indicates that the show cannot be guaranteed. In many cases it is difficult for the coordinator to ensure that the schools receive the requested show as the daily timetable is organised by the Graduate Diploma students without knowledge of the coordinator and not all shows are performed by all the Graduate Diploma students. Therefore if a certain person is sick or has a rostered day off a particular show might not be available. These problems could be easily solved if the *Science Circus* decided to formalise show requests made by teachers. Perhaps a section on the booking sheet could be designed so that all schools have the same information and the requests can be recorded when arranging the tour timetable.
Vandermark (1994a) found that one in four teachers thought the briefing materials could have contained more precise details of presentation content and allow the option of choosing a show for their class. Of the teachers who replied to the questionnaire 97% of teachers thought their class had enjoyed the *Science Circus* visit however there were many comments made regarding the hands-on content of the *Science Circus*. The majority of negative comments focused on how the *Science Circus* promotes itself as being hands-on and the inconsistency perceived to exist in this area, as only a small number of students actually participate in the presentation. The briefing material which is sent to the teacher does not say that the shows are hands-on, however, the flyer in general promotes hands-on science, which is where the confusion could lie. Redesigning the briefing materials would be inexpensive and may alleviate the above problems.

**Did you receive an activity sheet? Was it useful?**

Nine teachers had received an activity sheet and of these, five found them very useful. One teacher commented that the sheets could be improved by relating the activities to the curricula. Two teachers had not had time to use the sheets, but were looking forward to using them. The activity sheet was designed with a mix of activities with science content suitable for primary schools. There was one high school teacher who had received the activity sheet and commented that it was very useful.

These results indicate that the activity sheets are not reaching the teachers. This will be discussed in conjunction with the results of the next question. In 1992 Anderson suggested that the *Science Circus* needed to provide teachers with follow-up material. From Anderson's findings a booklet 'Science Toys and Activities' was produced and sold as a teacher and parent resource at the public venues. The development of the activity sheet will be discussed further in Chapter Eight.

**Did you find the Teacher's Resource Kit useful?**

Twenty one teachers commented that they had not seen the resource kit, eight teachers found it useful and four teachers said they didn't find it useful. The four teachers that did not find the kits useful all commented that the kit consisted mainly of advertising material
and three of these teachers wanted material (and the activity sheet) related to the Science Circus session.

Over half of the teachers who responded to the questionnaire did not know or had not seen the resource kit. This is a clear indication that the current method of distributing the resource kits is not effective. Currently the Graduate Diploma students are asked to give the kits to the school, preferably to the contact teacher. However this is often difficult for the Graduate Diploma students. There is often little time to speak with the contact teacher as sometimes they are not available or quickly leave the show once it has started. The Graduate Diploma students are busy organising their props and keeping students away from sometimes dangerous equipment, and often have to leave very quickly to present at another school. Hence the resource kit is not thought of until ticketing time which occurs at the office. Most often the resource kit is handed to the office staff along with the tickets for the students and teachers. A similar result was found by Vandermark (1994) that only 50% of the teachers surveyed were aware of the existence of such educational material.

The contents of the resource kit also need to be modified. At present they contain a lot of advertising material. Each kit includes: a Questacon Magazine with a subscription form, membership forms, a sticker, an activity with two cards (‘which card is bigger?’), information on other Questacon programs, an Exciter Pack order form and more recently an activity sheet. The Questacon Magazine has some activities in the back, however teachers could assume that this is a promotional tool.

One teacher commented on the “fantastic” card activity and requested similar activities. Perhaps more activities like this could be included, for example the activities Dr Michael Gore uses, such as ‘The Crazy Cafe Wall’.

There is a possibility that Questacon will soon produce a catalogue containing all the Questacon programs and publications that teachers can access. This would be ideal to provide teachers with a detailed and comprehensive list of what Questacon offers teachers and schools. On average the Science Circus visits 400 schools a year and the promotion of Questacon’s other programs may increase their usage.
If the *Science Circus* is to make an impact on teachers perhaps the resource kit could be sent to the teacher with the confirmation forms. This would enable the teacher to be more familiar with what the *Science Circus* does and to use pre-visit activities with their students. It is also important for the Graduate Diploma students to mention the teacher resource kit at the end of the one hour presentation, to remind teachers and also inform the students that there are activities for them to try.

**Did you use your complimentary teacher's ticket to attend the** *Science Circus* **public venue?**

Ten teachers used their tickets and all ten thought the *Science Circus* was "great" and "most informative". Of the 27 teachers that didn't use their tickets 20 said they had other commitments, five lived too far away and one said they didn't receive their ticket. The *Science Circus* public venue could be a source of many ideas for both primary and secondary school teachers and is a resource that the *Science Circus* can easily offer to these teachers. The 20 teachers who had other commitments may have been able to make it to the *Science Circus* if they had been given greater prior notice or the opportunity to visit during their lunch hour or after school. Perhaps the *Science Circus* could invite teachers along to the session when the Graduate Diploma Students train the local Explainers, who are high school students that have volunteered to assist at the *Science Circus* public venues.

Only one teacher commented that they did not receive a ticket, compared to the greater number who did not know about the activity sheet or the resource kit. This is interesting as generally the tickets are left at the office with the resource kit. Perhaps this is because each teacher gets a ticket, whereas there is only one resource pack and one activity sheet. This would suggest that the Graduate Diploma students need to tell all teachers, during the show, that the kit actually exists, just as they remind the teachers of their complimentary tickets.

**Was the** *Science Circus* **school visit useful for your senior students?**

Four high school teachers thought the *Science Circus* was not a useful visit for senior school students. However, few suggestions were provided on what would be useful to this age groups, as indicated below:
Too late in the year; exams are on; visit earlier in the year.

Not relevant to this age group... need to have program suitable for age group.

How else can the Science Circus help you as a teacher?

Nine teachers requested that Questacon publish their activities or provide more hands-on activity material. Two teachers wanted practical theme lessons and one high school teacher requested that classes be taken through the exhibits. These comments are very similar to the responses received from the teacher interviews.

Teachers in remote areas of Australia

Interviews

Of the eight interviews that were recorded in the remote communities there was only one interview that provided little feedback on how the format and content of the Science Circus visit could be improved. This teacher, who was the principal, had a negative attitude toward the Aboriginal community and little to share of his 12 months of being in the remote community.

The seven other teachers were delighted to have the Science Circus visit their schools and provided positive comments on the Science Circus activities. The role of education in Aboriginal communities was also discussed. Generally these teachers wanted the Science Circus to stay longer, provide teacher workshops and more activities and resource material. The suggestions are summarised in Table 7.4.

One of the teachers was a former volunteer at the Queensland Museum Sciencentre, where she had been trained to perform hands-on science shows and assist with holiday programs for children. This teacher was asked if she used many of the activities and ideas from the Sciencentre and she indicated that she did not. The teacher had not thought of using hands-on activities with her students until she had seen the Science Circus that day. This teacher had prior knowledge of hands-on activities and did not use them with the students. As
mentioned in Chapter Three of this thesis, Aboriginal children's learning is facilitated through hands-on learning. If the Science Circus were to spend more time with teachers, it would be very beneficial to them, especially those who do not have a science background, showing them how each of the activities work.

Pat Miller, the Key Learning Science Coordinator of Far North Queensland, said he has been promoting hands-on science activities in the remote communities because of their appeal with the Aboriginal and Torres Strait Islander children (pers comm 1996). He recently commented:

*They (the teachers) are slow at taking the idea up... we need to go in and show them what hands-on activities are all about.*

**Table 7.4: Suggestions made by teachers in remote communities.**

<table>
<thead>
<tr>
<th>Suggestion</th>
<th>Frequency of suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incorporate teacher workshops</td>
<td>6</td>
</tr>
<tr>
<td>Stay longer</td>
<td>6</td>
</tr>
<tr>
<td>More hands-on activities</td>
<td>5</td>
</tr>
<tr>
<td>More follow-up material</td>
<td>5</td>
</tr>
<tr>
<td>Relate activities to Aboriginal cultures</td>
<td>2</td>
</tr>
<tr>
<td>Interactive maths activities</td>
<td>1</td>
</tr>
</tbody>
</table>

It is difficult and expensive for any program to travel to isolated regions and train small numbers of teachers. The Science Circus already visits remote communities and could easily spend more time at each community to provide the needed service for teachers. One teacher pleaded for the Science Circus team to stay a few more days, so all her teachers could benefit.
In terms of relating the Science Circus program to Aboriginal cultures many issues were raised. The teachers suggested that the Science Circus work with an Aboriginal teacher or Aboriginal Liaison Officer to develop programs that the children can easily relate to. The teachers were also supportive of having the community involved and were impressed that the Science Circus made contact with the communities Chairman, to invite the community to participate.

Questionnaire

Four teachers indicated that the briefing material could have been sent a little earlier, preferably by facsimile as the mail system isn’t reliable because of the isolation. The information provided was helpful to organise the visit. There were only positive comments regarding the format of the workshop, language of science explanations and the instructions given to the students. Most teachers suggested that a longer stay to provide teacher workshops would be very useful.

A very successful, helpful and excellent learning.

Thank you for a very worthwhile visit... love to see you again next year.

They helped me understand the science... I enjoyed it as much as the kids.

There were no comments on how to improve the visit, or how to relate it more to the experiences of the Aboriginal children. The interviews provided more insight, although solutions were hard to find.


Summary

- Primary school teachers want more resource material that is related to the science curriculum and the demonstration shows.

- High school teachers would like the Science Circus shows to contain more demonstrations that they cannot do themselves.

- High school teachers would like the chance for their senior students to see the Science Circus exhibits during school hours, as part of the one hour performance.

- Significant numbers of teacher resource kits and activity sheets are not reaching the teachers.

- The visits to the remote communities are very well received, with teachers requesting the Science Circus to stay longer to include teacher workshops.
Section Two—A World Class Travelling Program

Introduction

To make the Science Circus of ‘world class’ value, a group of Questacon staff decided that the program would need to be of high quality and comparable to other similar programs throughout the world. The Science Circus program was evaluated using the following factors:

- the level of school students' enjoyment
- teacher assessment of the overall value of the Science Circus school visit
- teacher assessment of the appropriateness of presenters' language
- a teacher comparison of the Science Circus with other travelling programs in Australia
- visitor opinion of the Science Circus
- comparing Science Circus to other travelling science programs.

A range of methods were used to obtain this information including student and teacher questionnaires, teacher interviews, exit polls and secondary data analysis.

Student enjoyment levels

Enjoyment levels of students were determined by a questionnaire after the Science Circus visit. Four questions were summed together to get an overall score for enjoyment value. An average of $3.6 \pm 0.2$ was obtained for primary school students on a scale one to five, with five being the most positive. High school students had a slightly lower average of $3.3 \pm 0.4$. These results, shown in Table 7.5, are similar to the results discussed in Chapter Six, where high school students had more negative attitudes toward science.

A high school teacher, who himself and his class completed questionnaires, noted:
My students were very complimentary of the Science Circus ... they seemed very positive and excited... I am not sure why this isn’t reflected in their answers.

This comment suggests that one high school class was more complimentary of the Science Circus than indicated on the questionnaire. If other classes behaved in this way, then perhaps a score of 3.3 is quite positive.

Table 7.5: Enjoyment averages for primary and high schools students (mean ± standard error of the mean).

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary school students</td>
<td>3.6 ± 0.2</td>
</tr>
<tr>
<td>(n=350)</td>
<td></td>
</tr>
<tr>
<td>High school students</td>
<td>3.3 ± 0.4</td>
</tr>
<tr>
<td>(n=92)</td>
<td></td>
</tr>
</tbody>
</table>

Teachers assessment of the Science Circus

To determine if teachers thought the Science Circus was worthwhile, there were seven questions relating to the school visit on the post-visit questionnaire. The scores for each of the seven questions were summed to give an overall ‘worthwhile’ value. Teachers thought the Science Circus was a very worthwhile experience for their students with an average of 4.4 ± 0.1, on a scale between one and five, where five is the most positive score.

The teachers who were interviewed commented on the lack of hands-on activities during the school program. Some teachers were of the opinion that the Science Circus would be similar to the CSIRO travelling science program, Lab on Legs, that offers all students hands-on activities. Lab on Legs operates very differently from the Science Circus; it is a practical laboratory that visits a school for a week at a time, allowing each class to use the experiments. Those teachers that had experienced Lab on Legs and expected the Science Circus to be similar were disappointed in the level of interactivity. This is something the briefing notes must clearly describe, that is, the shows are demonstrations and the public venue exhibits are hands-on. These comments were also put forth by the primary school teachers in Anderson’s study (1992). Anderson found that teachers wanted the presenters...
to use more volunteers in order to provide more hands-on opportunities for the students. The teachers also suggested that the Graduate Diploma students ask the audience more questions that they can answer rather than rhetorical questions.

**Teacher assessment of presenters' language**

A number of methods were employed to determine if the Graduate Diploma presenters' language was appropriate for students. Regional and remote teachers were interviewed and sent questionnaires. The responses from the questionnaires sent to the ‘booked’ teachers, summarised in Table 7.6, indicates that the presenters’ language is appropriate for most student ages. The three responses of ‘probably not’ were from high school teachers, however, these three teachers did not indicate whether the presenters’ language was too basic or too complicated. The teacher interviews provided a little more insight and are discussed below. Vandermark (1994) found similar results with only one in five teachers commenting that the explanations were not appropriate for their students for most year levels.

**Table 7.6: The explanations of scientific concepts were appropriate for my students’ age.**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Definitely not</th>
<th>Probably not</th>
<th>Unsure</th>
<th>Probably yes</th>
<th>Definitely yes</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>8</td>
<td>20</td>
<td>6</td>
</tr>
</tbody>
</table>

Interviews with the high school teachers revealed that these teachers thought the level of science content and level of explanations could be increased. The teachers commented that although their students enjoyed the presentation the teachers wanted the visit to be educational as well. One primary school teacher thought the language was a little high for her Year One and Two class, however, she commented that some students may have understood more than others and all students enjoyed themselves. Of the teachers that were interviewed at the end of the show, almost all teachers thought the level of explanations was pitched correctly. There were a few conflicting viewpoints, some teachers wanting
more science and others wanting less for the same age groups.

This contradiction may be due to a number of reasons: different science levels of individual classes; different teachers; different presenting styles of the Graduate Diploma students; and the many different demonstration shows. The latter two reasons can be addressed to help improve the consistency of appropriate language levels. Presently the Graduate Diploma students have little training in particular age group understanding levels. All training is done by the Science Circus coordinators and Questacon staff, who have show presenting experience but few of whom are teachers. The Science Circus coordinators, do however, strongly recommend the Graduate Diploma students seek feedback from teachers, particularly at the start of the year. Workshops conducted by teachers on appropriate language levels would be a worthwhile addition to the current training strategy. All graduate Diploma students should be encouraged to learn particular demonstration shows suitable for the younger students.

**Remote Communities**

The results from interviews conducted with teachers in remote community schools were very complimentary of the Graduate Diploma students’ use of language and examples. Two teachers thought the Graduate Diploma students talked a little too fast for the children to understand, but thought the demonstration props “carried them through”. One teacher went as far to say that the little kids did not understand very much, however, “their eyes were so wide with amazement at the wonderful things it wouldn't have mattered”. All teachers had very positive things to say, and were amazed at the level of enthusiasm the presenters were able to maintain. One teacher expressed her support of the relaxed presentation style where the students were allowed to “run a little wild with the bubbles and slime”.

Few comments were made on the questionnaires. One teacher highlighted the difficulty in relating to non-English speaking students: she noted that the presenter “did a great job”. The issue of language is important and Graduate Diploma students should be reminded of the different language levels from community to community.
Public venue visitor assessment

The public venue visitors were asked to rate the value of their visit to the Science Circus in an exit poll. The visitor was asked to mark a Likert scale from one to five, with five being the most positive response, on how ‘worthwhile’ their visit was. Table 7.7 represents the frequency of the response to this question. There is a clear indication that a large majority, 84%, thought the Science Circus was very worthwhile visiting. Less than 1% of those surveyed thought the Science Circus was not worthwhile.

Table 7.7: Visitor exit poll response asking if their visit was worthwhile (n=693).

<table>
<thead>
<tr>
<th>Very worthwhile</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>154</td>
</tr>
<tr>
<td>3</td>
<td>51</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Not worthwhile</td>
<td></td>
</tr>
<tr>
<td>Frequency of response</td>
<td>433</td>
</tr>
</tbody>
</table>

Teacher comparison of other travelling programs in Australia

Teachers who had booked the Science Circus were asked to compare the Science Circus school visit to other travelling programs, such as puppet shows and music shows, in terms of education and entertainment values. Table 7.8 summarises the results.

The majority of teachers thought that the Science Circus was more educational that other travelling programs, although a considerable proportion were unsure. In both educational and entertainment terms the Science Circus was thought to be at least as valuable as other travelling programs. Teachers were unsure if the was more entertaining and approximately equal number thought yes and no. It would seem that the Science Circus is competing at an equal level with other travelling programs with teachers believing the program the Science Circus offers is more education and of similar entertainment levels to other travelling programs.
Table 7.8: Frequency of teacher responses when asked to compare the Science Circus to other travelling programs.

<table>
<thead>
<tr>
<th></th>
<th>Definitely not</th>
<th>Probably not</th>
<th>unsure</th>
<th>Probably yes</th>
<th>Definitely yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Science Circus was more educational</td>
<td>0</td>
<td>2</td>
<td>12</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>The Science Circus was more entertaining</td>
<td>1</td>
<td>7</td>
<td>17</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

Other travelling science programs

There a number of travelling science programs that operate in Australia and throughout the world. This study does not review all of these travelling programs and does not compare the Science Circus to all other programs which operate in different conditions with different needs: this alone would be a major project. However, to determine if the Science Circus is truly a world class travelling exhibition, two travelling science programs have been described, one within Australia, Reachout, and one in New Zealand, the Telecom Technology-Science Roadshow.

Many colleagues, whose opinions I value, have commented on various programs in Europe, mentioning that the programs operate in a similar way to the Science Circus, consisting of demonstration shows and interactive exhibits, however the Science Circus operates on a larger scale with a greater number of staff. Beetlestone (1995), in his review of Questacon thought very highly of the Science Circus, particularly its collaboration with the ANU and the Graduate Diploma program. As Director of Techniquest in Cardiff, Beetlestone has organised a Masters in Science Communication with a very practical component, not dissimilar to the Science Circus.

Reachout is the travelling outreach program of The Investigator Science and Technology Centre, in Adelaide. This program travels to all regions in South Australia and selected regions of the Northern Territory. Reachout tours five times a year visiting schools and
would see approximately 10 000 people each year. Reachout has one coordinator, a small number of part-time staff and 25 exhibits which travel in a van. The exhibits are similar to the Science Circus exhibits, that is, they are hands-on, very portable and relate science concepts to everyday things. When funding is available, Reachout tours to Aboriginal communities. The staff of the Investigator have developed exhibits of particularly relevance to Aboriginal people, and commissioned an Aboriginal artist to design and develop banners and exhibit text panels. The Reachout staff are past Graduate Diploma students and appear to have built on their Science Circus experiences to develop a program suited to South Australia and Aboriginal people living in that region. (pers comm Cooper 1996; pers comm Mulcahy 1997).

Each year the Telecom Technology-Science Roadshow (Roadshow) visits every large town and city in New Zealand and targets school students between eight and 13 years of age. The Roadshow changes the two demonstration shows and approximately 70% of the exhibition each year. The exhibits are not as easy to pack and unpack as the Science Circus exhibits, due to their weight and shape. Unlike in the Science Circus, schools visit the Roadshow and it opens to the public approximately 10 weekends throughout the year. The Roadshow provide excellent teacher resources, supplying schools with pre- and post-visit activities and teacher notes including exhibit details and show contents (pers comm Young 1995; pers comm McIntyre 1996; pers comm Mulcahy 1997).

Both Reachout and the Roadshow have similar goals to the Science Circus, however their approaches are different. A comparison is difficult due to the different styles of programs. However, the Science Circus seems as good as Reachout and the Roadshow, and covers a greater area and communicates science to more people each year. There are few existing programs outside of Australia and a number of European science centres are interested in the operation of the Science Circus to assist in their development of similar programs.

Few programs visit remote communities and the Science Circus is the only science program which has travelled to many of the remote areas in Western Australia and Queensland. The continuous support from Shell Australia, and the Australian National University the Science Circus has enabled the Science Circus to operate at a world class level for nine years, however, there is always room for improvement. Chapter Seven and
Chapter Seven—Results from the Evaluation of the Science Circus

Eight look into ways of improving the *Science Circus* to remain a world class travelling program.

**Summary**

- Primary and high school students enjoy the *Science Circus* school visit. The primary school students recorded a higher level of enjoyment.

- Teachers think the *Science Circus* is a very worthwhile experience for their students.

- Teachers think that the explanations of the scientific concepts are appropriate for most age groups.

- Teachers think the *Science Circus* offers more education and similar entertainment levels to other travelling programs.

- A vast majority of the *Science Circus* visitors thought their visit to the *Science Circus* was very worthwhile.

- The *Science Circus* is a world class travelling program.
Section Three—Providing a Diverse Range of Opportunities for the Graduate Diploma Students

Each Graduate Diploma student travels with the Science Circus four times a year. The tours are approximately three weeks long and travel to different regions in Australia. Audiences are very diverse, because of the large areas covered. Over the past two years the 29 Graduate Diploma students have seen many parts of Australia and have promoted enthusiasm for science to over 150,000 people.

To determine if the Science Circus is providing a diverse range of opportunities for the Graduate Diploma students, a review of venues, audiences and places was conducted, as shown in Table 7.9. The ten Graduate Diploma students were interviewed for their thoughts on their experiences with the Science Circus.

The Graduate Diploma students were very appreciative of the opportunities that the Science Circus provided for them. This review is related specifically to the Science Circus and does not include the opportunities provided by the Graduate Diploma course, which involve many other diverse experiences.

The highlights of 1995 and 1996 included the visits to Aboriginal and Torres Strait Islander communities and the School of Distance Education lessons.

The students expressed the need for shows tailored more to high school students, and wished there were more opportunities for high school visits. The Graduate Diploma students enjoyed all aspects of the Science Circus, particularly those where the students were involved in the hands-on workshops, for example those conducted for mentally and physically challenged students. Although the workshops required great preparation, the Graduate Diploma students welcomed the change and thought the “benefits were great”.

Table 7.9: The range of opportunities provided for the Graduate Diploma students during 1995 and 1996.

<table>
<thead>
<tr>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform shows to:</td>
</tr>
<tr>
<td>• pre-school students</td>
</tr>
<tr>
<td>• primary school students</td>
</tr>
<tr>
<td>• high school students</td>
</tr>
<tr>
<td>• students and parents in remote towns</td>
</tr>
<tr>
<td>• School of Distance Education students</td>
</tr>
<tr>
<td>• to all ages of the public</td>
</tr>
<tr>
<td>Conduct workshops for:</td>
</tr>
<tr>
<td>• pre-school students</td>
</tr>
<tr>
<td>• primary school students</td>
</tr>
<tr>
<td>• high school students</td>
</tr>
<tr>
<td>• students and parents in remote towns</td>
</tr>
<tr>
<td>• Aboriginal and Torres Strait Islander communities</td>
</tr>
<tr>
<td>• special schools</td>
</tr>
<tr>
<td>• hospital patients</td>
</tr>
<tr>
<td>• Double Helix members</td>
</tr>
<tr>
<td>Perform shows at old aged homes</td>
</tr>
<tr>
<td>Present to Rotary groups</td>
</tr>
<tr>
<td>Busk at markets and shopping centres</td>
</tr>
<tr>
<td>Organise, develop and implement media promotion strategies</td>
</tr>
<tr>
<td>Present on radio and television</td>
</tr>
<tr>
<td>Explain exhibits to all ages of the public</td>
</tr>
</tbody>
</table>
Summary

- The Graduate Diploma in Scientific Communication provides a diverse range of opportunities for its students.

- The Graduate Diploma students are appreciative of the number of opportunities provided by the *Science Circus*.

- The highlights for the Graduate Diploma students are the visits to Aboriginal and Torres Strait Islander communities and School of Distance Education lessons.

- The Graduate Diploma students would like to present more high school sessions.
Section Four—Optimising Visitor Numbers

Introduction

The number of school students and people at public venues depends upon many factors such as the size of the town, number of schools, time of year, effectiveness of advertising, other events, and even the weather. Over the past nine years the Science Circus has experienced a great range of venue audience numbers from as low as thirteen to over 2,000 in one day. It is easy to put a minimum and maximum figure on the number of school students and number of public venue visitors however the problem is predicting the response from the public and schools.

To determine if the Science Circus optimises the number of people who visit the public venue and the number of school students each of the following factors were investigated:

- past tour data
- who visits the Science Circus and why
- effectiveness of promotion strategies
- teacher return rate
- student return rate
- why teachers do not book the Science Circus
- secondary data
Tour data

It is very difficult to predict the number of schools that will book the Science Circus or the number of people that will visit the public venue on a particular day or night. To give an example of the variety the Science Circus encounters from tour to tour, the tour statistics of 1996 are summarised in Table 7.10.

Table 7.10: Visitor number of the 1996 Science Circus tours (unpublished tour reports, 1996).

<table>
<thead>
<tr>
<th>Tour</th>
<th>Tour Length</th>
<th>Approximate Visitor Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central West NSW</td>
<td>3 weeks</td>
<td>7 000</td>
</tr>
<tr>
<td>Tasmania</td>
<td>3 weeks</td>
<td>20 000</td>
</tr>
<tr>
<td>North coast, NSW</td>
<td>3 weeks</td>
<td>18 000</td>
</tr>
<tr>
<td>Far North QLD</td>
<td>4 weeks</td>
<td>24 000</td>
</tr>
<tr>
<td>Murray region, SA</td>
<td>3 weeks</td>
<td>10 000</td>
</tr>
<tr>
<td>Great Ocean Road, VIC</td>
<td>3 weeks</td>
<td>10 000</td>
</tr>
</tbody>
</table>

One cannot assume that the largest visitor numbers will be in an area of the highest population. For example, the Far North Queensland tour visited an area with a population of less than 100 000 compared to the catchment area of over 240 000 of the Great Ocean Road tour. However, the Science Circus saw 14 000 more people on the Queensland tour than the Victorian tour. One explanation may be that regional centres have less visiting attractions and the novelty of Science Circus captures a larger percentage of the population.

Table 7.11 summarises the school and venue statistics for the past seven years. The table is divided into three sections, school visits, public venue visitors and total visitors.
Table 7.11: Science Circus tour statistics for years 1990–1996 (unpublished tour reports).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>School Visits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schools visited</td>
<td>403</td>
<td>412</td>
<td>375</td>
<td>360</td>
<td>378</td>
<td>365</td>
<td>461</td>
</tr>
<tr>
<td>Students at school</td>
<td>56,028</td>
<td>63,560</td>
<td>57,244</td>
<td>61,148</td>
<td>55,884</td>
<td>46,865</td>
<td>57,577</td>
</tr>
<tr>
<td>Public Venues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return students</td>
<td>16,974</td>
<td>14,034</td>
<td>15,007</td>
<td>13,231</td>
<td>10,249</td>
<td>9,450</td>
<td>11,125</td>
</tr>
<tr>
<td>Child</td>
<td>5,986</td>
<td>4,887</td>
<td>4,067</td>
<td>3,621</td>
<td>5,577</td>
<td>3,380</td>
<td>5,425</td>
</tr>
<tr>
<td>Adult</td>
<td>10,985</td>
<td>9,985</td>
<td>9,626</td>
<td>9,959</td>
<td>9,528</td>
<td>7,876</td>
<td>8,761</td>
</tr>
<tr>
<td>Total at venue</td>
<td>34,297</td>
<td>29,462</td>
<td>25,298</td>
<td>26,807</td>
<td>25,840</td>
<td>19,332</td>
<td>27,099</td>
</tr>
<tr>
<td>% of venue-return student</td>
<td>49</td>
<td>48</td>
<td>59</td>
<td>49</td>
<td>39</td>
<td>48</td>
<td>41</td>
</tr>
<tr>
<td>% of venue-adults</td>
<td>32</td>
<td>34</td>
<td>38</td>
<td>37</td>
<td>37</td>
<td>40</td>
<td>32</td>
</tr>
<tr>
<td>% of venue-child</td>
<td>17</td>
<td>17</td>
<td>16</td>
<td>14</td>
<td>22</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>% student return</td>
<td>30</td>
<td>22</td>
<td>26</td>
<td>22</td>
<td>18</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Number of venues</td>
<td>62</td>
<td>69</td>
<td>59</td>
<td>53</td>
<td>55</td>
<td>55</td>
<td>52</td>
</tr>
<tr>
<td>Venue hours</td>
<td>208</td>
<td>232</td>
<td>194</td>
<td>204</td>
<td>223</td>
<td>181</td>
<td>180</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total people minus</td>
<td>73,351</td>
<td>78,988</td>
<td>67,535</td>
<td>75,792</td>
<td>73,280</td>
<td>56,747</td>
<td>73,551</td>
</tr>
<tr>
<td>Days touring</td>
<td>136</td>
<td>-</td>
<td>132</td>
<td>138</td>
<td>135</td>
<td>132</td>
<td>132</td>
</tr>
</tbody>
</table>

In 1996 a two-day workshop was held to look at possible directions the Science Circus could take. This meeting was not to make final decisions but to provide suggestions and ideas as to how the Science Circus might develop in the next five years. During this workshop the statistics in Table 7.11 were shown, excluding the 1996 data. When the 1996 data are excluded from this table there appears to be a trend suggesting that visitor numbers, in more recent times, were decreasing. In a recent report, commissioned by Shell, it was stated that the Science Circus attendance figures had declined significantly over the period 1990–1995 at the public venues and school visits (Sawatzki 1996). However, the

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5 Total people minus is calculated by adding the number of school students visited and the total number of public venue visitors, and then subtracting the number of students that used their free tickets to enter the public venue.
addition of the 1996 figures seems to indicate a reasonably stable pattern over the past seven years, except for the student return figures. The student return figure is the number of school students who visit the Science Circus using the free ticket they received after watching the Science Circus school session.

The 'total people minus' figures are a more accurate indication of the total number of people who saw the Science Circus. This figure is calculated by adding the school students visited at schools with the total number of people at the venue, and then subtracting the number of student returns. Hence, the school students are not counted both when the Science Circus saw them at school and when these students returned to the public venue with their free tickets. These totals are very consistent except for 1995.

In 1995 the Science Circus visited very remote regions, including the Goldfields region of Western Australia and North West Queensland, both vast areas with low populations. The previous visit to the Far North Queensland area, in 1990, proved to be very popular and lucrative, however just weeks before the Science Circus visited the region in 1995 there were major staff reductions at a major mine resulting in numerous strikes. Unfortunately for the Science Circus the tour had been arranged well in advance. Although it is Science Circus policy to carefully select tours that will provide a variety of densely populated areas and remote areas for each year, it is impossible to predict the situations like that described above.

Figure 7.1 shows the number of adults, children, student returns and total visitors at the Science Circus venue. The most significant drop is the student return number. Figure 7.2 shows the percentage of adults at a Science Circus public venue has been reasonably stable, the same with children. Figure 7.3 shows the number of students visited at schools has a high correlation (0.93) with the total venue numbers minus the students returns. In 1995 the school numbers were down, due to the low number of schools in the areas visited that year, and the venue numbers were also lower than usual.
The low rates of the student return numbers could be related to the reduced number of venues and opening hours. However there has been no decrease in the number of adults and children. Falk and Dierking (1992) believe that science centres compete for leisure time, and this could be the reason for the lower rate of student return. Chapter Eight looks at ways of increasing the student return figures.

\[\text{Figure 7.1: The number of adults, children, student returns and total visitors at the Science Circus venue for each year between 1990 and 1996.}\]

\[\text{Figure 7.2: The percentage of adults, children, and student returns at the Science Circus venue for each year between 1990 and 1996.}\]
Figure 7.3: A comparison of the number of total venue visitors and number of students visited at school for each year between 1990 and 1996.
Who visits the Science Circus and why?

Approximately half of the Science Circus visitors are aged between six and 17 and the other half are aged between 26 and 55 years of age, shown in Table 7.12. This age range is quite different from other science centres, with a greater proportion of children, which may be a result of the free student return tickets. The younger age group has equal numbers of males and females, however, the older age group has a significantly higher proportion of females. There is an obvious lack of visitors aged between 18 and 25 years of age. It could be concluded that parents are visiting with their children, with more mothers accompanying their children than fathers.

Table 7.12: Percentage of male and female Science Circus visitors (n=693).

<table>
<thead>
<tr>
<th>Age group</th>
<th>% Female</th>
<th>% Male</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6-12</td>
<td>19</td>
<td>18</td>
<td>37</td>
</tr>
<tr>
<td>13-17</td>
<td>6</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>18-25</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>26-40</td>
<td>18</td>
<td>9</td>
<td>27</td>
</tr>
<tr>
<td>41-55</td>
<td>11</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>&gt;55</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 7.13 indicates that there are few people that visit the Science Circus alone or without other family members. The Science Circus appears to be a family orientated event. Percentages are not given because the respondent could tick more than one box if applicable.
Table 7.13: Frequency of type of visitor accompanying the respondent.

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>family, with my children</td>
<td>390</td>
</tr>
<tr>
<td>friends</td>
<td>163</td>
</tr>
<tr>
<td>parents</td>
<td>121</td>
</tr>
<tr>
<td>alone</td>
<td>25</td>
</tr>
<tr>
<td>family, without children</td>
<td>23</td>
</tr>
</tbody>
</table>

Tennant (1995) found similar results in her study which investigated the effectiveness of the Science Circus in reaching adult visitors. Tennant found that there was extremely low attendance by adults not accompanied by children, and a low representation of the 18 to 25 and over 55 age groups. Tennant altered the standard public venue format to include an ‘adult only’ component consisting of science shows tailored for adults and a guided exhibit trail without children, however, enjoyment levels were not altered greatly. Tennant’s study indicated that a majority of adults visited the Science Circus for their children’s enjoyment and education.

Table 7.14 summarises the reasons why people visit the Science Circus and it appears that adults not only came for their own enjoyment but for their children’s enjoyment and entertainment. Tennant found that no adult visiting the Science Circus with children came solely for their own personal enjoyment or education and that half the adults thought they had learnt ‘a lot’ and 90% enjoyed the Science Circus ‘a lot’. The study found that a ‘child free’ environment is seen by adults as a more productive learning environment, however, the presence or absence of children had no impact on the degree in which they enjoyed or learnt from their overall Science Circus experience.
Table 7.14: Why children and adults visit the Science Circus.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Children</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal enjoyment</td>
<td>253</td>
<td>132</td>
</tr>
<tr>
<td>Personal education</td>
<td>56</td>
<td>62</td>
</tr>
<tr>
<td>Unique experience</td>
<td>48</td>
<td>58</td>
</tr>
<tr>
<td>Children’s enjoyment</td>
<td>0</td>
<td>182</td>
</tr>
<tr>
<td>Children’s education</td>
<td>0</td>
<td>182</td>
</tr>
</tbody>
</table>

Promotion strategies

The majority of children and adults find out about the Science Circus from school. Table 7.15 indicates the different promotion methods employed by the Science Circus (and others) and their effectiveness. Percentages are not shown as the respondents could choose more than one response.

It would appear that paid advertising is not an effective promotion tool for the Science Circus as more people find out about the Science Circus through school visits. In 1995, the Science Circus coordinator trialled an advertising campaign for the Tasmanian tour. The Science Circus was visiting the capital city, Hobart, and as this is a busy city with other events on, the Science Circus advertised in the major newspaper, the Hobart Mercury. Newspaper advertisements were placed before and during the Science Circus visit and the budget spent on advertising was double the usual amount. The exit poll conducted in Hobart revealed that 8% of those surveyed found out about the Science Circus through newspaper advertisements, compared to the usual 5%. This is another indication that in regional and major centres the Science Circus school visits are the best form of advertising.
Chapter Seven—Results from the Evaluation of the Science Circus

Table 7.15: Frequency of promotion method for the Science Circus public venue (n=693).

<table>
<thead>
<tr>
<th>Promotion method</th>
<th>Children</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>My children</td>
<td>0</td>
<td>301</td>
</tr>
<tr>
<td>School</td>
<td>264</td>
<td>192</td>
</tr>
<tr>
<td>Word of mouth</td>
<td>27</td>
<td>31</td>
</tr>
<tr>
<td>Newspaper advertisement</td>
<td>16</td>
<td>42</td>
</tr>
<tr>
<td>Newspaper article</td>
<td>14</td>
<td>40</td>
</tr>
<tr>
<td>Television</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Radio</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

Teacher return rates

All teachers who watch the Science Circus school visit receive a complimentary ticket to the public venue. The return rate is somewhere between 30–45%. The questionnaire sent to teachers after the Science Circus school visit asked them if they used their complimentary tickets and if not, why not. As previously mentioned in Section Two approximately one third of surveyed teachers used their complimentary ticket. The main reason that the teachers did not attend the public venue was that they had other commitments. To alleviate this problem perhaps more notice could be given to the teachers.

Student return rate

From the student questionnaire approximately 20% of those students who saw the Science Circus at school used their free ticket to visit the public venue. This percentage corresponds to the return rate of tickets at the door, from the register tally, which is somewhere between 18–23%. Of the students that used their free ticket 89% of these students thought the Science Circus public venue was 'great' with only 0.4% of the
students thinking it was boring (2 students). There was a range of explanations from those students that did not use their free ticket, and these are summarised in Table 7.16.

**Table 7.16: Reasons why students did not attend the Science Circus public venue.**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage of reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>busy/had other things on</td>
<td>45%</td>
</tr>
<tr>
<td>not allowed</td>
<td>20%</td>
</tr>
<tr>
<td>did not want to</td>
<td>10%</td>
</tr>
<tr>
<td>saw it at school</td>
<td>10%</td>
</tr>
<tr>
<td>forgot</td>
<td>7%</td>
</tr>
<tr>
<td>too far too travel</td>
<td>7%</td>
</tr>
</tbody>
</table>

The most common response from students who did not use their free ticket was that they had other commitments. This response could be either an indication that the students were not interested or perhaps the students required more advanced notice. The 10% of the sample that said they had already seen the *Science Circus* at school were perhaps not interested in having another science experience or they did not realise the difference between the school show and the public venue. If the latter is the case then the *Science Circus* presenters need to explain the difference between the school session and the public venue more clearly.

**Optimising school visits**

Table 7.11 indicates that there is a lot of variation in the number of schools visited each year. This is a reflection on the variety of areas visited, for example regional areas often have a large number of small schools. The number of school students has changed little in the seven years, with an average of between 55 000 and 65 000. In 1995 there was a considerably lower number school students, 47 000, but this was due to the low population
of the areas visited that year. In the past two years there have been only four tours which were capable of visiting more schools, however, in two of these cases there were few schools left in the region to fill these spaces. The other two tours were to larger centres where there were many other travelling programs visiting schools and other events that the school could request. These schools require at least six months notice to be able to include the Science Circus in their busy schedule. All the other tours could not include any other school bookings, and in many cases, the Graduate Diploma students gave up their rostered day off to present at schools. On a number of occasions the tour was so busy the coordinator was required to perform shows at schools.

There is a minimum and maximum number of school students in one session, of 60 and 120 respectively. Anderson (1992) found that a small proportion of teachers requested the session numbers to be reduced so more students could experience the hands-on activities and so students at the back could see the presenters and the demonstrations clearly. The number of students in a session was reduced for a trial period, however, as the Science Circus is a cost recoverable program, this was not a feasible solution. A light portable platform for large groups was investigated and trialled briefly, however, the lack of time to set up the science shows and great need for portability inhibited the success of the platform.

'Non-booked' schools

Teachers that did not book the Science Circus were asked why. The majority of the teachers commented that they had already organised other excursions for the term or year. Table 7.17 summarises the responses.

The teachers were asked to comment on how the Science Circus could address the problem that they specified. Eight teachers suggested earlier notification and two teachers wanted the program to be more curriculum based. Another two teachers suggested contradictory things, one asked for shows for smaller number of students and the other asked for shows that could deal with larger groups. The majority of these teachers said they would be interested in booking a visit at another time. There were no teachers that would not consider booking the Science Circus at some other time. This is an indication that perhaps
earlier notification may have resulted in a booking. At present the initial contact with a teacher occurs somewhere between three to six months. I would suggest that if the tours are planned well in advance then the schools should be notified between six and 12 months. The booking information does not need to be sent out this early, however, a general flyer indicating that a *Science Circus* will be visiting must be sent out well in advance.

**Table 7.17: Why teachers do not book the Science Circus (n=29).**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Frequency of reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other excursions that term</td>
<td>15</td>
</tr>
<tr>
<td>Other excursion already in the year</td>
<td>8</td>
</tr>
<tr>
<td>Other commitments that week</td>
<td>5</td>
</tr>
<tr>
<td>Limited budget/too expensive</td>
<td>4</td>
</tr>
<tr>
<td>Need earlier notification</td>
<td>3</td>
</tr>
<tr>
<td>Limited time for excursions</td>
<td>2</td>
</tr>
<tr>
<td>Needs to be more curriculum based</td>
<td>1</td>
</tr>
<tr>
<td>Not interested in science excursions</td>
<td>1</td>
</tr>
</tbody>
</table>

The response rate for the return of the ‘non-booked’ schools was low, approximately 16%, so the sample used in this study may not be indicative of all the schools that did not book the *Science Circus*. Those teachers that responded may have had more of an interest in science and the *Science Circus*.

**Optimising public venue visitors**

When a coordinator is planning a tour there are a number of factors to consider, such as the number of public venues, the population of the town and region, other events, number of schools in the region and time of year. It is very difficult to predict the number of people who will turn up at a venue on a particular day or night. The difficulty in predicting the
size of a venue crowd is well illustrated by the following example of the public venue figures on the recent NSW tour in 1996. The first night attracted 175 people, the second night 380 and the last night the venue attracted a capacity crowd of 1310 visitors.

An important question is: Does the *Science Circus* optimise the visitors’ experience at a public venue? Should the *Science Circus* have crowds of 1300 each night it is open? In terms of revenue it would be optimal, however, would it be feasible? Time and time again, in different towns, in different states, the longer the *Science Circus* stays in a particular town the greater the number of people who visit the public venue. Perhaps the *Science Circus* should stay longer in each town, therefore not visiting as many towns each tour.

Figure 7.3 shows the direct correlation between visitor number and school students. If the *Science Circus* is to open for a number of nights in one town it is advisable to wait until a large number of schools have been visited.

If the *Science Circus* is reaching its target figures of 80000 visitors each year, then the *Science Circus* is optimising its visitor numbers. A suggestion would be not to open the public venue until a considerable proportion of school visits had been completed to guarantee an adequate crowd.

\(^7\) total visitors, not the 'total people minus'
Summary

- The tour statistics for the past seven years show stable visitor numbers, except for the declining students return numbers.

- The majority of visitors are children aged between 6–12 years and adults between 26–55 years of age.

- Children visit the Science Circus for their own enjoyment.

- Adults visit the Science Circus for their enjoyment and their children’s education and enjoyment.

- The majority of visitors hear about the Science Circus public venue from the school sessions.

- The Science Circus school visits need to be promoted earlier, perhaps 6–12 months in advance.

- It appears that the Science Circus is reaching its target attendance figures, however the public venue visitor numbers could be increased.
Section Five—The Promotion of Shell and Questacon

Introduction

The Science Circus promotes both Shell and Questacon at school visits and the public venues. To determine if people are aware of the roles played by Shell and Questacon, two related questions were included on the teacher questionnaire and on the exit poll for the Science Circus public venue visitors.

The promotion of Shell

The majority of teachers that booked the Science Circus are aware that Shell is the Science Circus' major sponsor. Both before and after the Science Circus visit, 79% of the teachers gave the correct response. The remainder of the teachers did not respond to the question. After the Science Circus visit there were more teachers that thought Shell was not a responsible citizen, however, there is no evidence that this is due to the Science Circus visit. See Table 7.18 for the before and after results.

The teachers that did not book the Science Circus had a similar level of awareness with 76% of teachers responding correctly. There was only one incorrect response of “CSIRO”, with the remainder of the teachers not responding. Of these teachers who knew that Shell was the sponsor a majority of the teachers thought that Shell was a responsible world citizen.
Table 7.18: Teacher responses to the statement: Shell is a responsible world class citizen.

<table>
<thead>
<tr>
<th></th>
<th>Definitely not</th>
<th>Probably not</th>
<th>Unsure</th>
<th>Probably yes</th>
<th>Definitely yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Booked' teacher - before</td>
<td>2</td>
<td>1</td>
<td>14</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>'Booked' teacher - after</td>
<td>3</td>
<td>3</td>
<td>13</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>'Non-booked' teacher</td>
<td>0</td>
<td>3</td>
<td>9</td>
<td>9</td>
<td>1</td>
</tr>
</tbody>
</table>

Visitors of the public venue were asked who sponsors the Science Circus and 78% of visitors answered Shell, 2% gave incorrect results, such as “Esso” and “BP”, 1% recorded Questacon and/or ANU and the remaining 19% did not answer the question, as shown in Figure 7.4.

Figure 7.4: Results from the exit poll at the Science Circus public venue: Who is the major sponsor of the Science Circus? (n=693)
In a recent evaluation commissioned by Shell, a number of past Graduate Diploma students were asked questions regarding their awareness of Shell, the mining industry and the role of minerals. The Graduate Diploma students indicated that their time with the Science Circus increased their knowledge and awareness of Shell. However, the Graduate Diploma students did not think that the Science Circus increased their perception of Shell as a responsible world class citizen (Sawatzki 1996).

The Sawatzki report suggested that although considerable effort already goes into developing relationships between Shell and the Science Circus, there was a need to enhance the effective practices already in place. In particular, the report recommended that Shell define the key messages they want to convey about itself. Sawatzki suggested the development of a static display on Shell and its operations, including its role as a good citizen, for the public venue.

In the Science Circus exit poll, people were asked if they knew who sponsored the Science Circus, however, the visitors were not asked what they thought of Shell. Sawatzki recommended that the poll include this and attitudinal elements to help ascertain the effectiveness of the program.

The report also went as far to say:

Given the coverage of Science Circus, exposure of students to the program may well represent the first phase of recruitment for Shell. Whilst tracking student involvement for attendance to further involvement with Shell, including scholarships, work experience, and perhaps recruitment is difficult, backward tracking may well be possible so that the longitudinal effect of the program might be known (p. 19).

Although this would be fascinating to determine, the logistics of such an evaluation would prove to be near impossible.
The Promotion of Questacon

A majority of the ‘non-booked’ teachers, 70%, correctly reported that the Science Circus was a travelling component of Questacon, with responses ranging from Questacon, the National Science and Technology Centre and the science centre in Canberra. Two of the 29 teachers responded incorrectly, both thinking the Science Circus was a component of CSIRO.

Of the ‘booked’ teachers 68% responded correctly, three teachers answered incorrectly, with one thinking the Science Circus was part of Scienceworks in Melbourne, and a large proportion of the teachers did not respond to the question. There was no increase in the correct response before and after the Science Circus visit, with almost half of the teachers not responding to the question. The results are summarised in Table 7.19.

Table 7.19: Teachers' responses to the question: Which organisation is the Science Circus a travelling component of?

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Questacon</th>
<th>Incorrect</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Booked’ teachers - before (n=68)</td>
<td>46</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>‘Booked’ teachers - after (n=40)</td>
<td>20</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>‘non-booked’ teachers (n=29)</td>
<td>20</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

The teachers that booked a Science Circus visit were asked if they knew of any other Questacon programs, before and after the Science Circus visit. Although, after the Science Circus visit, the teachers are given a resource kit containing Questacon’s school program and other relevant teacher information, there was no indication of an increase in the number of teachers that knew about other Questacon programs. In fact, very few teachers responded to the question before and after visit. This question was an open ended question to test if the teachers were aware of the existing programs. Either they didn’t know or didn’t respond due to the open-ended nature of the question.
There is no mention of ANU in the goals used for this study. At the recent workshop looking at the future directions of the *Science Circus* this was recognised and the new goals now mention the third stakeholder, the ANU. It would be interesting to see if the visitors and teachers are aware of the involvement of ANU with the *Science Circus*.

**Summary**

- The majority of teachers are aware that Shell is the major sponsor of the *Science Circus*.

- The majority of public venue visitors are aware that Shell is the major sponsor of the *Science Circus*.

- The majority of teachers are aware that the *Science Circus* is a travelling component of Questacon.
Chapter Eight

Development and Implementation of New Programs

Introduction

This chapter addresses the second and third objectives and the associated research questions set out in Table 1.1 of this study. The two objectives are:

- to suggest and implement new programs for the Science Circus
- to determine if the new programs are beneficial.

The Science Circus had developed little between the years 1990 and 1995. The renewal of the Shell sponsorship for another five years, was approaching. With these two reasons in mind it seemed a logical time for the Science Circus to undergo an overall evaluation. It was hoped that there would be money allocated for an upgrade of the Science Circus. If this were the case the evaluation would provide an insight into what programs could enhance what the Science Circus offers schools and the general public.

Throughout the two years of this study there was a growing body of feedback derived from prior research, audience comments, experience of coordinators and Questacon staff, new research, and initial results of this study. This pot of information was used to suggest, implement and then finally evaluate the new ideas.

A number of ideas were generated through a variety of means. These ideas were investigated, developed, redeveloped, some discarded and some further developed and finally implemented. Some of the suggestions in this chapter have not been implemented. However, these ideas are considered to be innovative and potentially worthwhile additions to the Science Circus, with further development and assistance from a range of people.
This chapter is divided into two sections. The first summarises the suggestions, the development and implementation of a number of these ideas, for both the public venue and the school visits components of the Science Circus. The second section comprises the results from the evaluation of the two implemented ideas, Speedball and Totspot.

Section One—Suggesting and Implementing New Ideas

Prior research was investigated before the initial meetings with the Science Circus staff members to determine if there were indications of what changes, if any, needed to be made. The first issue that was raised is: ‘Who is the Science Circus target audience?’

Research conducted by Vandermark (1994a and 199b) and Tennant (1996) found that the majority of adults visiting the Science Circus accompanied their children and that adults aged between 18–26 were underrepresented. Even though an attempt was made to attract this age group, the endeavour was not successful. Advertisements, ‘adult only’ nights, ‘adult only’ shows and ‘adult only’ exhibit trails were trialled to varying degrees of success, but generally it was found that these changes did not enhance the adult visitor’s experience or adult numbers. The Science Circus team asked itself, ‘Just what does the Science Circus offer to this age group?’ The group was prepared to except that the answer may be ‘not enough to compete with other evening and weekend leisure time activities’. However, the recent Sawatzki report (1996) mentioned that Shell would like to pursue that age group and increase the attendance figures for this age bracket. Although this study does not address this issue, it is something the Science Circus and its sponsor need to answer, as the results will have implications on the types of programs that will be developed in the future.
Chapter Eight—Development and Implementation of New Programs

Coming up with the new ideas

Numerous meetings, both formal and informal, were held over the past two years to discuss the Science Circus, prior research and the initial results from this study. As a result of the initial meetings seven areas were identified that needed improving:

- the public venue atmosphere
- the decreasing number of student-returns at the public venue
- programs for children under the age of five
- the demonstration shows
- the low numbers of high school bookings
- resources for school teachers
- the remote community program.

After reviewing prior research (e.g. Leow 1993; Vandermark 1994a and 1994b; Tennant 1996) there seemed to be evidence suggesting that the Science Circus works well as a family event. The Science Circus staff decided that the new ideas should reflect this, focusing on the family as the main client of the Science Circus.

This section of the thesis is divided into three parts, the public venue, the school sessions and remote community visits.

The public venues

The exhibition atmosphere

An interesting embellishment of the Science Circus, in terms of format, would be an accentuation of the ‘circus’ atmosphere. Although the Science Circus is a very popular and exciting place to visit, the routine of the public venue has been firmly set with two demonstration shows on the half hour, a look at the exhibits between the shows with the occasional busk and competition. The Science Circus staff recommended slight changes to this routine, ones that would be easy to implement. The small changes were not new ideas,
they had been used before; the ideas were never implemented all at one time, however, to produce a synergistic effect. The ideas were:

- more busking between shows
- random explanations of exhibits
- mini-shows
- more competitions
- shows performed with two presenters (double shows)
- ‘snappier’ show announcements

The modification of the routine would provide a number of different experiences for the visitor and the Science Circus Graduate Diploma student. The Graduate Diploma students will experience less monotony, which in turn, may provide them with more energy and enthusiasm required for the public venues, especially explaining the exhibits. A floor manager is chosen for each public venue to welcome the visitors, announce shows and generally manage the crowds. With instruction from the coordinators at the start of the year, the floor manager would become more like a ringmaster, to emphasis the ‘circus’ feel. For example, running more competitions, randomly selecting Graduate Diploma students to explain exhibits and having ‘snappy’ show announcements. A portable microphone would allow all of these ideas to flourish.

Performing shows with another presenter is a different and interesting experience. The presenters can feed off each others’ enthusiasm. In large crowds, these double shows cannot be performed as the Graduate Diploma students have a busy roster. However, when there is not a capacity crowd and the Graduate Diploma students may need to be inspired, the use of double shows could help build enthusiasm.

These ideas were implemented in Tour Six of 1995 and throughout 1996. Although no formal evaluation was conducted, the Science Circus coordinators were of the opinion that the Science Circus had a more exciting feel and that the Graduate Diploma students were interacting with the public on a greater level.
To improve the appearance of the Science Circus a number of suggestions were given to the design team at Questacon. Suggestions for increasing the atmosphere were new banners, the incorporation of more colour and new uniforms. These ideas, along with others, were recently mentioned at the workshop discussing the future direction of the Science Circus.

**Body Torso**

To enhance the amount and quality of the busking at a public venue, the Science Circus staff members provided a variety of ideas for new props and topics. The most popular idea was the Body Torso, a plastic model of the human body with removable organs. The Body Torso has been purchased but has not yet been used. Although it is anticipated that there will be great use of the Body Torso, a script has not been written. Not all the Graduate Diploma students have a biological background, therefore the script should explain the various parts of the body in an interesting and relevant style. The Body Torso could be placed on top of a ‘circus tub’, for example a spare show tub. This tub could be placed on one of the Science Circus wooden trolleys to enable the Body Torso to be moved to various sites within the venue.

**Increasing student return numbers**

All students who watch the Science Circus performance at school receive a free ticket to visit one of the public venues. The number of students using their free tickets to enter the Science Circus has been decreasing over the past seven years, as shown in Table 7.11. A number of suggestions were made to help address this problem and they are detailed below:

- increasing promotion through school newsletters
- informing the school’s Parents and Friends Association
- enhancing the information on the student free ticket
- providing a draw card such as ‘star’ exhibit that would be easy to promote the public venue to the school students.
In Chapter Seven it was established that the majority of visitors find out about the Science Circus through the school sessions. It was also determined that the majority of visitors are family groups. Increasing the promotion of the Science Circus public venue to parents, through the schools, may help increase the student return rate, as more adults may suggest their children visit the Science Circus. Providing information to Parents and Friends Associations may help inform more parents.

The current ticket that the school students receive has a small amount of information about the Science Circus, the public venue and the school shows. There is a large photo of the Graduate Diploma students in an interesting pose. Although this photo may mean something to the school students, who have met a number of the Graduate Diploma students, the photo does not provide an image of the public venue. I strongly recommend that more information, benefits for family groups and an image portraying the fun and excitement of the public venue be incorporated in the student free ticket.

**Speedball**

During one of the meetings with the Science Circus staff, the idea of a ‘star’ or ‘hero’ exhibit was discussed. This ‘star’ exhibit would be an exhibit that immediately appeals to people and promotes the fun and excitement of the Science Circus exhibition to school students and the media. The exhibits which have been used to promote the Science Circus were usually the Rotating Platform and the Harmonograph, two popular exhibits (Clugston pers comm 1995). Both these exhibits are still popular, discussed later in this chapter, however they were not fulfilling the requirements of ‘star’ exhibits.

An idea for a star exhibit was ‘Speedball’. A similar exhibit already existed in another Questacon exhibition, Mathematica. However, it was not suitable for the Science Circus because of its weight and lack of portability. The Exhibition, Design and Development team at Questacon was approached, to see if it was feasible to have such an exhibit for the Science Circus. It needed to be portable, easy to assemble and able to withstand constant battering, as there is little possibility of maintenance when on the road for three to four weeks. Thanks to the dedicated staff members, the Science Circus Speedball was designed and built. It has a radar unit at which the visitors throw a tennis ball and a digital readout...
displaying the speed of the ball. The accompanying text panel describes how the speed of the ball is calculated.

The Speedball was trialled on Tour Four in 1996. An evaluation was carried out and the results are discussed in the second section of this chapter.

**Something for the under fives**

*Totspot*

In order to cater fully for the ‘family’ market, it was felt that the Science Circus needed to provide more for younger children and the parents looking after the younger children. There were not as many attractions for children under school age as there are for others at the Science Circus. The general exhibit height of approximately 80 centimetres, restricted young children’s use of the exhibits. Parents are often seen holding their children up for them to interact with the exhibit. The Science Circus staff members thought a special place was needed for children under the age of five. The group considered providing such an area, called Totspot.

*Totspot* would be a small area with a range of play-exhibits specially designed for young children. Older children would have restricted use of the Totspot and the parents of the young children would be encouraged to share their children’s experience. Carpet would be laid down for the children and chairs and stools would be provided for the adults. A prototype Totspot was trialled for Tour 6 of 1995 and from the recommendations of the coordinator and the Graduate Diploma students a more permanent Totspot was developed for 1996.

Included in the Totspot are: large-piecled jigsaw puzzles of animals, puppets, shakers, a magnetic aquarium, felt picture boards and a variety of children’s toys purchased from a children’s shop. An evaluation was carried out in 1996 and these results are discussed at the end of this chapter.
Chapter Eight—Development and Implementation of New Programs

The school visits

Science shows

The impact of school visits is important in the high return rate of students to the public venue. As a result of the feedback received by teachers throughout this study it was decided that the shows and school visits could be improved. In order to optimise the impact on increasingly demanding school students, the Science Circus wanted to ensure all show material was of a very high standard. The priorities were to have new shows or overhaul existing shows and encourage the Graduate Diploma students to vary the format of the show presentation at school visits. It was decided that shows that needed improving were revived or discarded. In 1995 the Chemistry Show, the Rock Climbing Show and the Laser Show were introduced. In 1996 the Roundabout Show was revamped and the Colour Show was rewritten to incorporate ideas from three previously discarded shows.

An example of varying the school visit format, is to have the Graduate Diploma students working together on the same show. In this case the one hour presentation can be modified and not strictly include two 20 minute shows. It allows the presenter far more creativity. This approach was actively encouraged by the coordinators in 1995 and 1996 and should be encouraged in the future, once the scholars have mastered the standard presentation format. However it is essential that the Graduate Diploma students retain their individuality in presentation style, particularly when being assessed.

At the end of 1995 and 1996 the Graduate Diploma students were involved in brainstorming sessions to generate with ideas for new shows. It is crucial for Graduate Diploma students to document any changes or new shows before they leave the Science Circus at the end of their year. If this does not continually occur many ideas will be lost.

Pre-school visits

In the past the Science Circus has not targeted pre-school groups for school visits. The main rationale for this was the first hand knowledge that children of this age could not concentrate for a full hour program. Many pre-schools have small numbers of students and would need to combine with older students in Year One or Two, reducing the enjoyment
for the older students due to the distractions from the pre-schoolers. The lack of training for the Graduate Diploma students on how to present to this age group, was another reason for avoiding them.

While touring with the *Science Circus* a number of teachers indicated their disappointment that the *Science Circus* did not include shows for the pre-school students. The teachers felt that the hands-on nature was very suitable to this age group. The *Science Circus* thus decided to prepare a program for this age group.

During Tour Six in 1995, the *Science Circus* trialled two half-hour shows for pre-schoolers. The tour coordinator gave a short workshop on how to present to this age group to the two Graduate Diploma students chosen to conduct the shows. The Graduate Diploma students conducted the workshops where all the material was provided. Each child had a hands-on experience with activities including the Cartesian diver, clucking cups, sticking cups on balloons and dancing balloons in the air flow of a hairdryer. The children were charged $3, the same amount as the one hour program, to cover the costs of the materials. The workshops had a maximum number of 25 students in each group and the teachers were informed that their assistance would be necessary. The informal feedback received by these teachers was overwhelmingly positive and very appreciative.

Jones (1992) investigated the learning ability of young children, five and six years of age, and found evidence that young children do learn and remember science concepts from a typical *Science Circus* demonstration show. She suggests that the *Science Circus* could conduct visits to younger children particularly if the shows were changed to suit the younger audiences. The half-hour show trialled in 1995 worked well, and with further modification a very successful pre-school program could be offered.

It would be important that the pre-school program be included in the initial booking sheets that are sent to schools advertising the forthcoming *Science Circus* visit. At present these workshops are performed only to schools when a teacher inquires about the suitability of the one hour performance for pre-school students. Although the half hour workshop requires more preparation than the standard one hour performance, there would be ways of reducing the workload. For example, the material required could be collected throughout
Chapter Eight—Development and Implementation of New Programs

the year and a Graduate Diploma student could be put in charge of maintaining the equipment. A similar duty is already required of two Graduate Diploma students who are responsible for the ‘Ditty’ and ‘Dotty’ boxes which contain the ‘bits and pieces’ for the public venue.

If pre-school visits are to be included for future years it would be desirable that the Graduate Diploma students attend a workshop conducted by early childhood educators, on how to present to pre-schoolers.

There was no formal evaluation conducted on the new pre-school visits, but only positive comments were received from the Graduate Diploma students and teachers.

Senior high school visits

Special events for senior high school students were discussed and a variety of ideas were brought up, such as interactive workshops and debates on science in society. However, not many concrete ideas were established. The results from the teacher interviews from this study have provided a number of ideas. These programs, however, have not been implemented. There is a definite need to develop a program for senior high school students and it is important for someone to coordinate the development of the new programs with people who are familiar with this age group, such as high school teachers and perhaps past Science Circus members who are currently involved in school education.

Activity sheets

The idea of providing resource material for teachers has been an issue that the Science Circus has been aware of for a number of years. Barbagallo (1991) and Langford (1992) both designed booklets for teachers to use as resource material. In 1992 the Science Circus produced a booklet written by past Graduate Diploma students called Science Toys and Activities. Any teachers requesting information are often referred to this booklet. The booklet contains 13 hands-on activities with easy to follow instruction and illustrations, with a brief science explanation of each activity. The booklet sells for $1.50 and although this is a very reasonable cost, it is something that teachers rarely purchase, and if so,
mainly at the public venues.

In 1995 Hepplewhite produced resource materials for primary school teachers and evaluated their success. Two sheets were designed, one based on the *Fire and Light Show* and another on the *Slime Show*. The sheets contained experiments that reinforced the topics covered in the show but no demonstrations conducted in the show. Each activity needed only basic equipment and simple materials so the teachers could conduct the experiments without having to find difficult items. The sheet was easy for teachers to reproduce by photocopying. Hepplewhite reported that half of the teachers surveyed had expected follow-up material, even though there was no mention of it, and the materials that these teachers received were the sort of thing they had expected. Few teachers had actually tried the experiments to give feedback on the suitability of the experiments. Those teachers that had used them thought they were suitable. The activities were easy to follow according to the teachers.

After the many interviews with teachers, see Table 7.1, there was a strong indication that teachers wanted an activity sheet, on general experiments. I developed a trial activity sheet (Appendix XVII), not only for the teachers but also as instructions for teachers in remote communities on the demonstrations presented to their students. The amount of time spent on producing the sheet was approximately 20 hours. The sheet is very basic, with illustrations drawn by me. Evaluation of the sheet showed that although it was appreciated, teachers were looking for more activities linked to the science curricula.

If the sheets provided to the teachers can be photocopied, the issue of copyright needs to be addressed. If there is a small fee for the activity sheet, it must be mentioned in the teacher briefing notes.

**Resources for Aboriginal communities**

When the *Science Circus* visits a remote community all the demonstration props are provided by the *Science Circus* and these resources are left with the teachers. A number of Questacon books and an *Exciter Pack* are also left with the teachers. From the initial evaluation, it was found that the teachers wanted information on each of the activities
performed and the science behind them. An activity sheet was written for community visits in 1996. This was a temporary measure and further resource material needs to be developed for teachers in remote communities.

In large schools the amount of time spent at the community and the amount of materials are not adequate. To help alleviate this problem a grant was received from DEETYA to design and build 10–20 exhibits that are light, portable and suitable for the Aboriginal and Torres Strait Islander students. Once the exhibits have been designed a booklet containing information on each exhibit should be developed and left with the teachers, along with details on the workshop activities.

**Interviews with Linda Cooper and Will Inveen**

Linda Cooper, the Deputy Director of The Investigator Science and Technology Centre in Adelaide, and Will Inveen, Questacon’s Project Officer for the South Pacific *Science on the Move*, have had experience in designing exhibits and developing education resource material for indigenous people. Both Cooper and Inveen stress the importance of providing exhibits that are interactive, with a game-type activity which results in an outcome. For example: *Packing Parcels*, which requires the user to correctly pack a number of different shaped parcels into a container; *Balancing Sticks*, where the user is challenged to balance six large bolt-like sticks on the head of a seventh stick; and *Steadiness Tester*, which tests the users’ control in sliding a ring over a path of bent pipe without the ring touching the pipe.

Cooper thought that exhibits need to relate to things that the Aboriginal students are familiar with. *Reachout*, The Investigator’s outreach program, recently toured the Pitjantjatjara Lands with an exhibition that contained the four following themes:

- Light and Seeing—the exhibits are about the sun, magnification, colour, rainbows and how people see.
- Sound and Hearing—these exhibits are based on how people hear, problems with hearing, musical instruments and music, animal hearing and the differences between human and animal ears.
- Healthy Lifestyles—the importance of healthy bodies, sport and exercise are themes of the exhibits.
- Technology—this set of exhibits looked at the technologies that are used in remote communities, including solar power, optical fibres, satellite dishes and multimedia.

The four themes were relevant to the students and their life experiences. The exhibits had no text at all and the illustrations were of Aboriginal people using the exhibits. Through the use of animated drawings, the panels conveyed the fun people could have with the exhibits. The exhibition travelled with a banner, painted by an Aboriginal artist, which represented the four theme areas. This banner was displayed in a prominent part of the community for all members to see. According to Cooper the banner was “a real talking piece” and the community members would gather around to discuss it. Cooper recommended that Aboriginal Education Workers travel with the exhibition to provide a liaison officer when in the community.

A number of ideas were considered for enhancing the resource material already provided for the teachers. Cooper believes successful resource materials are those that require little preparation by the teacher and are easy to use. Material that is not in a readably useable form will be ‘left on the shelf’ until the teacher has time to plan a lesson around the material. The idea of providing teachers with a video of the Science Circus session would enable the teachers and the class to revisit the shows and exhibits they had experienced. This type of resource material would need little preparation by the teacher, increasing the chance of it being used.
Section Two—Evaluation

Participant observation, exit polls and interviews with the Graduate Diploma students were employed to determine if the new ideas introduced to the public venue were successful. The two exhibits evaluated were Speedball and Totspot.

**Speedball**

To determine if *Speedball* was indeed a ‘star’ exhibit, visitors at the *Science Circus* public venue were asked to name their favourite exhibit on an exit poll. Data were collected on all three tours that travelled with *Speedball*. Table 8.1 summarises the top six responses of the question: ‘What was your favourite exhibit?’.

*Speedball* was the most common response with 70 people specifying that it was their favourite exhibit. A large number of people could not decide which was their favourite and wrote ‘all’, representing all of the *Science Circus* exhibits. Two of the ‘old favourites’, the *Rotating Platform* and *Harmonograph*, are still popular exhibits. A number of visitors commented on their favourite show, for example the *Liquid Nitrogen Show* and the *Fire and Light Show*. From the number of show titles included in the responses it seems that the public are not familiar with the term ‘exhibit’ and this should be addressed in future exit polls and questionnaires evaluating the *Science Circus*.

The *Science Circus* has a total of 58 exhibits, of which approximately 50 are present on any one tour. Of all the exhibits, 32 were mentioned as favourites, which indications the popularity of over half of the *Science Circus* exhibits. A list of all exhibits and those mentioned as favourites are included in Appendix XX. Other shows that were listed as favourites include the *Balloon Show*, *Laser Show*, *Slime Show* and *Chemistry Show*.

On three separate occasions the *Speedball* exhibit and the visitors interacting with it were observed for five minutes. A total of 28 people were observed. The majority of the participants were school aged children. At any one time there were a number of adults standing around the exhibit, watching children throw. Only five adults lined up for a go. Of
the 28 people observed, there were seven females, including one adult, that used the exhibit. The exhibit seems to be more popular with males. On many occasions a group of children would shove and push each other to collect a tennis balls from the return chute. This may have dissuaded adults and a number of females from participating. Since observing this behaviour, a Local Explainer has been placed at the return chute to retrieve the tennis balls and pass them on to the next person in the queue.

*Table 8.1: The most popular exhibits of the Science Circus. (n=361)*

<table>
<thead>
<tr>
<th>Favourite exhibit</th>
<th>Frequency of Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speedball</td>
<td>70</td>
</tr>
<tr>
<td>All</td>
<td>63</td>
</tr>
<tr>
<td>Liquid Nitrogen Show</td>
<td>37</td>
</tr>
<tr>
<td>Rotating Platform</td>
<td>33</td>
</tr>
<tr>
<td>Harmonograph</td>
<td>22</td>
</tr>
<tr>
<td>Fire and Light Show</td>
<td>21</td>
</tr>
</tbody>
</table>

The exit poll reflected the participant observation results. Table 8.2 indicates the number of females and males, and their ages, who mentioned *Speedball* as their favourite exhibit. The majority of visitors who use the exhibit are children aged between six and 12 years of age and more than two thirds of the respondents were males.
Table 8.2: The age and gender of the respondents that thought Speedball was their favourite exhibit.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-12</td>
<td>14</td>
<td>27</td>
<td>41</td>
</tr>
<tr>
<td>13-17</td>
<td>2</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>18-25</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>26-40</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>41-55</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>&gt; 55</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Speedball takes four people approximately one hour to assemble and 40 minutes to dismantle. The Graduate Diploma students and the Science Circus truck driver, who are responsible for this, think that Speedball is “worth the effort” because of the exhibit’s popularity. The Graduate Diploma students also think the exhibit is easy to describe when promoting the Science Circus public venue to school students and the media.

It took approximately one and a half hours to assemble and one hour to dismantle the entire Science Circus public venue, before the addition of Speedball. Although Speedball takes a considerable proportion of the total time, the addition of it only lengthened the ‘packs’ and ‘unpacks’ by approximately 15 minutes. The Graduate Diploma students, the Science Circus truck driver and the Questacon designers all have made suggestions to improve the ease of assembly and disassembly, and the portability of the components. It is hoped that a more portable Speedball is built for the Science Circus, and that the first Speedball is adopted by Questacon as a permanent exhibit.

Totspot

The visitors’ exit poll also included a closed-ended question to determine which Science Circus component visitors find the most interesting. The question was: ‘For you what was the most interesting part of the Science Circus?’ Totspot was one of the responses in the set.
of response options. As indicated in Table 8.3, Totspot had a total of 12 visitors rating it as the most interesting part of the Science Circus. Although this is a small response, it is an indication that people found it useful. The 12 responses were from an equal number of males and females.

**Table 8.3: Visitors most favourite part of the Science Circus.**

<table>
<thead>
<tr>
<th>Most Interesting Part</th>
<th>Children’s Response</th>
<th>Adults’ Response</th>
<th>Total Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shows</td>
<td>179</td>
<td>203</td>
<td>382</td>
</tr>
<tr>
<td>Exhibits</td>
<td>169</td>
<td>211</td>
<td>380</td>
</tr>
<tr>
<td>Explainers</td>
<td>16</td>
<td>25</td>
<td>41</td>
</tr>
<tr>
<td>Shop</td>
<td>32</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>Totspot</td>
<td>8</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>

The Totspot was observed on five different occasions, each for five minutes. At all times there were visitors using the area. A total of 22 people were observed during the 25 minutes. Although this is not a high number, the majority of the visitors observed used Totspot for over five minutes. There were few children over the approximate age of eight, and parents were usually present with the young children.

At times I also participated in the Totspot assisting children with the jigsaw puzzles. This provided the opportunity to speak with a number of the adults to gain their general views on Totspot. The adults were pleased to have something for their younger children to play with, especially while their other older children “watched shows and played with the exhibits”. One woman indicated that she was pleased to have somewhere to sit. The fact that Totspot usually has a number of visitors using it, is a reflection of its usefulness. The low number of children, under the age of five, at the Science Circus may help explain the lack of response for the Totspot option in the question: ‘Which is your favourite part of the Science Circus?’.
The Graduate Diploma students were asked for their opinion on the addition of Totspot. All ten students interviewed thought it was a very welcomed addition to the Science Circus as it is easy to set up, is portable and provides the chance for them to interact with younger children.

It would appear from this evaluation that both Totspot and Speedball are successful additions to the Science Circus. Neither would have been organised if it were not for Will Inveen, who was initially employed specifically to turn these ideas into reality. From this experience, it is obvious that implementing new ideas is a full time job. If the Science Circus is to implement further ideas and suggestions, it is essential that a staff member has the time and resources to put into such a venture. It is not sufficient for one of the tour coordinators to try to develop new exhibits whilst coordinating Science Circus tours and the Graduate Diploma in Scientific Communication coursework.
Chapter Nine

Conclusions and Recommendations

Science and technology form one element of society—one which people may wish to enjoy. This concluding chapter looks at how the Science Circus and its activities are involved in the public understanding of science. Specific recommendations are interspersed with the discussion at appropriate points.

This study evaluated the Science Circus’ effectiveness in meeting its goals and objectives. The study’s findings are relevant, not only for the Science Circus, but for all science centres and museums, and travelling science programs. A greater understanding of what hands-on science programs offer to students, teachers, remote students, and the public will enable the development of programs better suited to their target groups.

Primary school students have positive images of science, scientists and their roles in today’s society. High school students do not have such a positive image of science; they have, however, expressed an appreciation of the roles of science and scientists in society. The assumption that popularising science will help improve the way students perceive science may be accurate but it is not unequivocally proven. The Science Circus popularises science to a large number of people each year, however, there is little evidence to suggest that the Science Circus school visits have an effect on the attitudes of primary and high school students. In a one hour visit it would be difficult to change any attitude.

If the Science Circus is committed to providing a positive image of science, there is the opportunity for it to make more of an impact. Presently, the Science Circus provides one hour of promotion of positive images of science and scientists but, for students to be provided with the stimulation more that just once every five years, there is a need for support from all bodies trying to increase positive attitudes toward science. The Science Circus needs to complement the formal education system, if it is to have a role in effectively changing students’ attitudes. Teachers and other travelling programs, such as
the CSIRO Lab on Legs, should work together to make a noticeable increase in positive attitudes. Teachers require regular in-servicing, more hands-on resource material and support. It is recommended that:

- the *Science Circus* employ a person to produce pre- and post-visit activities, that are related to the science curricula, for both primary and secondary teachers.

- Questacon and the *Science Circus* develop a program that follows the *Science Circus*, providing in-service for teachers similar to the already existing Questacon program *Hands-on Minds-on*.

- a strategy is developed to allow the *Science Circus* exhibits to be further utilised by teachers and senior high school classes.

- the many different travelling science programs establish timetables, to ensure all programs complement rather than compete with each other.

The *Science Circus* is currently achieving its targeted number for schools and public venue visitors. The school student numbers are at a maximum with the current system of operation. The public venue number could be increased, particularly the student-return figures which have been decreasing over the past seven years. To optimise the number of people at the public venue it is important that an effective advertising strategy is in place. It is recommended that:

- the *Science Circus* promotes itself as a family activity, through the schools.

- the *Science Circus* student free tickets are redesigned to depict the excitement of the *Science Circus* public venue with an appropriate image and greater information about the exhibition.

- the *Science Circus* opens the public venue a greater number of times in each town.
Chapter Nine—Conclusions and Recommendations

- the teacher briefing material is redesigned to incorporate more information on the show and exhibition content.

- the teachers are given the option to request particular shows.

- the briefing material is sent to the teachers 6–12 months in advance.

All the evidence suggests that the Science Circus is indeed a world class travelling program. Further afield, the fact that it is being emulated in other countries suggest that this is so. In Australia, it is the largest and furthest travelled of travelling programs. Its audiences, primary and high school students, enjoy the school sessions, teachers think it is a very important experience for their students and a vast majority of the public venue visitors rated the Science Circus as very worthwhile. The addition of new exhibits and resource material were popular; there are, however, further suggestions which would allow the Science Circus to have a greater impact on the people of regional Australia. For the Science Circus to remain a world class travelling program it is recommended that:

- the Science Circus incorporates a new show to its repertoire each year. Tired shows should either be rewritten or retired.

- the coordinators continue to promote the ‘circus’ feel at the public venues to the Graduate Diploma students.

- the Aboriginal and Torres Strait Islander program be enhanced to incorporate exhibits, information on the exhibits and shows, and workshops for the teachers.

- the existing pre-school program be further developed and offered to all pre-schools.

- the Science Circus employ a person to coordinate the development of a relevant program for the high school students.
the Graduate Diploma students be provided training on how best to present to particular age groups. Specific attention is to be given to lower primary and upper high school students.

This study adds to the growing body of research on science centres and attitudes toward science and scientists. To determine whether programs like the Science Circus significantly alter student attitudes toward science or have any long term effects, a more detailed study undertaken over an extended period of time is needed. However, this would be very difficult because of other influences over such a long period of time.

I conclude that science centres and their travelling programs are integral to the public’s understanding of science. With more cooperation between the science centres and the formal education system, and indeed all the other bodies involved in, whether it be; popularising, promoting an understanding of, or promoting an awareness of science, the next generation will certainly be more scientifically literate and aware than the current one.
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Appendices

Appendix 1

A map indicating the places visited by the Science Circus between 1986 and 1996.
Appendix I

A map indicating the places visited by the *Science Circus* between 1986 and 1996.
Appendix II

The remote communities visited by the *Science Circus* between 1988 and 1996.
Appendix III

The ‘booked’ schools’ pre-test cover letter.

I have enclosed a reply-paid self addressed envelope for the questionnaire, but please fill it in and return it with the Teacher Questionnaire to John (see address). In this way your feedback will be appreciated.

An incentive! All teachers who respond to this questionnaire will be entered into a draw for a pair of Radio Camerons. This is partially supported by the Department for Education and Science, 1990. Please see the enclosed flyer for more information on the draw.

If you have any queries please call me on 05567 8890. I am looking forward to receiving your survey responses.

Many thanks.

Fiona Bartington, Coordinator - Self-Questionnaire Science Centre.
Hi - I coordinate the Shell Questacon Science Circus which will be visiting your school in November.

We are currently undertaking an evaluation of the Science Circus in the continuous effort to improve the program we offer schools. It would be great if you could help us out.

There are two components to this evaluation:
1. Survey before the Science Circus visit
2. Survey after the Science Circus visit.

Enclosed is the first component - the Pre-Visit Survey, which consists of two questionnaires:
- The Teacher Questionnaire (roughly 10 minutes)
- Your Students' Questionnaire (roughly 5 minutes)

I have enclosed a Replied Paid self addressed envelope for the questionnaires, however if you just fill out the Teacher Questionnaire you can fax it back to me on our FreeFax number: 1800 641 171.

In the Replied Paid envelope I have included:
- further instructions
- three yellow Teacher Questionnaires (one for yourself and two for any other interested teachers)
- and one class set of green Student Questionnaires (suitable for students between Years 4 and 12).

An incentive! All teachers who respond to the questionnaire will enter a draw for 6 Exciter Packs (Science Kits) valued at $55. Please see the attached flier for more information on the packs.

If you have any queries please call me on 06 2702 818. I am looking forward to receiving the many responses.

Many thanks

Fiona Barbagallo, Coordinator - Shell Questacon Science Circus
Appendix IV

The pre-test student questionnaire.
Student Survey - Before Visit

Please mark each line to indicate how you feel about science and scientists.

A) I think that science is:
   Interesting _________________________ Boring
   Fun ___________________________ Painful
   Easy ___________________________ Difficult
   Worthwhile ______________________ A waste of time & money
   All around us ____________________ Not all around us

B) We should encourage science research. __________________________
   We should stop science research.
   Science helps us. __________________________
   Science doesn’t help us.
   I notice science in my daily life. __________________________
   Science never comes to mind outside school.
   Girls like science. __________________________
   Girls don’t like science.
   I would like to be a scientist. __________________________
   I don’t want to be a scientist.

C) Scientists are:
   Interesting _________________________ Boring
   Outgoing __________________________ Shy
   Fun _______________________________ Serious
   Extremely intelligent ________________ Only as smart as you or me
   Good looking _________________________ Ugly
   Weird _____________________________ Normal
   Nerdy ______________________________ Cool
   Useful to have ______________________ Not useful to have

D) Who is your teacher? __________________________ Your class? __________________________
Appendix V

The ‘booked’ pre-test teacher questionnaire.
Shell Questacon Science Circus
Evaluation by Teacher Before Visit

Part One

1. What is your current teaching position? ________________________________

2. What are your teaching and science (if applicable) qualifications? ________________________________

3. What year level/s are you currently teaching? ________________________________

4. How long have you been teaching? ________________________________

5. How did you hear about the Science Circus visiting your area? ________________________________

6. Why did you book a visit with the Science Circus? ________________________________

7. What do you expect from the visit? ________________________________

(Please respond to Questions 8, 9 and 13 by placing a circle around the appropriate number)

8. I enjoy teaching science. 
   1 definitely not 2 probably not 3 unsure 4 probably yes 5 definitely yes

9. There has been sufficient briefing material provided prior to visit. 
   1 definitely not 2 probably not 3 unsure 4 probably yes 5 definitely yes
   If you think not, what else would you have liked to receive? ________________________________

10. Which organisation is the SQSC a travelling component of? ________________________________

11. What other programs does this organisation offer to regional areas of Australia? ________________________________

12. Who is SQSC's major sponsor? ________________________________

13. The SQSC's sponsor is a responsible world class citizen. 
   1 definitely not 2 probably not 3 unsure 4 probably yes 5 definitely yes

Please turn over →
Part Two

Please mark each line to indicate how you feel about certain aspects of science and scientists.

A) I think that science is:
   Interesting
   Fun
   Monotonous
   Satisfying
   Easy
   Relevant to me
   Worthwhile
   All around us
   Boring
   Painful
   Full of variety
   Bewildering
   Difficult
   Irrelevant to me
   A waste of time & money
   Not obvious around us

B) We should encourage science research.
   We should stop science research.
   Science contributes to society’s well-being.
   Science doesn’t contribute to our standard of living.
   I notice science in my daily life.
   Science never comes to mind outside school.
   Science offers equal opportunities for women.
   Science does not offer equal opportunities.

C) Scientists are:
   Interesting
   Outgoing
   Fun
   Extremely intelligent
   Arrogant
   Eccentric
   Socially inept
   Boring
   Introverted
   Painful to listen to
   Only as smart as you or me
   Humble
   Normal
   Socially adequate

D) Scientists:
   Try to be useful.
   Don’t care about the relevance of their work.
   Are only interested in their results.
   Try to spread their work for the greater good.
   Are good communicators.
   Are poor communicators.
Appendix VI

The 'booked' pre-test instruction sheet and example of class role.
Thank you for volunteering to participate in this evaluation!

Please note that all data in this survey will be confidential. However, to help with the statistical correlation of the before-visit and after-visit surveys, you will need to record your name and the numbers of the students' surveys. The only reason for your name is to send the after-visit survey.

Instructions for the Pre-visit Surveys

- The Teacher Questionnaire
  This questionnaire is for you to fill out.

- The Student Questionnaires
  These questionnaires are for your students to fill out. Please follow the points below.
  - Allocate each student in your class a number starting from one and keep a record of allocated numbers for the after-visit survey. This might be easiest if you follow the class role. Please note: I will not need a copy of your students' names. (An example list is attached)

  - Each survey has a number in the top right-hand corner. Give the appropriately-numbered survey to each student.

  - If the student is away, please assign them a number anyway and write ABSENT on their survey (in case they are present for the after-visit survey).

  - Get each student to complete their survey and collect.

- Information Form
  Please fill in the details on the information form so that we can send the post-visit surveys directly to you.

- Replied Paid Envelope
  Please place the completed
  1. Teacher Questionnaire
  2. Student Questionnaires and
  3. Information Form (pink slip)
  in the Replied Paid Envelope and pop in the mail!

Once again, thank you for your time.

Fiona Barbagallo
## Class 9A Roll Call

<table>
<thead>
<tr>
<th>Names</th>
<th>Present/Absent</th>
<th>SQSC Survey Number</th>
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<tr>
<td>Abberton, John</td>
<td></td>
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</tr>
<tr>
<td>Barbagallo, Fiona</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Dettrick, Jenny</td>
<td></td>
<td>3</td>
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<td>Fletcher, Luke</td>
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<td>Horvat, Cathy</td>
<td></td>
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<tr>
<td>etc</td>
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<td></td>
</tr>
<tr>
<td>Young, Janine</td>
<td></td>
<td>29</td>
</tr>
</tbody>
</table>

Please keep the allocated names on file until the after-visit survey has been handed out.

Thanks AGAIN

Fiona
Appendix VII

The ‘booked’ schools’ post-test cover letter.

Hi [Name],

Thank you for inviting us to your school for the post-test of the [Program/Activity]. We want to assure you that the test was conducted professionally and scientifically, ensuring that it meets the highest standards.

Here is the result of the post-test:

- The results have been analyzed and interpreted.
- Your school’s feedback has been taken into consideration.

Enclosed are the following:
- The post-test results.
- Your school’s feedback report.

I have enclosed a copy of the [Program/Activity] questionnaire for your review. However, if you need any additional information, we are here to assist you. Please call [Contact Number] or email us at [Contact Email].

In the [Program/Activity] folder, you will find:
- Further information.
- A green [Program/Activity] checklist.
- A list of schools that have completed the [Program/Activity].

Don’t forget to complete the feedback questionnaire and return it to us. Each completed feedback questionnaire is worth [Value] a total of [Total Value].

If you have any queries, please call me at [Contact Number].

Cheers,

[Name]
Coordinator
[School/Program/Institution]
Hi - Thank you for helping me with the *Shell Questacon Science Circus* evaluations by filling in the pre-visit survey with your class.

Here is the next (and final) stage. The surveys are to be completed *after* the *Science Circus* has visited your school, preferably between three and five days after.

Enclosed are two types of questionnaires:
- The Teacher Questionnaire (roughly 10 minutes)
- Your Students' Questionnaire (roughly 5 minutes)

I have enclosed a Replied Paid self addressed envelope for the questionnaires, however if you just fill out the Teacher Questionnaire you can fax it back to me on our **FreeFax number**: 1800 641 171.

In the Replied Paid envelope I have included:
- further instructions
- one green Teacher Questionnaire
- and one class set of yellow Student Questionnaires (suitable for students between Years 4 and 12).

Don't forget the incentive: those teachers who respond to the questionnaire will enter a draw for 6 Exsciter Packs (Science Kits) valued at $55.

If you have any queries please call me on 06 2702 818.

Cheers!

Fiona Barbagallo
Coordinator
*Shell Questacon Science Circus*
Appendix VIII
The post-test student questionnaire.
Shell Questacon Science Circus
Student Evaluation After Visit

Part One

1. How old are you?  
   - 5 - 11  
   - 12 - 15  
   - 16 - 20  
   - >20

2. Are you  
   - female  
   - or  
   - male?

3. Did you see the Shell Questacon Science Circus performance at your school?  
   - Yes  
   - No (if no, please go straight to Question 10)

Please respond to Questions 4-9 by placing a circle around the appropriate number.

4. The length of the show was too long.  
   - 1 definitely not  
   - 2 probably not  
   - 3 unsure  
   - 4 probably yes  
   - 5 definitely yes

5. If the Science Circus came back to this school, I would go again.  
   - 1 definitely not  
   - 2 probably not  
   - 3 unsure  
   - 4 probably yes  
   - 5 definitely yes

6. I didn’t learn any science.  
   - 1 definitely not  
   - 2 probably not  
   - 3 unsure  
   - 4 probably yes  
   - 5 definitely yes

7. I enjoyed the Science Circus visit.  
   - 1 definitely not  
   - 2 probably not  
   - 3 unsure  
   - 4 probably yes  
   - 5 definitely yes

8. The presenters were pretty cool.  
   - 1 definitely not  
   - 2 probably not  
   - 3 unsure  
   - 4 probably yes  
   - 5 definitely yes

9. I wish science was always so much fun.  
   - 1 definitely not  
   - 2 probably not  
   - 3 unsure  
   - 4 probably yes  
   - 5 definitely yes

10. Did you go to the Science Circus at night or on the weekend, to use the hands-on exhibits?  
    - Yes  
    - Did you enjoy yourself? _____________________________
    - No  
    - Why didn’t you go? ________________________________

Please turn over ➡
Part Two

Please mark each line to indicate how you feel about science and scientists.

A) I think that science is:

- Boring
- Fun
- Not all around us
- Worthwhile
- Difficult
- Interesting
- Painful
- All around us
- A waste of time & money
- Easy

B) I would like to be a scientist.

- Science helps us.
- I don’t want to be a scientist.
- Science doesn’t help us.
- Science never comes to mind outside school.
- Girls don’t like science.
- We should encourage science research.
- We should stop science research.

C) Scientists are

- Not useful to have
- Useful to have
- Outgoing
- Shy
- Nerdy
- Cool
- Extremely intelligent
- Only as smart as you or me
- Good looking
- Ugly
- Weird
- Normal
- Serious
- Fun
- Boring
- Interesting

D) Who is your teacher? ________________________

Your class? ________________________
Appendix IX

The ‘booked’ post-test teacher questionnaire.
Shell Questacon Science Circus
Teacher Evaluation After Visit

Part One

1. Did you watch the Shell Questacon Science Circus (SQSC) performance at your school?
   □ Yes   □ No (if no, please go no further)

2. How old are you?  □ 18 - 25  □ 26 - 40  □ 41 - 55  □ >55

Please respond to Questions 3-11, 14 and 16 by placing a circle around the appropriate number.

3. The SQSC was good value for money.

4. The length of the presentation was too long.

5. If the SQSC came back to this area, I would organise another class visit.

6. The nature of the presentations helped the students to understand the science being presented.

7. Overall the visit from the SQSC was an enjoyable experience for the class.

8. The explanations of scientific concepts were not appropriate for my students’ age.

9. I have incorporated a more “hands on” style of teaching since the SQSC visit.

10. The SQSC presenters related well to the students.

11. There was sufficient briefing material provided prior to visit.

If you think not, what other material would you like provided?

11. Which organisation is the SQSC a travelling component of? ____________________
12. What other programs does this organisation offer to regional areas of Australia?

13. Who is SQSC’s major sponsor?

14. The SQSC’s sponsor is a responsible world class citizen.

15. If you also teach senior secondary students did any of your senior students attend the SQSC visit?
   - Not Applicable
   - Yes Was it a useful visit?
   - No Why not?

Any further comments or suggestion for this age group would be very useful.

16. Please compare the SQSC to other travelling programs (e.g., drama/arts/science).
   - The SQSC was more educational.
   - The SQSC was more entertaining.

17. Did you receive a follow-up activity sheet?
   - Yes Was it a useful?
   - No

18. Did you find the Teacher’s Resource Kit useful?
   - Yes
   - No Why not?
   - Have not seen it

19. Did you use your complimentary teacher’s ticket to attend the SQSC public venue?
   - No Why not?
   - Yes Was your visit worthwhile?

20. How else can the SQSC help you as a teacher?
Part Two

Please mark each line to indicate how you feel about certain aspects of science and scientists.

A) I think that science is:

- Interesting
- Difficult
- Monotonous
- Satisfying
- Painful
- Relevant to me
- Worthwhile
- Not obvious around us

B) We should encourage science research.

- We should stop science research.
- Science contributes to society’s well-being.
- Science doesn’t contribute to our standard of living.
- Science offers equal opportunities for women.
- Science does not offer equal opportunities.
- I notice science in my daily life.
- Science never comes to mind outside school.

C) Scientists are:

- Humble
- Outgoing
- Fun
- Extremely intelligent
- Boring
- Eccentric
- Socially inept

D) Scientists:

- Try to be useful.
- Are only interested in their results.
- Are good communicators.
- Don’t care about the relevance of their work.
- Try to spread their work for the greater good.
- Are poor communicators.
Appendices

Instructions for the After-visit Surveys

Please note that all data on the survey is confidential. The only reason I need your name is to help with the statistical completion of the pre- and post-test surveys.

* The Teacher Questionnaire
  This questionnaire is for you to fill out.

* The Student Questionnaires
  These questionnaires are for your students to fill out. Please follow the steps below.
  1. Hand out the surveys ten days after the tour. The number in the top right-hand corner corresponds with the number allocated in the pre-visit survey.
  2. Please give each student a copy of the survey. The number allocated in the top right-hand corner of the survey in the bottom right-hand corner corresponds with the number allocated in the pre-visit survey.
  3. If a student who filled out a pre-visit survey is away, please write "ABSENT" on their assigned survey.
  4. If a student was absent for the pre-visit survey, they can still fill out the after-visit.
  5. If there are any students who did not see the Science Centre and filled out the pre-visit survey, please get them to complete this survey.
  6. Get each student to complete their survey and collect:

* Information Form
  Please fill in the details on the information form.

* Replicated Paid Envelope
  Please place the completed:
  1. Teacher Questionnaire
  2. Student Questionnaires and
  3. Information Form (pink slip)

in the Replicated Paid Envelope and pop in the mail.

Many, many thanks.

Flora Barboglio

Appendix X

The ‘booked’ post-test instruction sheet.
Instructions for the After-visit Surveys

Please note that all data in this survey will be confidential. The only reason I need your name is to help with the statistical correlation of the before-visit and after-visit surveys.

• The Teacher Questionnaire
This questionnaire is for you to fill out.

• The Student Questionnaires
These questionnaires are for your students to fill out. Please follow the points below.
  • Hand out the surveys a few days after the Science Circus visit.
  • Please give each student a yellow survey ensuring that the number in the top right-hand corner corresponds with the number allocated in the pre-visit survey.
  • If a student who filled out a pre-visit survey is away, please write ABSENT on their assigned survey.
  • If a student was absent for the pre-visit survey, they can still fill out the after-visit.
  • If there are any students who did not see the Science Circus and filled out the pre-visit survey, please get them to complete this survey.
  • Get each student to complete their survey and collect.

• Information Form
Please fill in the details on the information form.

• Replied Paid Envelope
Please place the completed
  1. Teacher Questionnaire
  2. Student Questionnaires and
  3. Information Form (pink slip)
in the Replied Paid Envelope and pop in the mail!

Many, many thanks.

Fiona Barbagallo
Appendix XI

The letter of appreciation sent to schools that participated in the evaluation.

12 December 1999

Thank you very much for your response to the Science Circle evaluation. We have been encouraged by the interest and helpful suggestions and ideas we have received in the past months, and we have kept in mind as much as possible in assessing teachers and their students.

As promised there would be a "topper school prize" and the school who won the six Question-a-minute Papers was St. Patrick's in Cochrane West. Perhaps they had the luck of the Irish.

Thank you once again.

Fiona Barbagallo
Coordinator
Shell Questacon Science Circus
12 December 1996

Thank you very much for assisting with the Shell Questacon Science Circus evaluation. We had an overwhelming response from the schools in your area. With your help, suggestions and ideas we have started to look at new ways in assisting teachers and their students.

As promised there would be a "lucky school prize" and the school who won the six Questacon Exsciter Packs was St Patricks in Geelong West. Perhaps they had the luck of the Irish!

Thank you once again,

Fiona Barbagallo
Coordinator
Shell Questacon Science Circus
Appendix XII
The Exsciter Pack flyer.
EXciting SCience and TEchnology Resource PACK • Exploring science and technology the fun way

- Hands-on activities for children
- Challenging for a variety of ages
- Explanations of science principles
- Complete with activity booklet and materials
- Popular educational resource for both schools and families

Designed and developed by Questacon – The National Science and Technology Centre

AGES 5 – 12+

The National Science and Technology Centre
<table>
<thead>
<tr>
<th>Pack Title</th>
<th>Quantity</th>
<th>Price Per Pack</th>
<th>Total $</th>
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<tr>
<td><strong>BUBBLES</strong></td>
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<td>$9.50</td>
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<tr>
<td>Float a paper clip, make a soap powered boat, create bubbles of different shapes and explore the science of surface tension. Learn about animals that walk on water, how detergents clean away dirt and lots more!</td>
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<tr>
<td><strong>ENVIRONMENT</strong></td>
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</tr>
<tr>
<td>Explore the science of our environment—investigate air pollution, make your own recycled paper and study the effects of sewage. Learn about soil erosion, acid rain, biodegradable materials, the effect of salt on the growth of plants, and more!</td>
<td></td>
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<tr>
<td><strong>MUSIC</strong></td>
<td></td>
<td>$8.00</td>
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</tr>
<tr>
<td>Explore the science of sound, investigate how musical instruments work, make your own musical straw and rubber band guitar! Learn about how we talk and hear. Make the sound of a clucking hen using a cup and create other special sound effects!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BALLOONS</strong></td>
<td></td>
<td>$9.50</td>
<td></td>
</tr>
<tr>
<td>Discover how rockets work, make a balloon powered boat and stick a pin into a balloon without bursting it! Investigate how hovercraft glide and satellites orbit the earth. Learn about air pressure, static electricity and more!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CANDLES</strong></td>
<td></td>
<td>$8.00</td>
<td></td>
</tr>
<tr>
<td>Explore the science of candles, create shadows of candle flames and make candles you can eat! Investigate the fascinating world of heat, design a hot air spinner and interpret invisible messages using a candle. Learn how water can be boiled in a paper cup, and more!</td>
<td></td>
<td></td>
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<tr>
<td><strong>LIGHT</strong></td>
<td></td>
<td>$10.00</td>
<td></td>
</tr>
<tr>
<td>Discover how rainbows form, make 3-D images and multiply money using mirrors! Investigate images using lenses made from water and bubbles. Design and make a sundial to tell time and a kaleidoscope to make spectacular patterns. Learn about optic fibres, animation techniques and more!</td>
<td></td>
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Available from the Questacon Shop, or by posting or faxing this order form (allow 14 days for delivery) to:

The Questacon Company
King Edward Terrace, Canberra ACT 2600
Fax (06) 260 1755

Postage and packaging charges
1 pack .........................add $4.00
2–4 packs .....................add $2.00 each
5 or more packs.............add $10.00 to total

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Appendix XIII

The ‘non-booked’ schools’ cover letter.
Hi - I coordinate the Shell Questacon Science Circus, a travelling science show.

The Science Circus is currently undergoing an evaluation in the continuous effort to improve the program we offer schools. It would be great if you could help us out.

Your school is one that decided not to book a visit with the Science Circus and I hope you will participate in this short questionnaire, which will only take 5 minutes.

Your response will help us develop a more worthwhile, appropriate and stimulating program for teachers and their students.

Please fax your response back to me on our FaxFree number: 1800 641 171.

If you have any queries please call me on 06 2702 818.

Many thanks

Fiona Barbagallo
Coordinator
Shell Questacon Science Circus

1 November 1996
Appendix XIV

The 'non-booked' teacher questionnaire.
To: Fiona Barbagallo
FreeFax Number: 1800 641 171

Shell Questacon Science Circus
Evaluation by Teacher

Part One

1. What is your current teaching position? ____________________________

2. What are your teaching and science (if applicable) qualifications? ____________________________

3. What year level/s are you currently teaching? ____________________________

4. How long have you been teaching? ____________________________

5. Did you receive information on the Shell Questacon Science Circus (SQSC) visiting your area?  
   - Yes  
   - No  
     (if no, please go to Question 9)

   If you would like to book a visit, please contact Brad Papworth on 019 605 165.

6. Why did you not book a visit with the SQSC?  
   - other commitments that week  
   - not interested in a science excursion  
   - insufficient lead time to organise visit  
   - other ____________________________

7. In relation to your response above, how can the SQSC address this problem? ____________________________

8. Have you promoted the SQSC Public Venues to your students? (eg newsletter/bulletin board)  
   - Yes  If yes, how? ____________________________  
   - No ____________________________

9. Would you be interested in booking the SQSC the next time it is in your area?  
   - Yes  
   - No ____________________________

10. I enjoy teaching science.  

<table>
<thead>
<tr>
<th>1 definitely not</th>
<th>2 probably not</th>
<th>3 unsure</th>
<th>4 probably yes</th>
<th>5 definitely yes</th>
</tr>
</thead>
</table>

11. Which organisation is the SQSC a travelling component of? ____________________________

12. What other programs does this organisation offer to regional areas of Australia? ____________________________

13. Who is SQSC’s major sponsor? ____________________________

14. The SQSC’s sponsor is a responsible world class citizen.  

<table>
<thead>
<tr>
<th>1 definitely not</th>
<th>2 probably not</th>
<th>3 unsure</th>
<th>4 probably yes</th>
<th>5 definitely yes</th>
</tr>
</thead>
</table>

Please turn over ➔
Appendix XV

The control group's cover letter.
Hi - I coordinate the *Shell Questacon Science Circus* which is visiting your area in November.

We are currently undertaking an evaluation of the *Science Circus* in the continuous effort to improve the program we offer schools. Your school is one that did not book the Science Circus and I am hoping we can use your school as a control for the evaluation. It would be great if you could help us out.

There are two components to this evaluation:
1. **Survey before the Science Circus visit** (green)
2. **Survey after the Science Circus visit** (yellow).

If you could arrange for your students to fill out each of the surveys, with approximately 2 weeks in between each. Please read the Instruction Sheet for further details.

I have enclosed a Replied Paid self addressed envelope for the questionnaires, for ease of return.

The Student Questionnaires are suitable for students between Years 4 and 12.

**An incentive!** All teachers who respond to the questionnaire will enter a draw for 6 Exciter Packs (Science Kits) valued at $55. Please see the attached flier for more information on the packs.

If you have any queries please call me on 0419 217 697. I am looking forward to receiving the many responses.

Many thanks

Fiona Barbagallo
Coordinator - *Shell Questacon Science Circus*
Appendix XVI

The control group’s pre- and post-test instruction sheet.

Instructions for the Pre-Visit Surveys

- The Student Questionnaire:

These questionnaires are for your students to fill out. Please follow the steps below:

- Allocate each student in your class a number starting from one and keep a record of allocated numbers for the after-visit survey. This might be easier if you write in the class lists. Please note: I will not need a copy of your students’ names.

- Each survey has a number in the top right-hand corner. Use the appropriately-numbered survey to each student.

- If the student is absent, please assign them a number (absent) and write ABSENT on their survey (in case they are present for the after-visit survey).

Instructions After Visit Survey

- Hand out the surveys two weeks after the pre-visit surveys.

- Please give each student a yellow survey, ensuring that the number in the top right-hand corner corresponds with the number allocated in the pre-visit survey.

- If a student who missed the pre-visit survey is away, please write ABSENT on their assigned survey.

- If a student was absent for the pre-visit survey they can still fill out the after-visit survey.

- Get each student to complete their survey and collect.

- Replied Envelope:

Please place the completed
1. Green Questionnaire
2. Yellow Questionnaire
in the Replied Envelope and place in the mail.

Thank you for your help.

From: Stranger
Instructions for the Pre-visit Surveys

• The Student Questionnaires
These questionnaires are for your students to fill out. Please follow the points below.
  - Allocate each student in your class a number starting from one and keep a record of allocated numbers for the after-visit survey. This might be easiest if you follow the class role. Please note: I will not need a copy of your students' names.
  - Each survey has a number in the top right-hand corner. Give the appropriately-numbered survey to each student.
  - If the student is away, please assign them a number anyway and write ABSENT on their survey (in case they are present for the after-visit survey).
  - Get each student to complete their survey and collect.

Instructions After-Visit Survey

• Hand out the surveys two weeks after the pre-visit surveys.
  - Please give each student a yellow survey - ensuring that the number in the top right-hand corner corresponds with the number allocated in the pre-visit survey.
  - If a student who filled out the pre-visit survey is away, please write ABSENT on their assigned survey.
  - If a student was absent for the pre-visit survey they can still fill out the after-visit survey.
  - Get each student to complete their survey and collect.

• Replied Paid Envelope
Please place the completed
  1. Green Questionnaires
  2. Yellow Questionnaires
in the Replied Paid Envelope and pop in the mail!

Thank you for your time.

Fiona Barbagallo
Appendix XVII
The activity sheet.
Please - try some of these!

**Balloon and Cups**

- **things you need**
  - balloons
  - two or more plastic cups

- **things to try**
  Blow up the balloon until it is about half size, but don't tie it off. Place the rim of the cups firmly against the balloon as you blow the balloon all the way up. Carefully take your hands off the cups and look at the result! The cups have managed to stay on the balloon.

- **so what's going on?**
  When the cup is placed on the small balloon, the curved surface of the balloon takes up some space inside the cup. As the balloon gets bigger, its surface becomes flatter and it takes up less space inside the cup. The air in the cup spreads out, reducing the air pressure. The higher pressure outside the cup pushes it onto the balloon.

**Cartesian Diver**

- **things you need**
  - plastic pen cap (without a hole in the top)
  - plasticine
  - large plastic softdrink bottle with its lid
  - water

- **things to try**
  Put a small lump of plasticine on the tail-part of the pen cap. You will need to adjust the amount of plasticine until the pen cap floats just above the surface of water. Fill the plastic bottle to the brim with water. Carefully place the pen cap into the bottle so it is just floating and screw the bottle's lid on. When you squeeze the bottle watch the pen cap dive to the bottom. If you stop squeezing the diver will float to the top. You can even make the diver hover at half way.

- **so what's going on?**
  When the pen cap is placed into the water, an air bubble is trapped underneath the pen cap. When you squeeze the bottle, the air bubble is compressed, more water fills the pen cap making it more dense. When the bottle is no longer squeezed the air bubble goes back to its original size. The cap and large bubble is less dense than the water, and so it floats to the top.

**Musical Coathanger**

- **things you need**
  - wire coathanger
  - cotton thread, approximately one metre
  - spoon

- **things to try**
  Tie a 50 cm length of cotton thread on each end of a wire coathanger. Wrap the other end of each thread around the student's pointer fingers and ask them to place these fingers in their ears. Get the student to bend over so that the coathanger can swing freely. Tap the coat hanger with a spoon. What did they hear?

- **so what's going on?**
  When the coathanger is tapped, it shakes or vibrates, making a noise. The noise is louder to the person when their fingers are in their ears. The vibrations travel better through the cotton than through the air.
Bubbles

♦ things you need
  • great bubble mix (recipe below)
  • bubble wands/pipe cleaners/wire coathanger
  • string
  • large flat tray eg pot plant dish/baking tray

♦ how to make great bubble mix
  • 1 part glycerol
  • 4 parts detergent
  • 7 parts hot water
  ... add all to a bucket and give it a good stir
  ... the longer the bubble mix is left, the better it becomes

♦ things to try besides blowing beautiful big bubbles
Either convert a wire coathanger into a round bubble frame using your muscles or make a round loop using a couple of pipe cleaners. Pour some of the bubble into the flat tray and dip the new bubble frame in. When you have a soap film gently move the frame up and down in the air. Watch the soap film bounce up and down and flatten out when you have stop moving the frame.

♦ so what’s going on?
Soap films and bubbles want to take up the smallest amount of space they can. That is why bubbles are round and the trampoline bubble returns to a flat shape.

♦ more things to try
Use pipe cleaners to make a cube shape, approximately 8 cm wide, with a handle. A container is needed that will enable the cube frame to be fully immersed in the bubble solution. Firstly did the frame in using the handle. Slowly remove the frame and you should have created a (flat) square shape in the middle.
You are half way there! Carefully redip the bottom part of the frame into the bubble mix. Gently lift the frame out and you should have trapped a cube bubble shape on the inside of the frame.

♦ so what’s going on?
A square bubble! But is it really? Carefully pop the soapfilms pulling on the cube bubble. One by one the shape of the cube bubble will become rounder and rounder, until you are left with a sphere shaped bubble. It was always round, it was just being pulled out of shape!

White Slime

♦ things you need
  • a packet of 100% cornflour
  • plastic container
  • water
  • spoon

♦ things to try
Empty the cornflour into the container. Slowly add the water (about half the amount of cornflour) and stir the two together. Make it fairly runny but so you don’t get any on your finger when you “bounce” it off the surface.

This stuff is amazing! Stir the white slime very slowly with a spoon. Try to stir it fast. Try punching it or bouncing a finger off the surface. Roll some of it into a ball - keep rolling though!

♦ so what’s going on?
This white slime is a stir thickening fluid. That is it gets thicker when you stir it. It is a little like beach sand. When running on the wet sand at the beach, the sand is quite firm. However if you stand still your feet start to sink. When standing still the water has time to flow between the sand grains. Sudden forces such as running or stirring disturb the particles without allowing time for water to flow into the spaces between them, so the particles “jam-up” and the mixture behaves like a solid.
# Appendix XVIII

The public venue exit poll.

## Survey

<table>
<thead>
<tr>
<th>Town</th>
<th>Date</th>
</tr>
</thead>
</table>

1. Are you
- [ ] Male
- [ ] Female

2. How old are you?
- [ ] < 5
- [ ] 5-12
- [ ] 13-18
- [ ] 19-25
- [ ] 26-40
- [ ] 41-65
- [ ] 66+  

3. How worthwhile was your visit to the Science Centre?
- [ ] Very worthwhile
- [ ] Moderately worthwhile
- [ ] Not worthwhile

4. Who are you visiting the Science Centre with?
- [ ] Alone
- [ ] With parents
- [ ] With family, without children
- [ ] With friends
- [ ] With family, with children
- [ ] Other, please specify

5. Why did you visit the Science Centre?
- [ ] For personal fun/enjoyment
- [ ] For my child/children's enjoyment
- [ ] For personal education
- [ ] For my children's education
- [ ] For a unique experience
- [ ] Other, please specify

6. For you, what was the most interesting part of the Science Centre?
- [ ] Science show
- [ ] Hands-on exhibit
- [ ] The shop
- [ ] Other, please specify

7. How did you find out about the Science Centre being in town?
- [ ] Newspaper article
- [ ] Radio
- [ ] Television
- [ ] Friends
- [ ] Other, please specify

8. What was your favourite exhibit? Why?

Thank you for your time and help.
Survey

Town __________________________  Date __________________________

1. Are you  □ Male or □ Female?

2. How old are you?
   □ < 5  □ 6-12  □ 13-17  □ 18-25  □ 26-40  □ 41-55  □ >55

3. How worthwhile was your visit to the Science Circus?

    1  2  3  4  5
    □ Not at all □  □  □  □ Very

4. Who are you visiting the Science Circus with?
   □ Alone
   □ With my family, without children
   □ With my family, with children
   □ With parents
   □ With friends
   □ Other, please specify __________

5. Why did you visit the Science Circus?
   □ For personal fun/enjoyment
   □ For personal education
   □ For a unique experience
   □ For my children’s enjoyment
   □ For my children’s education
   □ Other, please specify __________

6. For you, what was the most interesting part of the Science Circus?
   □ Science shows
   □ Hands-on exhibits
   □ The shop
   □ Explainers help
   □ Tots Spot
   □ Other, please specify __________

7. How did you find out about the Science Circus being in town?
   □ Newspaper article
   □ Newspaper advertisement
   □ Television
   □ Radio
   □ At school
   □ From my child/ren
   □ Word of mouth
   □ Other, please specify __________

8. What was your favourite exhibit? ___________________________________________________________________

9. Who is our major sponsor? ___________________________________________________________________

Thank you for your time and help.
Appendix XIX
The remote community questionnaire.
School name (optional):

1. Was there sufficient briefing material provided prior to the visits?  
   Yes ☐   No ☐   Please Comment

2. Was the information provided in sufficient time to organise the visit?  
   Yes ☐   No ☐   Please Comment

3. Could the Science Circus have spent more time at your school? For example doing teacher workshops, spending 1-2 days, community involvement etc.  
   Yes ☐   No ☐   Please Comment

4. Was the content of the shows and workshops appropriate for your students?  
   Yes ☐   No ☐   Please Comment

5. In the shows, were the scientific explanations appropriate for the students?  
   Yes ☐   No ☐   Please Comment

6. In the workshops, were the instructions clear for your students?  
   Yes ☐   No ☐   Please Comment

7. What are your general impressions of the visit?

   ...

Thank you for your help and time... PTO
8. What are the teachers’ impressions of the visit?

9. Have you used any of the resource material which was left with you?
   Yes ☐  No ☐  Please Comment

10. Please comment on the two activity books provided.

11. Could the Science Circus have done more for your students?
    Yes ☐  No ☐  Please Comment

12. Could the Science Circus have done more for your teachers?
    Yes ☐  No ☐  Please Comment

13. Do you think the students benefited from the experience?
    Yes ☐  No ☐  Please Comment

14. Please feel free to make any further comments/suggestions on our visit, the accommodation and meal arrangements, transport, etc.

Thank you for your help and time –  
Fiona Barbagallo  
Coordinator  
Shell Questacon Science Circus
Appendices

Exhibits in the Science Circus (and show) list, and those mentioned in art pub:

Above
Balance Beam
Balancing Balls
Balancing Ships (in)
Balancing Skis
Blackout
Dazed Drums

Colour Filters
Coloured Shadows
Coloured Water
Comet
Corner of Your Eye
Crazy Coins
Crossing the Bow
Cycloid

Dice and Probability
Dish
Dudley’s Triangle

Falling in Liquids

Genetics

Hand Battery
Hand Cuffs
Harmoigraph

Humbug
Inertia Rods

Lovers
Luminous Figures
Lamp the Loop

Lift
Magic Mirror
Magic Slings
Miracle Aquatad
Mirage
Mirror of Wonder

Appendix XX

The Science Circus exhibit (and show) list, and those mentioned as the most popular by visitors.
Exhibits in the Science Circus (and the frequency of exhibits mentioned in exit poll)

Abacus 1
Balance Sticks 1
Balancing Balls
Balancing Broomsticks 4
Balancing Blocks
Blackout
Buried Treasure

Colour Filters
Coloured Shadows 5
Coloured Words 1
Consecutive Digits
Corner of Your Eye
Crazy Cube 1
Crossing the River 1
Cycloid 1

Dice and Probability
Diver 1
Dudney’s Triangle

Falling in Liquids

Genetics

Hand Battery
Hand Cuffs 3
Harmonograph 22

Illusions 1
Inertia Rods

Levers 2
Lissajous Figures 2
Loop the Loop 2

Magic Mirror
Magic Square
Magnetic Aquarium 4
Magnetism
Mirror of Window 10
Mixed Images 8
Moebius Strip 2
Oil and Water 5
Optical Fibres 2
Packing Parcels 1
Pendulum 4
Pick Up Points 4
Polarised Light 4
Reaction Timer 1
Roller Race 33
Rotating Platform
Seeing Sound 6
Seeing to Infinity
Short Sight 1
Ski Jump 70
Speedball
Star Tracer
Swinging Rings 1
Thongophone
Touch Test
Tower O Brahma 2
Uphill Cone
Which Triangle

Zoetrope

**Shows (mentioned on Exit Poll only)**

Balloons 2
Bubbles 8
Chemistry 5
Eggsciting 1
Fire and Light 21
Laser 8
Liquid Nitrogen 37
Pressure 1
Up Up and Away 1