Coral reefs as sites for experiential environmental education: Learning with Australian students – a foundational study.

Thesis submitted by

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FRONTISPIECE

maggie and milly and molly and may

maggie and milly and molly and may
went down to the beach (to play one day)

and maggie discovered a shell that sang
so sweetly she couldn't remember her troubles, and

milly befriended a stranded star
whose ray's five languid fingers were;

and molly was chased by a horrible thing
which raced sideways while blowing bubbles: and

may came home with a smooth round stone
as small as the world and as large as alone.

For whatever we lose (like a you or a me)
it's always ourselves we find in the sea.

ee cummings

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To the best of my knowledge, the work contained in this thesis is original. I, Carl M. Stepath, declare that this is my own work and has not been submitted in any form for another degree or other publication at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

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Signature Date

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Not only were the teachers a very helpful and professional group, but the participating students were also a pleasure to work with. They were enthusiastic and responsive. By and large, all took part in the role-playing in the classroom, the coral reef

monitoring exercise and cheerfully answered multiple surveys and interview questions. The research would not have been possible without their participation, and inspiring involvement. I am very appreciative of the adolescents who contributed their time, energy and responses to this educational research. The relationships established during this very short and highly energised project were very meaningful and inspiring to me personally, and I wish them well in their endeavours after high school.

It is also important to note the significant time and energy donated by research assistants from James Cook University and the Cairns community. The names of additional people who assisted me, and helped make the completion of this research project viable are too long to list in this acknowledgement (see Appendix A). Everyone's contribution is sincerely appreciated.

ABSTRACT

Marine education is a subset of environmental education. It aims to educate a citizenry capable of making astute decisions about the impact of human activities on marine and reef environments, as well as encouraging ecologically sensitive practices. Coral reefs are critical for biodiversity, food habitats and as tourist destinations, but they are in serious decline around the world. This research explores high school students' educational reef experiences with respect to specific learning outcomes. Students were selected from five Queensland State and non-state schools, and 57% were enrolled in senior secondary marine studies programs. These students were surveyed and interviewed while groups were trained in coral reef ecology and monitoring in both the classroom and at various sites in the Great Barrier Reef. Both quantitative and qualitative methods were employed. The quantitative quasi-experimental design included various treatments, a contrast group as well as before and after treatment surveys. Qualitative investigation augmented these analyses with structured student interviews and accounts.

In this study, I analyse changes in Queensland Years 11 and 12 high school students' environmental knowledge (awareness), attitudes and ecological actions toward coral reefs when experiential education is added to classroom curriculum. The Three A's of Coastal and Marine Studies, according to the Marine Education Society of Australasia, are awareness, attitudes and action. This presupposes a learning situation where a gain in knowledge (awareness) will lead to a change in attitude, and thereby improve positive personal actions toward marine environments. This research analyses whether the link between the knowledge-attitude-action variables are linear in relation to the effect of direct reef experience.

The student participants were divided into four groups, with each group receiving different educational interventions. These included a classroom presentation on coral reef ecology and monitoring, and then participation in reef monitoring at a Great Barrier Reef site. Some students received both interventions, while others received only one treatment and a contrast group received neither. Pre- and post-test survey questionnaires and interviews collected student responses, and then the results were compared.

This research contributes a Model of Ecological Intention to Act relating to marine education theory and practice. A unique model was developed and tested as part of the research process. Results show reef experiential education to have a positive

effect on students' environmental knowledge (awareness), attitudes towards reef environments and stated intention to act. The reef experience alone caused the greatest change in environmental attitudes and ecological intention to act. This alludes to the fact that knowledge itself could be slowing down the improvement of attitudes and intention to act. However in my study, not only were students' initial environmental scores found to be low, the relationship was not linear across the variables since a change in knowledge (awareness) was not significantly correlated to changes in attitudes or intention to act. Comparisons of classroom interventions and experiences of immersion at a coral reef were revealed in both quantitative and qualitative analyses. Data can be read as both statistically and educationally significant. An interdisciplinary methodology for addressing pedagogical questions in marine education was developed that provides baseline information for future research.

Past research reveals more about environmental knowledge and attitudes than about students' educational experience and preferences. An attempt to advance the understanding of learning in marine experiential education was made by addressing the idea of moving away from linear learning models, and developing an analytic methodology. This study identifies future issues and challenges, and supplies a focus on adolescent student learning, learners, and their experiences.

This work took an elemental step in addressing the question of proximal relations between humans and coral reefs, and analysis brought together literature and techniques from varying disciplines to generate statistical findings, while student accounts confirmed the learning value of structured activities underwater as part of reef trips. It is time for us to begin the long journey of bringing natural environments closer in/to curricular practice as we rethink issues of sustainability and education in the 21st century.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

A	Attitude
Ac	Ecological Intention to Act
ANOVA	Analysis of Variance
ARE	Aquatic Resource Education
AUSMEPA	Australian Marine Environment Protection Association
CDC	Curriculum Development Centre
CGC&MP	Commonwealth Government Coastal and Marine Program
CSHS	Cairns State High School
CSIRO	Commonwealth Science and Industrial Research Organisation
DSP	Dominant Social Paradigm
DV	Dependent Variable
EE	Environmental Education
ENN	Environmental New Network
EWV	Ecological World View
GBR	Great Barrier Reef
GBRMPA	Great Barrier Reef Marine Park Authority
GCC	Good Counsel College
GCRMN	Global Coral Reef Monitoring Network
IV	Independent Variable
IEEIA	Investigating and Evaluating Environmental Issues and Actions
JCU	James Cook University
K	Knowledge
KAB	Knowledge-Attitude-Behaviour Model
K-A-A	Knowledge-Attitude-Action Relationship
MEIA	Model of Ecological Intention to Act
MESA	Marine Education Society of Australasia
MGOAI	Millward-Ginter Outdoor Attitude Inventory
MS ppt	Microsoft Power Point Presentation
MTAQ	Marine Teachers Association of Queensland
NEP	New Environmental Paradigm
NOAA	National Oceanographic and Atmospheric Administration

NSEE	National Society of Experiential Education
PADI	Professional Association of Dive Instructors
QSA	Queensland Studies Authority
REB	Responsible Environmental Behaviour
RMIT	Royal Melbourne Institute of Technology
SCCC	Southern Cross Catholic College
SMCC	St. Mary's Catholic College
SOSE	Studies of Society and Environment
SPSS11	Statistical Package for the Social Sciences, Version 11
STEP	Secondary Transition Education Project
TAFE	Technical and Further Education
TpB	Theory of Planned Behavior
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WSHS	Woree State High School

The Cairns Post

Friday, April 4, 2003

| NEWS |

Students study Reef in depth

Figure 1. “Students study Reef in depth” – Article From Cairns Post, April 4, 2003

SECTION ONE: THESIS FOUNDATIONAL INFORMATION

Chapter 1

How This Marine Education Study Came About

> *Australians are surrounded by ocean and ambushed from behind by desert – a war of mystery on two fronts. What worries us about the sea and the desert? Is it scale or simply silence? Historically we see ourselves as outback types, although we know we are suburbanites.…The desert is a spiritual place, we vaguely understand, and the sea the mere play ground of our hedonism.*
> (Winton, 1993, p. 21)

1.1 Introduction

In this study, I address an identified area of research need in environmental education and assess the effectiveness of reef experiential education, which is a part of the field of marine environmental education. Marine education aims to educate a citizenry capable of making astute decisions about the impact of human activities on marine environments as well as altering fundamental societal practices involving oceans and seas. As a practising marine educator in Hawai'i in 1994-1999, I became interested in researching coral reef education as a part of the field of marine environmental education. In February of 2000, I moved to Queensland with the specific intention of researching the value of coral reef experiential education in one of the best-known marine environments in the world – the Great Barrier Reef. This thesis is the result of research work undertaken with Australian high school students in classroom and marine environments between August 2002 and November 2003.

Australia made sense for this type of doctoral study since there is much interest concerning coral reef conservation and preservation, given the economic benefits generated by the Great Barrier Reef Marine Park alone were estimated to be $700 million dollars in the late 1990s (KPMG Consulting, 2000). High school programs reflect these economics and interest in marine environments with over 60 high schools offering Marine Studies subjects in Years 11 and 12, the senior years of schooling in Queensland. I have undertaken to research whether classroom presentations together with actual experiences of reef environments, including snorkelling and underwater

experiences, would change Queensland high school students' knowledge, attitudes and action with respect to coral reef environments.

1.2 Motivation for Study

My initial motivation to undertake this doctoral research came after I observed a group of Grade 8 students on their second encounter with a fringing coral reef in Kaua'i, Hawai'i. On the first visit, the students while walking along the reef were picking up bits of algae and coral and were throwing them at each other. On the second visit two weeks later, I noticed some students were looking at various seaweeds and calling to their friends to also look. One of the previously more distracted students showed his find to another student and said, "Look at this *Padina* [genus of brown algae, seaweed], it is just like the picture we saw in the book. Look at how the leaves come out like plants at home, and the base is fastened like roots of a tree." Both nodded, and one placed it back into the water before continuing their reef walk. On their second visit to this reef, instead of just enjoying themselves, the Grade 8 students as a group were less boisterous and more interested in examining the living plants and creatures. It seemed to me that the students' way of relating to the reef and its ecosystem was different as they were not only being taught in the classroom, but were also having a "real life" experience of the reef. Similar observations of the change in students' interactions with plants and animals have been noted by other outdoor education studies such as those by Bogner (1998) as well as Kruse and Card (2004). Further visits by the same eighth grade students to the same reef confirmed that they were beginning to understand that the reef was a living entity rather than just a playground.

While being moved and inspired by students' behaviour on the reef, I was also aware that environmental experiential education was in danger of being dropped from many formal education systems, despite its potential to improve implementation of environmentally based concepts and practices (Fien, 2004; Finger, 1994). Fien (2004), argues that education can "play an important role in motivating and empowering people to participate" (p. 185) in efforts to preserve environments for the future. Current research shows that coral reefs are in need of broad-based conservation efforts (Hughes, et al., 2003; Tilmant, 2000). Addressing these facets of environmental learning and preservation necessitates the adoption of more ecologically focused worldviews. This study was designed to investigate these issues in Australia along the Queensland coast bordering the Great Barrier Reef Marine Park. This choice was made because of the

economic and cultural focus on the Great Barrier Reef, and the existence of a well developed and highly coordinated high school marine studies programs.

I am concerned that Hungerford and Volk (2003) can say that “in the current socio-economic climate, one wonders if EE [environmental education] ... will ever help resolve the many serious issues that face humanity” (p. 4). One reason why current environmental education programs are not as effective as they may be is because “there remains the problem of marginalisation of the field of environmental education by bureaucracies at national, state and local levels” (A. Gough, 1997, p. 130). Nevertheless, the formal curriculum of Marine Studies in Queensland does introduce the choice of environmental education into senior curriculum, making it a good place for marine research.

In the 1970s, environmental awareness and attitudes became an issue for educational and environmental researchers. Early studies showed the importance and relevance of marine education (Fortner, 1978, 1983). Fortner’s foundational marine education research investigated marine and aquatic knowledge and attitudes and identified relationships of these factors to students’ experiences and information sources. Marine education is a multi-disciplinary study and education institutions had tremendous difficulty implementing experiential education training into its rigid departmental schemes (Fortner, 1983; Fortner & Teates, 1980).

Educational institutions in Australia are addressing the need for more programs concerning the marine environment. In Queensland by 2004, sixty high schools had incorporated various experiential programs into the Year 11 and Year 12 Marine Studies senior syllabuses. Experiential activities are strongly recommended as part of marine studies curriculum in Queensland (Queensland Studies Authority, 2005a). The benefits stated as emerging from this “hands on” or experiential education, where students actively have experiences of marine environments, are enhancement of students’ employment opportunities, establishment of a basis for further education and development of responsible attitudes toward the marine environment (Queensland Studies Authority, 2005b). The Marine Education Society of Australasia (MESA) has been instrumental in supporting the development of high school marine education in Queensland (Griffith University and the Department of the Environment, Sport and Territories, 1997). These experiential programs enable students to not only engage in experiential education on the reef but also to engage in classroom studies including reviewing government policy and practices. My research attempts to address the

question of the value of experiential education in marine environments in the context of marine studies programs at Year 11 and Year 12 – the final two years of schooling in Queensland. I have investigated the value of reef experiences in the face of the continued deterioration of coral reefs around the world and the fact that in Queensland, Australia, the Great Barrier Reef is protected as a World Heritage Area. Perhaps it is not the reef that needs to be managed, but humans!

1.3 The Study is Timely

Coral reefs are a vital aspect of the planet's ecological system (Hughes, et al., 2003), and human beings are increasingly causing intense and significant damage to coral reef environments. To reverse or slow the rate of this damage, Oskamp (2002) points out that: "Enormous changes to human lifestyles and behavioral patterns will be required to reach the goal of environmental sustainability for the earth" (p. 174). Thus, it is vital to find ways for people to learn to effectively manage reef environments to ensure their long-term life (Maragos, Crosby & McManus, 1995; Talbot, 1995). An estimated 30% of world coral reefs are already severely damaged, and there is the probability of a 60% loss of all coral reefs by 2030 (Hughes, et al., 2003). Moreover, while coral reefs provide ecosystem goods and services, with economic gain to many human societies, there is concern about how this can be made sustainable in the near future. There is no doubt that learning to care about coral reef environments is a matter of urgency and a key value of marine education in Queensland and around the world.

1.4 Knowledge (Awareness), Attitude, Action

In this study, I investigate whether a relationship exists between, ecological knowledge, positive environmental attitude and responsible environmental action. In previous community and school related work in Hawai'i, I observed the learning of environmental knowledge and the related modifications in environmental attitude, while in the process seeing no apparent changes in the environmentally responsible actions of students who appeared environmentally aware. A problem kept surfacing which suggested people appeared to have great difficulty incorporating responsible actions in their day-to-day lives that lowered the effects of their ecological footprints (Redefining Progress, 2006). Their ecological footprints remained large despite increases in awareness. Many well-intentioned people are continuing the very same consumptive patterns that have caused the problems in the first place (Oskamp, 2002).

It became obvious to me that responsible environmental action is important to improve coral reef health. So, I thought, marine experiential education might help people learn how to change their ideas about how to act. A well-accepted pedagogy in Queensland is the Coasts and Marine Schools Project (Marine Education Society of Australasia, 2004) Three A's of awareness, attitude and action. In order to study this problem it was decided to evaluate connections between students' answers to various survey and interview questions. This research poses the question whether students' increased direct experience with a coral reef along with learning about coral reefs in the classroom can produce changes in environmental awareness, attitudes and ecological action. I address the problem by asking the following questions:

a) Does direct experience of a coral reef with high school students participating in coral reef monitoring produce significant positive change in their environmental awareness, attitudes and self-reported ecological action strategies?
b) Does previous experience of the Great Barrier Reef influence significant positive change in the environmental awareness, attitudes and ecological action strategies of student participants?
c) Do classroom presentations in addition to reef visits produce a higher degree of change in their environmental awareness, attitudes and self-reported ecological action strategies?

My research investigates one means for augmenting the action component of the Three A's through experiential education. Ideally, any reef experiential learning intervention would improve positive or friendly actions toward the coral reef environment, while also improving the positive environmental awareness and attitude outcomes within the context of the contemporary formal education system. Thus, I aim to investigate whether classroom marine education plus real life reef experience can change student attitudes. My initial position is that reef experiences should lead to increased positive environmental actions, and that changes in awareness (as environmental knowledge), attitudes and perhaps action can be investigated and measured.

1.5 Call for Marine Experiential Education

Earlier marine environmental research focused on reef knowledge and attitudes (Fortner, 1983) while recent policies promote awareness and environmental action (Marine Education Society of Australasia, 2004). Marcinkowski (2001) argues that

there is an apparent disparity between the stated importance in environmental education of people's actions and their actions. Thus, there is a need to understand their actual performance with respect to educational outcomes in order to investigate whether responsible environmental behaviour is actually being approached as an achievable or desirable objective.

There is a real need to research experiential education further as a practice, which has a sustainable future and an augmented teaching strategy for marine studies in order to produce a clearer picture of what pedagogical and eruditional outcomes it can generate for teachers and students. Is it possible that the implementation of marine experiential education can improve learning outcomes in a formal school education setting in relationship to reef ecology? My research investigates realities of curriculum practice. In this way, I hope to make a real contribution to marine education research.

1.6 The Study and Approaches

The study was conducted in 2002 and 2003 with a total population of 389 student participants in Years 11 and 12, from 5 coastal Queensland schools who were learning about coral reef ecology in the classrooms and on visits to Great Barrier Reef sites. The methodological approaches used in this investigation were developed in conjunction with educators working in/with existing formal marine studies programs in high schools in Queensland. Both quantitative and qualitative approaches were used to develop a greater understanding of the pedagogical and learning benefits of direct experiences with coral reefs. For the quantitative approach, the key independent variables were two interventions, a classroom presentation and a coral reef visit, while the dependent variables were environmental knowledge, attitude and action skills. Changes in environmental knowledge, attitudes and ecological action were investigated, firstly, with respect to a traditional knowledge-attitude-action relationship; secondly, with respect to the relationship of these variables to each other; and thirdly, with respect to other education and social science theories. The qualitative approach was employed to ascertain how students were able to report marine ecology learning and underwater coral reef experiences.

The thesis is unusually organised because of the mixed-method cross-disciplinary approach, and the need to explain the educational interventions utilised. Portions of chapters are repeated, with issues being introduced in the literature review, then developed and explained in greater detail in the theoretical framework section over

the next two chapters. This is intended to provide the reader with initial concepts, and consequently develop and expand them through future chapters to clarify their development in differing disciplines. A theoretical framework chapter appears separately from the literature review. This was done to explain theoretical development and application within the study. An earlier attempt was made to consolidate the content in fewer chapters, but this was difficult considering the different methods and analysis strategies used. Consequently, a unique thesis organisation evolved to address these issues.

1.7 Contribution of Research in Practice

The contribution of this study relates to a merging of two approaches to environmental education research. A majority of environmental education research belongs to the quantitative paradigm (Rickinson, 2001), and reflects methods used in scientific research. My research provides a lens for understanding how theoretical claims about teaching and learning are transformed into effective learning by blending quantitative and qualitative methods. The aim is to provide a more holistic method for researching educational variables, while also including the perspectives of participant students. The research measures variable change in different learning situations and it was designed specifically for this unique study of learning in the marine environments in Queensland. I designed explicit learning interventions to be compatible with current marine studies practice within real situations in schools. My research was embedded in and not constructed separately from educational practice in the participating high schools.

While the findings about students' knowledge, attitude and action will contribute to research on Australian adolescent high school students, the study has implications for future reef education for all levels of Australian schools. Moreover, the study investigates strategies to strengthen awareness and attitudes toward coral reefs, with the aim of enhancing positive environmental action.

1.8 Synopsis

This thesis reports on research about learning in an inter-disciplinary marine experiential education project, which uses a mixed approach incorporating quantitative and qualitative analysis. The thesis is divided into three sections. The first section contains the introduction, literature review, a theoretical framework, a procedural and

intervention explanation, as well as a presentation of the quantitative and qualitative methodologies. The second section contains the analysis of results from the quantitative and qualitative methodologies. The third section presents the discussion and conclusion.

Because of the interdisciplinary nature of this work and the marine education context within which it is set, both an extensive literature review and theoretical framework are presented to lay the foundation for this research. Immediately following this chapter, the literature review expands proposed explanations and provides a contextual foundation for the study.

Chapter 2

Literature Review: Historical Perspective on Marine Education

> *The current crisis has largely been created by the 'well-educated' ... people impeccably groomed, excellently educated at the best universities … eating fine foods and reading classy literature, while orchestrating the investment and legislation that ruin the world.* (Orr, 1999, p. 232)

2.1 Introduction

Environmental education aims to provide a citizenry with tools to make good decisions about environmental issues. Marine education, a subset of environmental education, utilises experiential education techniques and is a field that contains many overlaps from other disciplines. Marine education has attracted comparatively little research attention and coral reef education even less. In this thesis, I treat coral reef education, which can be located in the broad field of environmental education, as a subset of marine education. With the exception of Fortner (1978, 1983), previous marine related research does not take into account the inclusion of experiential education in school curriculum. By addressing this omission, my study is timely and worthwhile in the light of current concern for reef preservation expressed in the recently released Millennium Ecosystem Assessment report which noted the world has lost 27 % of coral reefs in the past few decades (Coryalan, et al., 2005).

The critical problem for education in the 21st century is how to address the serious long-term threat due to human actions damaging the integrity of environmental conditions which support biologically diverse life (Orr, 1999; Oskamp, 2002). In May 1997, the United States Oceans and Security Conference in Washington, D.C., *Potomac Declaration*, Recommendation 10 argued that concerted national and international efforts be undertaken to introduce environmental studies into all levels of school curricula in order to increase environmental awareness and promote a deeper understanding of environmental ethics (National Oceanic and Atmospheric Administration, 1998).

The theoretical basis for this work fills a research gap and expands knowledge about marine experiential education. This research investigates a means of improving specified learning outcomes in marine education. This research sets out to investigate the relationship between high school student learning and direct experiences with coral

reefs located in the Great Barrier Reef offshore from the coastal mainland of Queensland. The research question is framed as: How does marine experiential reef education affect the testable environmental knowledge, as well as the self-reported environmental attitudes and ecological intention to act, of high school participants? What I discuss in this chapter is how I came to frame this doctoral research. I discuss a contextual framework of the literature and past studies, which form the basis of developing this marine environmental education research. This literature review elucidates the theoretical underpinnings for the study as a whole.

2.2 Environmental Education

2.2.1 Environmental Education Definition

The definition of environmental education is contested and there has been a rich discussion in the education field. Even though the United States Environmental Education Act of 1970 is neither a sufficient nor a universally accepted definition, it provides a commonality with which to begin this review. In this Act environmental education is defined as:

> an integrated process which deals with man's [*sic*] interrelationship with his [*sic*] natural and man-made [*sic*] surroundings, including the relation of population growth, pollution, resource allocation and depletion, conservation, technology, and urban and rural planning to the total human environment. Environmental education is a study of the factors influencing ecosystems, mental and physical health, living and working conditions, decaying cities, and population pressures. Environmental education is intended to promote among citizens the awareness and understanding of the environment, our relationship to it, and the concern and responsible action necessary to assure our survival and to improve the quality of life. (Linke, 1980, p. 26)

In the 1970s, a number of countries, including Australia, New Zealand, Canada, United States of America (USA) and the United Kingdom (UK), developed governmental policy to incorporate the new field of environmental education into the formal education systems. Environmental education subsequently developed as a field for conceptualisation and research.

2.2.2 Creation of the Awareness-Attitude-Action Objectives

In the USA, Stapp (1970) conceptualised curriculum development and implementation in environmental education for elementary and secondary levels. By 1977, the Queensland Department of Education had developed a policy for environmental education in state schools. Environmental education is unusual in that it is an educational endeavour created from a global state of concern in the 1960s and 1970s (A. Gough, 1997). Society and education came under intense pressure to provide a mechanism for changing approaches to environmental problems (Fortner, 1991b). New thinking demonstrated that a paradigm shift is possible when discordant information surfaces and forces a re-evaluation of an existing paradigm (Disinger, 1993). Environmental ideas started to emerge all over the world, and key environmental texts began to change how people thought about social relations and economic relations to natural environments; such as *Silent Spring* (Carson, 1962), *The Historical Roots of Our Ecological Crisis* (White, 1967), *The Tragedy of the Commons* (Hardin, 1968) and *The Population Bomb* (Ehrlich, 1971). International policy increasingly recognised environmental problems.

The United Nations first formulated policy on environmental education at its 1972 *Conference on the Human Environment* in Stockholm. A key proposal was *Recommendation 96*, stating that education and training are vital to the long-term success of environmental policies because this is a key means for mobilizing an enlightened and responsible population, and of securing the “manpower” [*sic*] needed for practical action programs (Linke, 1980). The United Nations Environment Programme (UNEP) international workshop on environmental education, sponsored by United Nations Educational, Scientific and Cultural Organization (UNESCO), followed in Belgrade, Yugoslavia in 1975. The *Belgrade Charter* called for an international program establishing environmental education as an interdisciplinary field, which would encompass all levels of school and community education. A particular focus was on the education of ordinary citizens living in both rural and urban areas informing them of the steps they might take to manage and control the quality of their environments (A. Gough, 1997; Raven & Berg, 2004). The stated goal of environmental education was: “to develop a world population that is aware of, and concerned about the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations and commitment to work individually and collectively toward solutions of current problems and prevention of new ones” (A. Gough, p. 19). The *Belgrade Charter*

confirmed the need to regard environmental education as a lifelong process, and described a set of criteria. The Charter created the idea that a logical sequence of objectives embracing environmental awareness will enhance environmental attitudes and moves an educated citizenry towards active participation in environmentally ameliorative action. Whether participatory action does in fact emerge from awareness, which leads to a change in attitudes has been an area of much discussion and research since the 1970s.

The UNESCO-UNEP Tbilisi, Georgia, Intergovernmental Conference on Environmental Education in 1978 introduced a new education curriculum to promote and teach the students skills to find environmental solutions. Its objectives, which led to responsible environmental behaviour research in the 1980s, promoted:

> *Awareness* – to help social groups and individuals acquire an awareness and sensitivity to the total environment and its applied problems;
>
> *Sensitivity* - to help social groups and individuals gain a variety of experiences in, and acquire a basic understanding of, the environment and its associated problems;
>
> *Attitudes* – to help social groups and individuals acquire a set of values and feelings of concern for the environment and motivation for activity participating in environmental improvement and protection;
>
> *Skills* – to help social groups and individuals acquire skills for identifying and solving environmental problems;
>
> *Participation* – to provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems (Hungerford & Volk, 1990, pp. 8-9).

These objectives were intended to provide a framework for the formation of environmental education in schools, and inform subsequent governmental policy documents. They still frame much of formal environmental education policy today, but are under critical examination throughout the world in relation to issues of social and human constructions (Finger, 1994; Payne, 2003; Phillips, 2000; Robottom, 2004), transformative education (Albert, et al., 1998; O'Sullivan & Taylor, 2004; Takahashi, 2004) and sustainability education (Fien, 2004). Nevertheless, the Tbilisi framework remains pertinent for the purpose of this research.

I have constructed the following diagram to illustrate how the 1978 Tbilisi objectives for environmental education articulate with the most recent objectives

expressed by the Marine Education Society of Australasia (2004). Figure 2 lists down the left side the objectives promoted by the 1978 Tbilisi environmental education conference. On the right side are the Three A's of coastal and marine education (Marine Education Society of Australasia, 2004). My research does not investigate the Tbilisi 1978 objectives of sensitivity and skills, but only those of awareness, attitudes and action, in line with current Marine Education Society of Australasia objectives.

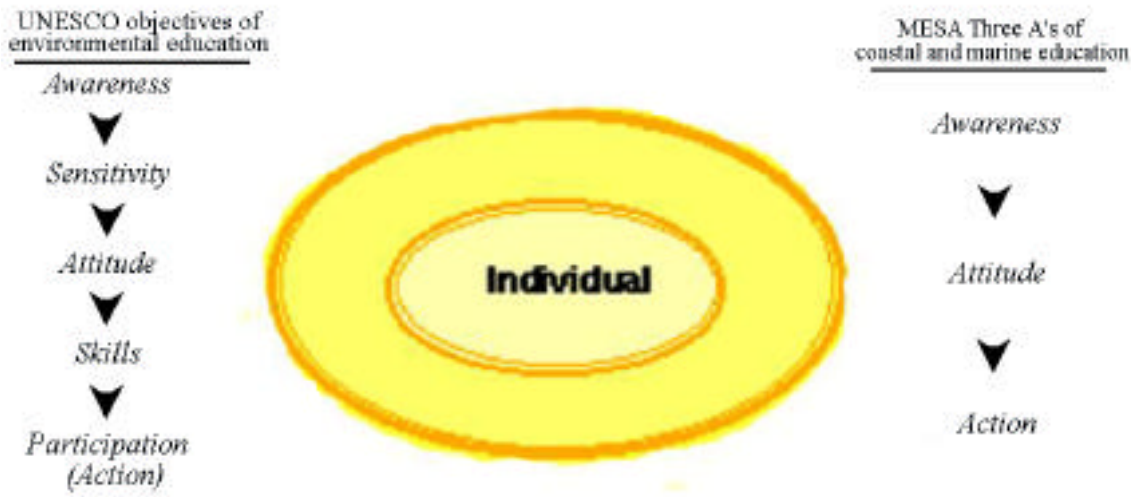

Figure 2. Environmental awareness to ecological action process (modified from Hines, Hungerford & Tomera, 1986/1987; Hungerford & Volk, 1990).

In my research, consideration is given to the varying relationships of awareness, attitude and action, which emerge as research problems from experiences in real learning situations. The assessment of changes in students' environmental knowledge (as awareness), attitudes and actions are crucial foundational goals of environmental education, and are seen as appropriate measures for learning/teaching program evaluation (Bogner, 1998; Dettmann-Easler & Pease, 1999; Hsu, 2004). This research asks the question whether high school students' increased direct experience with a coral reef along with learning about coral reefs in the classroom can produce changes in environmental awareness, attitudes and ecological action. In order to evaluate connections between reported environmental awareness, attitude and action, it is necessary to create a context in which to consider the research problem.

2.2.3 The Lucas Model

In 1972, Arthur Lucas developed an environmental learning model by scrutinising various teaching strategies for environmental education to determine a number of ways to disseminate knowledge and facilitate the learning process. Russell Linke, an influential Australian educator in the 1970s, saw the Lucas Model of Environmental Education as creative and definitive of the field, especially when compared with previous ideas of environmental education:

> This [Lucas] model identifies three independent or primary classes of environmental education – education *about* the environment, *for* (the preservation of the) environment, and *in* the environment – that produces [*sic*] four additional meaningful combinations. Education *about* the environment involves the provision of information on environmental issues and the teaching of appropriate technical and intellectual skills. These objectives are clearly cognitive in the taxonomic sense and extend across the entire range of intellectual ability. Education *for* the (preservation of the) environment involves the development of an interest in and concern for environmental conservation and the inculcation of other associated attitudes and values. Education *in* the environment describes any form of education conducted outside the traditional classroom – it is characterized by a particular pedagogical technique rather than by a set of behavioural objectives. (1980, p. 36)

By 1975, the Curriculum Development Centre (CDC) in Canberra, the Australian national capital, deemed Lucas' ideas so important that it sent all schools in Australia the message that "it is only when education *for* the environment is the intention that environmental education is actually taking place and the aims have a possibility of being achieved" (A. Gough, 1997, p. 11). Lucas' environmental education model was highly influential in defining both education practice and research direction, and is still utilised today (Department of the Environment and Heritage, Government of Australia, 2005). After the initial and definitive stages of international environmental education policy occurred in the 1970s, came the period of the creation of innovative teaching and practice of curriculum change (A. Gough, 1997).

2.2.4 Developments in Environmental Education

By the 1980s, it became better understood that to protect world environments, education practice could not be viewed in isolation: environmental changes are closely

interwoven with social and economic changes. The 1980s were a time for the expansion of environmental education and emergence of various approaches. Researchers diverged in their opinions on how best to teach environmental education in order to meet the Tbilisi Charter objectives. Disinger (1987) argued that environmental education is best accomplished through introduction of discrete topics into standard science curricula while Robottom (1987) argued that if mainstream curriculum is a number of puzzle pieces made up of various subjects, then environmental education may not fit well into this puzzle at all (A. Gough, 1997). The *Brundtland Report of the World Commission on Environment and Development* (1987) and the United Nations Conference on Environment and Development (UNCED), the Rio Earth Summit, in Rio de Janeiro (1992) concluded environmental education was a hotchpotch of subjects incorporated into the curriculum by educators from other fields in order to satisfy a perceived need. Following the *Brundtland Report*, the Rio Earth Summit again focused world attention on environmental education and the urgency of addressing environmental issues through education (Fien & Tilbury, 2002). By 1992, a non-binding international agreement called *Agenda 21*, established a further blueprint for world action. The Rio Principles reinforced the original idea that improving environmental quality and value of the environment can be achieved through education (Hamú, 2002). In Australia, Fien (1995) published a professional development curriculum package addressing issues concerning ecological sustainability in contemporary educational systems. One declared aim of sustainability education is “a rediscovery of our connections to the natural world” (Australia 21 Ltd Nature and Society Forum Inc Sustainable Population Australia Inc., 2003, p. 1). The program conceptualised how environmental, social and economic issues can be introduced into various secondary school curricula. This task has proved to be a complex undertaking and a challenge for educators at all levels (Fien, 1997; N. Gough, 1991; A. Gough, 1997; Raven & Berg, 2004).

There is increasing agreement among environmental educators that social and economic education for preservation of the natural environment must be taken seriously in both formal and informal settings (Fortner, 1991b; Gigliotti, 1990; Fien, 2004). For example, the Netherlands response in 1992 was an *Action Plan for a Sustainable Netherlands by 2010*. It outlined how far the Netherlands was living beyond what was regarded as the Earth’s sustainable means (Dresner, 2002), and maintained that changes in current citizen action would have to accompany any educational or administrative approaches to sustainability. However, in the decade since the Earth Summit in 1992,

the United Nations Secretary-General Kofí Annan, in 2001, reported that “progress towards the goals established at Rio has been slower than anticipated and in some respects conditions are worse than they were ten years ago” (Hamú, 2002, p. viii). Therefore, even as the imperative nature of environmental preservation is increasingly understood, there is continual concern environmental education is failing to achieve its oft-stated objectives. Debates on the relationship between environmental education, economic and social environmental preservation and determining the future of environmental education, are currently taking place in the educational community. While there is a lack of resolution (Rickinson, 2001), the issue of generating “action necessary to assure our survival and to improve the quality of life” (Linke, 1980, p. 26) continues to be relevant.

2.2.5 Behaviouralism Challenged

A key concept of contemporary environmental education is responsible action, which was incorporated into the *USA Environmental Education Act* (1970) and the Tbilisi 1978 definition of environmental education, and is referred to as “responsible environmental behaviour” by Hines et al., (1986/87), and Hungerford and Volk (1990). Environmental educators agreed that the major aim of environmental education was to produce individuals who willingly and responsibly participate in environmental maintenance and remediation.

Disinger (1993) argued education is a behavioural and social science. Nonetheless, there is international and Australian critique of Hungerford and Volk’s approach as some environmental educators consider this position far too behaviourist (N. Gough, 1999/2000; Gough & Whitehouse, 2003; Hart & Robottom, 1993; Payne, 2003). Robottom (1993) argues the main aspiration of environmental education is the development of independent critical thinking in relation to environmental issues. He suggested that a behaviouralist research focus not only creates and sustains divisions of labour between researchers and practitioners, but also imposes the researcher’s environmental, educational and social values onto students and teachers in a way that is fundamentally disempowering. Robottom also argues there are other important developments in the educational process besides behaviourism, and when behaviouralist thinking and analysis become the sole focus of environmental education research, too much can be lost with respect to other learning outcomes. Many researchers argue much can be learned about individual pedagogical situations through more holistic and

personal qualitative approaches (Cobb, Confrey, diSessa, Lehrer and Schauble, 2003; Ellis & Flaherty, 1992; Hendricks, 1994; Huberman & Miles, 2002; Jacobson, 1997; Knapp & Poff, 2001; Linacre, 1995; Marcinkowski, 1991; Patton, 1990; Strauss & Corbin, 1998).

Fien (2000) makes the case, environmental problems are far more extensive than an individual's behaviour and are the cumulative result of our economic and social arrangements as well as our consumptive society and consumerist ways of living. Fien argues there is a need to work to transform the relationship between human and non-human life. He would like students and teachers to remain focused on the original objectives of environmental education, while developing critical thinking to enable agency within a democratically oriented curriculum of economic and social environmental preservation. Environmental education is not about the environment per se, but the web of relationships between persons, their social group, and their environments (Robottom & Sauvé, 2003). Lucas' (1972) early idea of educating *in* the environment, which is characterized by a pedagogical technique rather than by a set of behavioural objectives, relates to a transformative web of relationships (O'Sullivan, 1999) and can still be used in contemporary practice. O'Sullivan argues experiential education facilitates meaningful learning and can possibly promote responsible environmental behaviour, or improved ecological action that can be seen as education *for* the environment.

2.3 Experiential Education

2.3.1 Changing Educational Frameworks

Experiential education can facilitate meaningful learning about the effects of human relationships on the marine ecological environment (Kahn, 2001). Experiential outdoor education "is a process through which a learner constructs knowledge, skill and value from direct experiences" (Adkins & Simmons, 2002, p. 1) and many marine education programs utilise this pedagogy. It is the active construction of meaning from situations that include direct contact and interaction with outdoor environments orchestrated mainly, but not wholly, by the teacher. Thus, students learn about their relationship to differing environments from exposure, direct contact, instructor modelling, as well as direct teaching (Newhouse, 1990). It is argued the process of actively engaging students in activities related to the environmental subject (such as a coral reef) will have real consequences for those students as learners (Stevens &

Richards, 1992). Experiential education creates a place and a space that enables a meaningful connection to outdoor environments by facilitating “consequential learning” (Whitehouse, 2002, p. 57). The importance of experiential education and developing meaningful learning were described by Dewey (1966) as:

> having some instinct and finally some habit, getting new sensations and experiences, having those react, modify, reconstruct, and control, and stimulate in a new way the old instinct or habit which is expressed in action and gives birth to new experiences which modify in turn instinct and habit, and so on indefinitely. (p. 306)

This meaningful learning is important since enormous changes to individual lifestyles and cultural practices will be required in order to reach a sustainable level of human use of the planets ecosystem (Oskamp, 2002; Coryalan, et al., 2005), providing we can collectively make the decision to do so (Diamond, 2005). This raises the question as to “whether environmental education should not take a different form than further information and knowledge transmission” (Finger, 1994, p. 159).

According to the traditional linear learning approach promulgated in earlier constructions, analysis and synthesis of research on responsible environmental behaviour in environmental education (Hines, et al., 1986/87), a person learns knowledge and this promotes attitudes to change, which lead to a change in his or her actions (Hungerford & Volk, 1990). The concepts are being raised here, with clarification concerning knowledge of *what* and attitudes about *what* being addressed in the next chapter. This learning model proposed by Hines, et al. (1986/87) assumes that a person’s environmental knowledge scores are directly linked to his or her future environmental behaviour, so as knowledge increases the environmentally positive behaviour will improve. Matthews and Riley (1995) in a two year Cornell University research project that consulted 35 governmental agencies, concerning teaching and evaluating outdoor education programs, concluded, “it is important to realize that awareness is not enough to cause long-lasting behavioral change” (p. 6). Many environmental education and public awareness campaigns are designed to raise awareness, and in a review of a number of environmental studies, Yerkes and Haras (1997) found that developing awareness of environmental issues is not enough to ensure students recognise their environmental responsibilities and act upon them. While environmental issues are “the main subject matters of environmental education, ... the

specialised disciplinary structure of school curricula is not well suited to this work" (Robottom & Sauvé, 2003, p. 125).

The idea of developing environmental knowledge and participatory action skills together seldom has expanded into formal educational disciplines (Ewert, 1987; Rockland, 1995; Salter & Hearn, 1996). Of particular importance in "situated learning is the participation and the social and cultural world within which that participation occurs" (Quay, 203, p. 107). Considering the relevance of participatory action skills appears to be very important, since evaluating the effects of differing types of knowledge skills changes ecological action research outcomes (Jensen, 2002; Kaiser, Wölfing & Fuhrer, 1999; Kaiser & Fuhrer, 2003; Kollmuss & Agyeman, 2002). Students and teachers have "reported an improved level of academic engagement when students were working outdoors" (Powers, 2004, p. 28). Only through direct participation can children develop a genuine appreciation of democracy and a sense of their own competence and responsibility (Hart, 1997, p. 3).

For decades, many educational researchers have sought to understand and plot the factors that lead people to move from environmental knowledge to 'pro-environmental behaviour' (Courtenay-Hall & Rogers, 2002; Jensen, 2002). Many researchers have addressed this lack of continuity between the possession of environmental knowledge and displaying pro-environmental behaviour. While studies have addressed this gap between learning and why people act environmentally, no definite explanation has been found (Kollmuss & Agyeman, 2002).

The development of critical thinking skills appears to be especially important to encourage students to draw personal conclusions and make decisions based on their own ideas (Quay, 2003; Robottom, 2004; Rosebery, Warren & Conant, 1992). Willis (1977) argues that when students interact with the world around them, they become more actively engaged in the learning process. Using metaphor within experiential education, it is possible for the learner to achieve desired curriculum outcomes through learning discovery and comparison techniques (Horton & Haines, 1996), as experiential education can provide a mechanism for linking knowledge skills and expertise (Caine & Caine, 1994; Kruse & Card, 2004). Kalinowski (1991, p. 13) points out, "one cannot overemphasize the importance of providing direct firsthand experience for students as they progress through their formal learning." First-hand experience of outdoor environments helps knowing become real and useful to students, while also helping to improve their attitude (Dettmann-Easler & Pease, 1999), and creating new ways for

them to learn in addition to the classroom (Payne, 2003; Quay, 2003). Is it true that "nature experience remains vital to environmental education" (Russell, 1999, p. 125), and the influence of underlying nature experiences could lead to insight regarding dominant human/nature relationships?

A number of articles have been written concerning whether environmental education leads to the development of critical thinking skills. Matthews and Riley (1995) found that in effective environmental education programs, presenting environmental 'facts' is less important than the social context and interactions generated in which the education is done. A Canadian study about four university students on an overseas field trip to Cuba suggested that critically responsive pedagogy invites involvement by incorporating experience, reflection, and action (Jakubowski, 2003). Klein and Merritt (1994) argue "knowledge is actively constructed by the cognizing subject, not passively received from the environment, and coming to know is an adaptive process that organizes one's experiential world; it does not discover an independent, pre-existing world outside the mind of the knower" (p. 15). If "students [are] to take an active role in learning and building on factual knowledge to improve investigation and critical thinking skills" (Klein & Merritt, 1994, p. 20), then experiential education can have the effect of forming unforgettable critical images in students' minds (Fortner, 1991b; Persing & Baldwin, 2004; Powers, 2004).

The Bogner (1998) study investigated the influence of short-term outdoor ecology education on long-term environmental perspectives empirically evaluating the effect of outdoor ecology education on approximately 700 German students' environmental perspective with a pre- and post-treatment evaluation format. The post-test using multiple-choice knowledge statements, was delayed for 1 month after participants experienced the outdoor education program. The objective of this study was to evaluate whether the program affected changes of students' attitudes toward nature, and improved factual ecological knowledge. It was found that for students aged 11 to 14, knowledge and attitude scores improved after experiential learning, and that the two programs investigated improved cognitive levels, and favourable shifts were noted in actual and intended behaviour. Bogner was able to conclude that outdoor ecology programs influenced positive student actions towards environments, because of the favourable shifts in their actual and intended behaviour. Students enrolled in the study were to some extent self selected, as research revealed a more proenvironmental orientation in students enrolled in the program before any education at the nature site

took place (Gustafson, 2001). Even so, the research demonstrates a strong relationship between the variables of knowledge, attitude and action, but it is necessary to repeat this study with a less proenvironmental sample of students if this is practicable.

Mittelstaedt, Sanker and VanderVeer (1999) studied the effect a summer science camp had on awareness and attitude of 46 American children aged 9 to12. This study made use of an attitudinal survey instrument called the Millward-Ginter Outdoor Attitude Inventory (MGOAI), which showed a reported validity coefficient in excess of 0.80 (Mittelstaedt, et al., 1999). The MGOAI used the total scores for all responses and gives them a numerical score, and has proved to be an effective means of measuring attitudinal change. The Mittelstaedt et al. study scores reflect attitude as very positive, positive, noncommittal, negative attitude, and very negative toward the environment. All study participants showed an increase in positive attitudes towards the environment, and almost one-fourth of the reported intentions to act occurred during the following year. The small group of students investigated in this project, the fact that the student campers were self-selected, that no control or contrast was provided, and the lack of an action component in the study were areas that can be expanded upon.

Finger (1994), explored the relationship between environmental experiences, learning, and behaviour with qualitative research and two surveys with 786 and 1004 Swiss respondents and found “the main factors predicting environmental behavior, or absence thereof, are experiences in and with the environment” (p. 141). Analysis of a pilot study by Finger concluded “that participating in formal continuing environmental education offerings was far from leading to corresponding social environmental and social behavior change” (p. 147). These results imply the relationship between experience, learning and behaviour is very complex. The question for Finger is whether environmental education should continue to promote the distribution of information and knowledge transmission. This study was extremely well orchestrated and had an appropriate sample, but no experiment consisting of varied educational interventions was used to investigate this question. Ewert (1996) also found that experiential training promotes environmental responsibility through awareness building, attitude formation, and student empowerment. The area not fully addressed by these studies is testing whether environmental education promotes environmental responsibility through the transmission of information and awareness building, attitude formation, and student empowerment in a quasi-experimental designed study.

There are complexities involved in the study of these relationships. Kruse and Card (2004) examined the effects on campers of a Florida conservation education camp, whereby 383 school age children between the ages of 10 and 18 years rated their conservation knowledge, attitudes, and actions. The quantitative assessment was a quasi-experimental comparative research design with repeated measures utilising survey questionnaires comparing changes from pre-tests to post-tests. Campers with previous conservation camp experience had more positive knowledge and attitude responses, with all campers' self-reported knowledge, attitude, and behaviour increasing during the camp, even though "campers with previous camp experience did not perform environmentally responsible behavior more often than those who were attending camp for the first time" (p. 44). An animal husbandry component existed throughout the camp experience to determine if it impacted self-reported conservation knowledge, attitude and behaviour of the participants. An increasing trend was observed from the beginning of camp to the end, which indicated that animal husbandry hands on experience and participation has a positive impact on campers' retention of knowledge, attitude and behaviour.

Research emphasis on learning by doing is a reasonable path to investigate as "'lived experience' must be pursued and interrogated" (Silverman, 2004, p. 344). Experiential education can be an important life-experience that may have the additional effect of promoting positive environmental actions (Finger, 1994). Stevens and Richards (1992) argue, "experiential education can change schools because it requires new roles of students, teachers, and administrators. It can provide a different, more engaging way to treating academic content through the combination of action and reflection" (p. 5), and this relationship was explored in this study of marine experiential education. This is important because experiential learning acknowledges that the cognising subject (the student) is not passively receiving content, but is actively constructing knowledge (Klein & Merritt, 1994). In the process of 'coming to know' does one not discover an independent, pre-existing world outside the mind of the knower, which embodies cognitive understanding and thereby learning? It is this concept that an investigation should be designed to measure.

In summary, the demonstrated relationship between experiential education and the development of positive environmental awareness, attitudes and responsible ecological action in practice remains a fruitful area for future research (Clitheroe, Stokols & Zmuidzinas, 1998; De Young, 1993; Ewert, 1996; Finger, 1994; Kruse &

Card, 2004; Matthews & Riley, 1995; Mittelstaedt, et al., 1999; Palmberg & Kuru, 2000; Yerkes & Haras, 1997). It is possible that the experiential approach to education could circumvent a number of criticisms levelled at traditional educational programs (De Young, 1993; Ewert, 1995; Finger, 1994; A. Gough, 1997; Knapp, 1999; Matthews & Riley, 1995; Warren, Sakofs & Hunt, 1995). In addition, research indicates experiential education improves students' focus on critical thinking skills (Jakubowski, 2003; McDonnell, 2001; Stevens and Richards, 1992), environmental attitudes, social science concepts, and ecological action skills (Dewey, 1938; Ewert, 1996; Mittelstaedt, et al., 1999; Neill & Richards, 1998; Newhouse, 1990; Palmberg & Kuru, 2000; Ratcliffe & Grace, 2003; Stevens & Richards, 1992). Programs most likely to change students' ecological action skills involve concrete, environmentally positive, action-oriented experiences that are designed to promote greater participatory action outcomes (Ewert, 1995; Finger, 1994; Matthews & Riley, 1995; Mittelstaedt, et al., 1999; Yerkes & Haras, 1997).

Awareness alone is not enough to cause long-lasting behavioural change (Finger, 1994; Knapp, 1999; Marcinkowski, 2001; Matthews & Riley, 1995; Newhouse, 1990; Palmberg & Kuru, 2000; Ratcliffe & Grace, 2003; Stevens & Richards, 1992; Yerkes & Haras, 1997). Therefore, to encourage ecological intention to act, it is important to improve the students' ownership of awareness and interest in expanding the use of their knowledge with respect to environmental situations (Knapp, 1999; Matthews & Riley, 1995; Mittelstaedt, et al., 1999; Palmberg & Kuru, 2000; Ratcliffe & Grace, 2003; Stevens & Richards, 1992; Yerkes & Haras, 1997). Outdoor educators have directed considerable attention toward environmental intention to act activities (Matthews & Riley, 1995; Yerkes & Haras, 1997), and the self-reported effect of these activities should be measured. My study contributes to this body of research and explores whether experiential education techniques outperform classroom teaching in relation to advancing environmental knowledge, attitudes and ecological intention to act.

2.3.2 Levels of Environmental Knowledge in High Schools

Environmental knowledge is defined as "a student's ability to understand and evaluate the impact of society on the ecosystem" (Gambro & Switzky, 1996, p. 29). Current research shows a low level of environmental knowledge in high school students of a number of different countries. Low levels of ecological knowledge were found in

an American study (n = 370) of Year 12 high school students by Bogan and Kromrey in Florida (1996). Blum (1987), an Israeli, compared five similar surveys in the USA (n = 24,493), Australia (n = 4,713), England (n = 11,009) and Israel (n = 2,029) on knowledge and beliefs of Years 9 and 10 students on environmental issues. He found "students' knowledge levels were rather poor" (p. 12) for high school students from developed countries. Low knowledge scores are seen in Australia as well as other countries. As students become active experiential learners outside the classroom, many of the traditional classroom hierarchies are modified as well as possible changes in teachers' roles. It is possible that changes in this low knowledge level could be improved with experiential education, which challenges the position of the student as a passive receiver of knowledge (Marcinkowski, 2001; Stevens & Richards, 1992).

Allison and Pomeroy (2000) investigated this issue in a theorising work, which explores issues of epistemology and ontology as these relate to research in experiential education drawing on the work of Guba and Lincoln (1994). This work provides a language for considering epistemological and ontological issues, while using a unique matrix for comparing philosophical approaches to research. Their research found individual meanings for experiences is somehow being lost in the course of educational research; consequently, "a shift in the epistemological paradigm may be required" (Allison & Pomeroy, 2000, p. 97). However, in surveying literature on high school students, it became evident that the learners' experiences are only being represented in a very limited way in empirical research (Rickinson, 2001). The use of additional research methods provides a means for student experiences to be illuminated. A combination of both quantitative and qualitative methods provides more "support for multimethod, multivariate, and comparative research approaches" (Roberts & Yerkes, 2000, p. 61). Thus, to an increasing extent, evaluation of experiential education programs "is conducted with a mixture of quantitative and qualitative methods, mixing aggregate data gathered in statistically sound ways with narrative and descriptive data gathered through interviews, focus groups, and observation" (Albert, et al., 1998, p. 9). Evaluation of experiential education techniques is therefore highly applicable to this marine education research concerning high school learning and reef experience in Queensland coastal communities.

2.4 Marine Education

Although the ocean and its processes have been studied throughout history, formal marine education is a recent phenomenon that emerged from philosophical realignments of curriculum in the latter part of the 20th century. During the 1970s, interest in teaching and learning about the world of water increased noticeably in the USA (Fortner, 1991a). Simultaneously, there was growing interest in marine education in Australia (Moffatt, 1997) and in the late 1970s and early 1980s the foundation for marine studies in Australia was laid. Fortner (1991a) defined marine education as that part of the total educational process that enables people to develop sensitivity to and a general understanding of the role of the seas in human affairs and the impact of society on the marine and aquatic environments. For the purposes of this research, marine education refers to education that relates to the ocean, coastal waters and human relations to these environments. The 1997 USA Potomac Declaration concluded that continuing intensification of human activity in coastal and marine areas will adversely affect marine and coastal ecosystems worldwide and threatened the well-being of the human population (National Oceanic and Atmospheric Administration, 1998). The purpose of marine education is to develop greater understanding of the seas (Crossland, 2002; Day, 2003; Fortner, 1991b; Keener-Chavis, 2001; Queensland Studies Authority, 2005a; Siemer, 2001; Tilmant, 2000; Wolfenden, 1995), as what happens in and to the sea affects the day-to-day lives of everyone on the planet. The literature concerning marine education is fragmented to some degree, but I discuss here the key literature I used to develop my theoretical understanding.

Marine education is seen as an integral part of reef protection support (Tilmant, 2000). Formal marine education refers to that carried out at schools, colleges and universities (Fortner & Wildman, 1980). The implementation of marine studies curricula in schools has been difficult, as the ocean sciences are interdisciplinary by nature. Incentives are needed to be put in place to encourage collaboration between faculties (Keener-Chavis, 2001; Salter & Hearn, 1996), or the creation of specialist subjects for study – as is now the case in Queensland high schools (Queensland Studies Authority, 2005a; Moffatt, 1997). In Australia, the Marine Education Society of Australasia (2004) approached the problem by designing an integrated education curriculum for teachers with a marine focus spanning a number of subjects for both primary and secondary education. A few marine studies courses appeared in Queensland during the 1970s and 1980s, but most concentrated on activities such as gaining boat

licences, snorkelling and SCUBA skills (Moffatt, 1997).

Marine Studies as a formal senior secondary subject, has been taught in Queensland schools since 1989 (Queensland Studies Authority, 2005c), and in 2004, there were 60 high schools in the state offering a marine education program (Kenman, 2005). Even though sometimes difficult to implement, marine education in its many aspects, including scientific, historical, artistic and political, has the potential to enlighten and enliven standard curriculum and assist in increased ocean ecological awareness for an informed citizenry (Fortner & Teates, 1980). Over the last 30 years human impact on coral reefs has increased to the extent that the very existence of reefs is threatened (Hughes, et al., 2003). Currently, the Great Barrier Reef is under mounting ecological pressure (Great Barrier Reef Marine Park Authority, 2003). Therefore, marine education is especially relevant to the island continent of Australia, with much of its economic and social existence dependent on its population's relationship to the sea. The teaching of marine education becomes a logical focus for research in coastal reef neighbouring communities along the Great Barrier Reef.

Marine education can and does play a pivotal role in attempts to improve environmental literacy and contribute to debates on levels of sustainability for our oceans and coral reefs. Coral reefs cannot be isolated from the human communities bordering them and being used by them (Talbot 1995). Nevertheless, marine education programs have evolved in a relatively haphazard manner as part of a larger movement that has been influential for several decades under the various titles of conservation education, outdoor education, and environmental education (Fortner & Wildman, 1980) and education for sustainable development.

When a number of high schools in Australia began to teach Marine Studies, the focus was on "direct, experiential learning through various 'hands on' projects", as promoted by Knapp (1999, p. 74), even though his original work was not in marine education. As Marine Studies is increasingly popular in Queensland high schools, the question arises as to whether the students have been taught well. A Queensland Education evaluation report was completed in 2004 (Queensland Studies Authority, 2005c) on the effectiveness of the Marine Studies Trial-Pilot Senior Syllabus 2002-2003 as teachers developed work programs and implemented the course. The report found that while teachers and students felt the syllabus was appropriate and clear, the subject is physically demanding and difficult to teach. There are inconsistencies in teacher qualifications, and because the subject's teacher population is ageing "sufficient staff

may not be available in the future" (Queensland Studies Authority, 2005c, p. 10). One area not addressed in this evaluation is learning outcomes. Neither environmental attitudes nor situational learning relationships were investigated, even though they were designated as aims of the program. The question of learning outcomes does have significance due to Queensland schools now teaching Marine Studies, as the future of our oceans depends on the environmental values and ethics of the people of Australia (Moffatt, 1997).

2.4.1 Interdisciplinary Issues in Queensland Marine Education

When examining marine education in high schools, it is important to look at the curricular structure in the secondary education system. While marine education can be seen as interdisciplinary in nature, this does not necessarily translate into comprehensive marine programs across curriculum. Rather, marine education became located as discrete subjects in the 1980s due to the institutional barriers imposed by syllabuses, assessments, senior assessment authorities and timetabling (Fien, Yencken, Connell & Sykes, 2002; Fortner & Wildman, 1980). In Australia, the introduction of the Secondary Transition Education Project (STEP) in the early 1980s helped introduce marine studies programs into mainstream curricula and included gaining boat operation licences, snorkelling and SCUBA certification, and radio operators licences from Technical and Further Education (TAFE) institutions (Moffatt, 1997). What has proved to be more acceptable to teachers over the years is an instructional module that treats standard curriculum topics in a new way (Marine Education Society of Australasia, 2004). A prime example of this is the Reef Guardian School Participation program designed by the Great Barrier Reef Marine Park Authority (GBRMPA), which supplies designed curricula on their website. The Reef Guardian framework uses oceanic or reef related examples of teaching situations to advance the pedagogy of the living marine ecology concept. It presents a comprehensive marine educational program to teachers and schools, but being a recent innovation, there is no research available concerning how it has been integrated across the disciplines. The Reef Guardian project has advanced the teaching of marine studies, particularly in primary schools, but has not overcome the interdisciplinary problem as high schools hold firmly to separate disciplines (Fortner, 1991a; A. Gough, 1997; Whitehouse, 2001). The ongoing problem is that it is difficult to integrate marine education into education systems that are not designed to address interdisciplinary issues (Robottom & Sauvé, 2003). The creation of distinct Marine

Studies curriculum in Queensland does represent an innovation on an international scale, created as it has been within a disciplinary senior school structure.

2.4.2 Background Information for Marine Education in Queensland

Marine education has a history in Australia since the 1970s. It was initiated by a number of marine teachers throughout the country (Moffat, 1997) and has grown even though the support from the formal education system was weak, and formal marine education teacher training at any Australian university institution is non-existent. The curriculum of individual school subjects relies heavily on individual teacher motivation. Moffatt has described marine teachers as a group of "innovators, [that] have developed a subject that is worthy of national recognition" (p. 196). A formal organisation called the Marine Teachers Association of Queensland (MTAQ) was founded in 1993 as a support and guidance to marine education teachers and to coordinate their activities (Moffatt, 1997). It has many principal goals, which are enumerated on its website. These include promoting fellowship and training amongst teachers through: in-service and training courses, annual conferences, policy development, coordination and communication, and conducting regional events in support of local teachers and marine education. Some of these events are the Marine Olympics, Seaweek, Ocean Care Day, National Water Week, and World Water Day (Marine Teachers Association of Queensland, 2004). The members attend annual conferences at different sites along the Queensland coast. New information is disseminated and support is available to new and experienced member teachers from a number of sources. Other sources of curriculum information for Queensland teachers are The National Oceans Office, the Queensland Government: Environmental Protection Agency/Queensland Parks and Wildlife Service, Commonwealth Science and Industrial Research Organisation (CSIRO) and United Nations Educational, Scientific and Cultural Organization (UNESCO). Teacher information is also supplied by the Marine Teachers Association of Queensland (Marine Teachers Association of Queensland, 2004), augmented by the Great Barrier Reef Marine Park Authority Reef Ed Program and the Marine Education Society of Association of Australasia.

Reef Ed (Byrnes, et al., 1988) was developed as the reef education arm of Great Barrier Reef Marine Park Authority (GBRMPA) and Reef HQ (the GBRMPA Aquarium in Townsville). Formal education support through Reef Ed was initiated in the early 1990s, followed by the introduction of the Reef Guardian program for schools

in 2003, which has enrolled over 200 schools in the state. Reef HQ's aim is to assist students to develop the knowledge and skills, attitudes, and patterns of behaviour which will enable them to contribute to an ecologically sustainable Great Barrier Reef (Duncan, 1998). This resource has been developed to assist students to:

- develop an appreciation of the diversity and the fragility of the Great Barrier Reef;
- understand the interrelationship between the Great Barrier Reef and society;
- adopt ecologically sustainable lifestyles;
- take action for the Great Barrier Reef (Great Barrier Reef Marine Park Authority, 2006).

GBRMPA supplies education resources are designed and delivered for integration into Queensland Key Learning Areas of Studies of Society and Environment (SOSE), Science, English, Technology and the Arts.

The Marine Education Society of Australasia was formed in 1985. The Marine Education Society of Australasia was taken under the umbrella of GBRMPA in the mid-1990s. Its members are teachers and government employees (Moffatt, 1997) as well as educational administrative staff. The Marine Education Society of Australasia provides curricular support for marine education programs, and promotes the Coastal and Marine Schools Project as part of the Commonwealth Government Coastal and Marine Programme (CGC&MP). The aims of the CGC&MP are to extend and develop curricula and professional development programs for teachers from Kindergarten to Year 12, and to provide the latest research information to schools as well as the general community, media, industry and recreational groups (Marine Education Society of Australasia, 2004). Examples of success in this area are Seaweek (a national annual event to focus awareness and encourage appreciation of the sea), state organised competitions between schools, providing teacher resources, networks to address specific new government legislation and teacher qualifications, yearly conferences held to update members on new teaching techniques, distributing curriculum materials and promoting the need for conservation and management of the sea (Moffatt, 1997). The formal school system is tacitly behind these innovations for curriculum and teacher support, but there is always a need for more formalised support for teachers and their programs.

In Queensland, Marine Studies subjects are developed for the senior secondary

level, by the Queensland Studies Authority, and are chosen by students who take a Marine Studies subject as part of a senior schooling program. This interest may lead to a future career or employment in a marine area. In the Evaluation of the Marine Studies Trial-pilot Senior Syllabus 2002-2003, of the 243 students surveyed, 59 wanted to continue study in the marine area, 57 did not and 127 were unsure (Kenman, 2005). Marine education programs are divided into two streams. One stream called Marine Studies is a Queensland Studies Authority board subject and part of OP eligible science, where a high percentage of marine studies courses are selected in conjunction with more academic science courses appropriate for university entry (Queensland Studies Authority, 2005c). The other stream, Marine & Aquatic Practices, follows the vocational path preparing students for jobs in ocean-oriented ecotourism or similar (Moffatt, 1997) and is a substantial step forward in terms of training (certificate 1). Both streams of Australian marine studies encourage the learning of participatory action skills (Hossack, 1997; Marine Education Society of Australasia, 2004; Moffatt, 1997). Moffat (1997) suggests a very high percentage of the marine teachers are from related fields, but few received formal training in marine education per se, though many have training in marine biology or marine engineering.

It is important to note that “Australia is leading the way” (Sullivan, 2002, p. 1) in developing cohesive and coherent policies for sustainably managing marine resources. One of the goals of Australia’s 1998 *Oceans Policy* is to develop community understanding of the oceans (Herr & Haward, 2001). While significant research knowledge about the marine environments is building, educational research that focuses on student learning is scarce. In particular, the role of experiential education in marine environments in Australia has not been the focus of research attention until recently. This absence of research is addressed in this PhD project, and in the next section, I discuss relevant research literature concerning adolescent learning and the knowledge, attitude and action relationship.

2.5 The Knowledge (Awareness)-Attitude-Action Relationship

2.5.1 Australian Research

Research in Australia concerning environmental knowledge and learning was initiated by Eyers in 1975. This doctoral study (n = 4713) addressed environmental knowledge and beliefs among tenth grade students, and was included in Blum’s (1987) four-nation review on knowledge and beliefs of students on environmental issues. The

Blum review reported that Australian boys had higher environmental knowledge than girls, and students' beliefs tended to be stronger than their factual and conceptual knowledge. There was a significant gender difference in environmental knowledge, but not in environmental attitudes with girls scoring higher than boys in half of the belief (attitude) items. School was a less common source of environmental knowledge than mass media and no differences between different school systems were observed. Blum concluded, "schools have much to do to improve the knowledge base" (p. 13) because of the low knowledge scores.

There are only four additional significant Australian studies of school children, which address various aspects of the environmental knowledge, attitudes and intention to act relationship. These studies followed the publication of Blum's (1987) paper, and were not entirely focused on students from years 10 and 11. Two additional studies of university students are also addressed. All these studies are relevant here because of the relative paucity of Australian research in the area of adolescent environmental knowledge.

One study of Year 11 students (n = 148) at a secondary school in Queensland measured students' environmental knowledge and attitudes both factual and conceptual (Clarke, 1996). Respondents' scores were low on environmental knowledge and positive environmental attitudes. The students' gender and academic orientation were not statistically related to either attitude or knowledge scores, but females were moderately more committed to the environment. The Connell, Fien, Sykes and Yencken (1998) study also surveyed Year 11 high school students, but these were from Melbourne and Brisbane (n=5688). This study focused on beliefs, knowledge, commitment and educational implications. The student respondents identified protection of the environment as the most important problem in Australia and strongly supported belief systems characteristic of support for an environmental paradigm. However, the majority displayed relatively low levels of knowledge concerning key environmental action-taking skills. The average score on the environmental knowledge test was 5 out of 10. Gender differences led the authors to conclude "women are more environmentally conscious than men" (p. 45). The authors concluded, "there is a paucity of research ... since only a handful of studies have examined the environmental attitudes of school-age Australians" (p. 39). With respect to environmental knowledge, a study by Skamp, Boyes and Stanisstreet (2003), of Year 10 students in New South Wales (n $\approx$ 250), concluded Australian secondary students have gaps in their environmental

knowledge. Skamp et al. also found students believed “others, not themselves, needed to change their attitudes and lifestyles in order to improve environmental quality” (p. 18).

A small education study by Whitehouse (2001) investigated the discourses of environmental activism in regional Queensland. This paper looked at the social risks of environmental activism in the school as discussed in the narratives of two young women and a school principal who undertook environmental projects in their schools. The study (n = 3), with two students (Year 10, age 15) and one principal (age 42), documented the complex social negotiations people are forced to undertake in response to being negatively constituted as “greenie” at school. The students met resistance from their peers and family and the principal fielded complaints from members of the local school community. This micro-qualitative analysis shows that, despite the implementation of environmental education, assuming an environmental identity at school can be problematic and difficult to enact. Environmental action is not seen as “cool” in some adolescent peer groups, nor, is “environmental action central to the legitimate practices of schooling in some communities” (p. 71). The study suggests that successful projects rely on people who are willing to actively, and persistently, negotiate social opposition in order to achieve an ecological vision for their schools.

An environmental concern study by Schaper (2002) evaluated nationality, gender and age amongst business school students (n = 200) from Australia, France and Singapore. This study found no statistically significant link between gender and environmental concern, and “whatever the level of a student’s environmental concern, such scores do not automatically translate into environmentally friendly behaviour” (p. 74). Results from the Lenzen, Dey and Murray (2002) study of New South Wales second and third year university students ($n \approx 90$) stated that “individual awareness and concern are a prerequisite for, but do not necessarily lead to changes toward more sustainable lifestyles” (p. 42). The above studies addressed one or two elements of the environmental knowledge, attitudes or ecological action relationship.

Present research indicates continued low levels of testable environmental knowledge among Australian students that has been consistent with past research results. Research by Blum (1987), Clarke (1996), Connell et al. (1998), and Skamp et al. (2003) showed low levels of environmental knowledge for Australian high school students. Environmental knowledge scores for Australian students were shown to be low in the 1970s (Eyers, 1975). Twenty years ago, Robottom (1985) argued the current

formal education system must be evaluated from differing perspectives to ensure the best educational outcomes possible for high school students that reflect holistic real world needs. Has this been accomplished? The relationship between knowledge, attitudes and action has been investigated in only two Australian studies, and these were Blaikie (1992, 1993) in Melbourne, and Walker and Loughland (2003) in New South Wales.

The Blaikie (1992, 1993) student sample was comprised of Royal Melbourne Institute of Technology (RMIT) tertiary students and residents of Melbourne ($n \approx 4000$), and investigated the nature, origins and levels of commitment to ecological attitudes with respect to gender, age and responsible behaviour. The study found a strong association between commitment to environmental attitudes and "levels of environmentally responsible behaviour" (p. 16). Women were shown to hold only marginally more positive environmental attitudes than men.

Walker and Loughland (2003) designed an environmental education research project concerning the socio-cultural influences on environmental understandings of Australian school students in response to Rickinson's (2001) review. This study ($n = 2238$) of primary and secondary students in Australia investigated socio-cultural influences on environmental understanding. This study of Years 3, 6, 8 and 11 evaluated the students' environmental knowledge, attitudes and behaviours as well as their experiences of learning. The authors argued that even though the aims of environmental education are well documented, and there is agreement that environmental education in schools is an important strategy in achieving environment improvement, little is known about the environment understandings held by children. Their study sought to provide data on the environment understanding of young people. The authors reported knowledge on environmental issues to be inconsistent, and no significant differences between males and females in knowledge scores were found. The media, such as news and nature documentaries, were the prime source of environmental information. And most secondary school students felt environmental quality will get worse. The methodology combined qualitative and quantitative research methods. Walker and Loughland noted "the practice of environmental education in Australian schools ... continues to be marginalized in the school curriculum" (Walker & Loughland, 2003, p. 227).

This is supported earlier commentary by A. Gough (1997), who argued that to improve environmental knowledge, environmental education must be treated as an

integrated aspect of curricula and be more consistently and coherently taught in schools. Robottom and Sauvé (2003) claim teaching and learning pedagogies have become relatively static, with curriculum and textbooks storing predefined values making the system hard to change. These Australian studies mentioned in this section of the literature review provide a foundational basis concerning environmental knowledge, attitudes and actions that are expanded upon in this thesis.

2.5.2 International Research

Given the scarcity of education research addressing the environmental knowledge, attitude and ecological action relationship in Australia, I looked to international studies and reviewed four American, one English and two Canadian research papers. Hines et al. (1986/1987) took on the challenge to determine which variable or variables are most influential in motivating individuals to take up responsible environmental action in a meta-analysis of 128 studies of environmental behaviour research from 1971. The following variables were found to be associated with responsible environmental behaviour: knowledge of issues, knowledge of action strategies, locus of control, attitudes, verbal commitment, and an individual's sense of responsibility. A slightly stronger relationship was detected between attitude toward action and environmental behaviour ($r = 0.377$, $sd = 0.145$) than was observed between attitude toward the environment in general and environmental behaviour ($r = 0.338$, $sd = 0.243$). Thus, "the research indicated that both of these types of attitudes were related to behavior in an environmental context" (p. 4).

An insightful review of the literature was completed by Newhouse (1990) in Canada, which discussed implications of attitude and behaviour research for environmental conservation. The author formed the question whether or not there are implications from attitude and behavior research for environmental conservation. She clearly defined the ecological crisis not "as a technical problem but as a crisis of maladaptive behavior. It has long been recognized that the root of environmental problems is human behavior" (p. 26). She notes "it is crucial that attitude and behavior research be applied in the design of educational programs" (p. 26). This research project utilises social psychology theories to directly investigate student attitude and related actions within marine education research.

The author examined the determinants of responsible environmental behaviour from Hines et al. (1986/1987) and Hungerford & Volk (1990), and incorporates

psychological aspects by also examining social psychology that examined the attitude-behaviour discrepancy problem with respect to direct experience (Fazio & Zanna, 1978; Millar & Millar, 1996; Rajecki, 1982) as well as the normative influence theories of Ajzen and Fishbein (1980), and concluded "the recognized discrepancy between attitude and behavior in many studies, the discrepancy may partially be the result of poor research design and confounding factors, such as social norms" (p. 31). A widely accepted model for teaching in environmental education is described as the practice of increasing knowledge leading to favourable attitudes which in turn leads to action promoting better environmental quality, but "research into environmental behavior, unfortunately, does not bear out the validity of these linear models for changing behavior" (p. 9). Knowledge of ecology was listed as an important variable in the process of promoting responsible behaviour since "it is almost always a prerequisite to sound decisions regarding solutions to issues" (p. 11), but "the research would indicate that knowledge of ecology does not, in itself, produce environmental behavior" (p. 11).

This in depth review and analysis was extremely useful for this research study. It contributes to understanding the problem of my study, since it discusses the knowledge, attitude, action relationship, as well as the effect of direct experience. The experimental design of my research tests a number of the hypotheses posed by Newhouse (1990), such as "that most environmental attitudes are formed as a result of life experiences" (p. 28) and "direct experience with an object is also believed to result in more attitude-behavior consistency than indirect experience" (p. 27), and it examines the claim that "evidence that attitudes lead to appropriate behaviors or actions is not strong" (p. 27).

Critics have argued that few environmental education "interventions actually encourage responsible environmental behaviour because they do not actively involve students in environmental issues" (Zelezny, 1999, p. 5). A meta-analysis by Zelezny concerned educational interventions that improve environmental behaviours and evaluated 18 educational interventions conducted in classrooms and in non-traditional settings. Educational interventions were defined as planned strategies that provided information and/or training to modify or achieve a predicted proenvironmental outcome (p. 6). The four aims of Zelezny's analysis were to: 1) summarise educational interventions on proenvironmental behaviour in classroom and non-traditional settings, 2) compare the effects of educational interventions on proenvironmental behaviour on the basis of quantitative estimates, 3) look for trends in intervention effectiveness as related to active participant involvement, and 4) to evaluate the research methods of

environmental education studies that aimed to improve environmental behaviour in the psychological and educational literature from 1971 to 1996, and identify published studies related to the effect of educational interventions on proenvironmental behaviour. The limitations were that not all the studies were of equal quality, self-reported measures of behaviour were used rather than observed behaviour. Meta-analysis is powerful but has drawbacks because of the quality of the journals and validity of study subjects, methods and measures.

Analysis found that educational interventions can effectively improve environmental behaviour. Active participant involvement was positively related to the effectiveness of improving environmental behaviour, and non-traditional interventions were less effective in improving environmental behaviour than classroom interventions, however, the non-traditional interventions usually involved adult participants and consisted of shorter-term programs with no active participant involvement. The meta-analysis found that various indexes of attitude strength "were found to correlate differentially with education and gender" (Zelezny, 1999, p. 10), which challenged the idea "that attitude strength is a unitary construct" (p. 10). The average treatment effect for classroom interventions was $r = .65$ and the interventions in non-traditional settings was $r = .27$ for proenvironmental behaviour. Interventions were defined as "planned strategies that provided information and/or training to modify or achieve a predicted proenvironmental outcome" (p. 6). It was found that interventions that change proenvironmental behaviour presented credible information and actively involved participants.

Zelezny noted that a limited number of "studies measured actual behaviour, and quite often poor research methods were used" (p. 5). The article did not stipulate these poor research methods, so it is difficult to ensure not reproducing them in my study. It was also noted that intervention effectiveness was greatest for participants who were 18 years or younger, and the most effective interventions lasted 10 hours or more and this was relevant to my study.

An evaluation completed in Canada the same year by Hart and Nolan (1999) considered views about what constitutes legitimate research in environmental education and how these are shaping and reshaping research methods. This critical analysis considered more than 40 journal articles and doctoral dissertations. An interpretive (narrative) and critical (feminist) qualitative research design examined relationships between cognitive, affective and behavioural variables were examined, and "in almost

every case, the environment-related experience was found to have a positive effect on knowledge, attitude and predisposition to action or responsible environmental behaviour" (p. 7). Race, class, gender and ethnic background were shown to shape environmental values and perspectives, and "several studies reported that, in general, knowledge levels about the environment and/or environmental issues were low among secondary school students" (p. 7). One key finding was that positive change in environmental attitudes came after exposure to some form of short or long-term environmental education experience. While positive attitudes about the environment appeared to be increasing, there was very little understanding about what this means.

An American overview of literature presented by Marcinkowski (2001) addressed an issue and action instruction program for stewardship education. It was written as a chapter in an edited book (Fedler, 2001) concerning best practices in boating, fishing, and stewardship education for the American Recreational Boating and Fishing Foundation.

> The most popular program theory operating in EE [Environmental Education] and, quite possibly ARE [Aquatic Resource Education], is known as the knowledge-attitude-behavior (K-A-B) model. The kinds of behavior (B) of interest here are the wide range of stewardship behaviors that are collectively known as Responsible Environmental Behavior (REB). Unfortunately, the growing body of research about REB both within and outside the field of EE clearly demonstrates that this is an overly simplistic model: the K-A-B relationships are neither direct nor linear, and there are more variables and phases involved in the process of forming or shaping REB. (Marcinkowski, 2001, pp. 110-111)

The Rickinson (2001) environmental education research review from the UK about learners and learning is a critical review of the evidence. It examined empirical studies on learners in primary or secondary school environmental education published between 1993 and 1999. This review used systematic, comprehensive and analytical methods, and the findings were based on examination of over 100 journal articles, books and reports, published between 1993 and 1999. The author states the current evidence based on learners and learning can be understood in terms of six nodes or applications of evidence. These include the areas of student (1) environmental knowledge, (2) environmental attitudes and behaviours, (3) environmental learning outcomes, (4) perceptions of nature, (5) experiences of learning, and (6) influences on

adults. Rickinson's comprehensive analysis of the field of environmental education research highlighted its diverse nature and rapidly expanding size. Many studies, which focused on the knowledge, attitude and action relationship were quantitative in nature and positivist in foundation, and were found to be fractured and unfocused with respect to methodologies and related outcomes. Previous shortcomings overlook the students who are the subjects of environmental education research. One weakness of research to that point was that researchers have disregarded "the children who are the subjects of environmental education" (Payne, 1998, p. 20). Efforts to deal with such deficiencies need to be informed by a thorough and grounded appreciation of what studies have been undertaken concerning students and learning.

Past research reveals more about environmental knowledge and attitudes than about students' educational experience and preferences, and more about learning outcomes than learning processes. This research and evidence base is not static and is continually developing and changing as new foci emerge on learners and what learning is. These changes and introductions bring with them new and different methodological and conceptual approaches. The Hart and Nolan (1999) review identifies issues and challenges, as a case is made for studies focused more explicitly on learning and the role learners play within this process. Rickinson (2001), too, makes a strong case for future studies focused on learning, learners, and their experiences.

Studies from the field of environmental social psychology, such as Kaiser et al. (1999) used techniques of environmental psychology research to investigate the relationship between environmental attitude and ecological behaviour. The study was based on Ajzen's (1988) theory of planned behaviour, which has been shown to be useful in predicting ecological behaviour or action.

The Kaiser et al. (1999) study established environmental attitude as a powerful predictor of ecological behaviour. This study (n = 1643) employed a unified concept of attitude and a probabilistic measurement approach which investigated two environmental attitude types predicting ecological behaviour. These categories, as described by Hines et al. (1986/1987), were (1) attitudes toward the environment, and (2) attitudes toward ecological behaviour. In the Kaiser et al. study, questionnaire data from members of two different Swiss automobile associations were collected to investigate three measures of orthogonal dimensions by means of factor analysis: (1) environmental knowledge, (2) environmental values, and (3) ecological behaviour intention. Two flaws of much research were "the lack of measurement correspondence

and the lack of consideration of situational influences" (Kaiser, et al., 1999, p. 1). An attitude/action (behaviour) relationship was evaluated in my own study, where sincere attempts were made to consider the situational influences and address measurement correspondence.

Dependent variables of knowledge, attitude and intention to act were investigated, and these variables are used in my study. Kaiser et al. found that factual knowledge

> about the environment is a precondition of one's environmental attitude, this knowledge should not be related with ecological behaviour strongly because its influence is attenuated both by environmental attitude and ecological behaviour intention. Hence it is not surprising that several studies found either no relationship between factual environmental knowledge and ecological behaviour, or at best a moderate relationship. (p. 4)

The relationship between environmental attitude and ecological behaviour is shown to be weak in a number of studies considered by Kaiser et al. (1999). As Hines et al. (1986/1987, p. 7) noted, "the relationship between environmental attitude and ecological behaviour may be affected by influences beyond people's volitional control." The Kaiser et al. study does not directly address student learning in formal education institutions, but is appropriate for my work, since it discussed the theories utilised in the measurement of the environmental knowledge, attitude and intention to act variables used in my study. My quantitative research design was based on many theories raised by the Kaiser et al. study. Factual knowledge "measures the cognitive aspects, and verbal commitment measures the behaviour intention component of environmental attitude" (p. 2). Since the "behaviour *intention* to perform the behaviour in question is the immediate antecedent of overt behaviour" (p. 3), it can be used to imply behaviour or action in a non-longitudinal study. This previous work allowed for the use of intention to act as a variable to be measured for change between the beginning of the project and six weeks later.

My research addresses the two Kaiser et al. noted flaws affecting the attitude-behaviour relationship. The flaw of lack of measurement correspondence is addressed by measuring the appropriate facets of correspondence between the different variables of knowledge, attitude and action intention. The flaw of lack of consideration of situational influences was addressed in my study by providing similar situations in coral

reef and classroom environments within a quasi-experimental research design and implementation of prescribed educational interventions.

More recently, Frick, Kaiser and Wilson (2004), argued knowledge is commonly seen as a necessary precondition for a person's behaviour. However, in education, it is necessary to identify the types of knowledge that affect behaviour in order to be able to investigate them further. In randomly surveying Swiss adults (n = 2736), it was found that types of knowledge have differential influence on conservation behaviour. Action-related and effectiveness knowledge had a direct effect on performance, while system knowledge had less, and exerted a mediated influence by strongly affecting the other two types of knowledge. "Strictly speaking, before a person can act, he or she must have some understanding of the natural states of ecosystems and the processes within them (system knowledge) as well as know what can be done about environmental problems (action-related knowledge)" (p. 4).

Eisler, Eisler and Yoshida (2003) examined cultural and gender influences on attitudes, beliefs, opinions, levels of knowledge about nature and the environment, and behaviour affecting the environment (n = 1317). University students (age 18-43) from Japan, Germany, Sweden, and the United States completed a seven component survey scale. The study found environmental knowledge was low, and there were cultural and gender differences across the cultures as well as within cultures. "Compared with male subjects, female subjects across countries perceived the risk factors as more serious as regards ecological and environmental problems. Male subjects showed higher environmental knowledge, whereas females showed higher motivation for ecological thinking and behavior" (p. 89). A Taiwanese study of university students (n = 121) conducted by Hsu (2004), assessed changes in responsible environmental behaviour by use of pre-test and post-test surveys, followed with statistical analysis of the student responses over a 16-week environmental education program. The program successfully and significantly promoted students' intention to act, perceived knowledge of environmental issues, and perceived knowledge of and skills in using environmental action strategies. These tested effects were shown to be maintained for 2 months after the conclusion of the program. Formal environmental education can effectively promote responsible environmentalism. However, Hsu concluded "environmental educators cannot assume that several years of formal education will ensure that students gain all knowledge and skills needed for environmental literacy and continue to retain them after graduation" (p. 46).

Turning our attention to secondary school students, the Dutch National Assessment Program of environmental knowledge, environmental attitudes, and environmentally responsible behaviour evaluated a sample of more than 9,000 students (average age 15 years) from 206 secondary schools. Environmental knowledge was found to be fragmentary and sometimes incorrect (Kuhlemeier, Van Den Bergh & Lagerweij, 1999) even though 57% of these students held positive environmental attitudes. This study showed the relationship between environmental knowledge and actions can be very weak. Interestingly, there was a significant correlation between positive environmental attitude and environmentally responsible behaviour. The question posed by the researchers is whether "students who know a lot about the environment have a positive attitude toward it and are likely to behave in an environmentally responsible manner" (p. 4). Even though the relation between environmental knowledge, environmental attitudes and behaviour was found to be very weak, Kuhlemeier et al. found a more substantial relation between environmental attitude and behaviour. The authors argue "insight into the interaction between humans and the environment and into the mechanisms that underlie environmental problems is an extremely complex subject that may be viewed from various perspectives and disciplines" (pp. 5-6).

Two American high school studies were undertaken by Gambro and Switzky (1996) and Bradley, Waliczek and Zajiicek (1999). Gambro & Switzky tested the environmental knowledge of 1870 American high school students to reveal low levels of environmental knowledge (a consistent finding across many educational studies), where knowledge is "defined as a student's ability to understand and evaluate the impact of society on the ecosystem" (p. 29). A majority of the students were able to recognise basic environmental problems, however, most could not apply their knowledge to comprehend the consequences or potential solutions. Little growth in environmental knowledge occurred from the 10th to 12th grade. Bradley et al. evaluated students' (n = 475) environmental knowledge and attitudes from a questionnaire administered before and after exposure to a 10-day environmental science course. Students' environmental knowledge scores increased by 22% and environmental attitudes became more favourable. The authors remarked "it is encouraging for educators to learn that attitude can be influenced, at least in part, by what is taught in the classroom" (p. 18). A statistically significant correlation was found between higher knowledge scores and attitude scores. In gender related issues, "males tend to possess

better technical and environmental knowledge, whereas females tend to possess stronger environmental feelings and a greater concern for the environment" (p. 18).

It is timely to investigate developing new educational techniques that promote learning by the "development of a relationship between people and the environment" (Fien, 2003, p. 6). While there is a diversity of findings about knowledge, attitude, and action toward environmental issues in different contexts, a strong argument can be made for researching experiential education as a means of improving students' learning in reef environments and how education can affect attitudes and ecological intention to act.

2.5.3 Attitudinal Studies in Marine Education

Ewert and Galloway (2004), European researchers Kaiser et al. (1999) and the Australian researcher Kurz (2002), suggest that almost two-thirds of all environmental-psychology publications include the notion of environmental attitude in one form or another. However, the literature on awareness (knowledge), attitudes and action in marine environmental education is quite scarce. In an investigation of randomly selected Floridians' attitudes about the environment and coastal marine resources (n = 17,632) by Milon, Adams and Carter (1998), the researchers found a majority of subjects indicated a high level of environmental concern. The individuals who expressed the highest levels "were female, non-Black, either a Democrat or an independent, or a contributor to an environmental group" (p. vi). Most interestingly, "the level of participation in saltwater recreation activities was consistently related to concern about coastal marine resources" (p. vii).

Four early reports on marine education awareness assessments were mentioned by Fortner and Wildman (1980). These were Fortner (1978), Howe and Price (1976), Leek (1979), and Needham, (1975). Needham, in an unpublished dissertation, tested Samoan marine education students and demonstrated substantially improved attitudes with marine education. Work done by Leek with Ohio students in grades 4, 8, and 11 showed moderate changes in mean scores on knowledge surveys with increased marine education. The Howe and Price study tested both attitude and awareness as pertaining to marine related subjects and found that high school students had relatively little knowledge of marine issues but expressed positive attitudes toward the environment. A Virginian marine education PhD study of coastal and inland tenth grade students (n = 787) undertaken by Fortner (1978) addressed the problem of identifying the "major sources of marine knowledge and attitudes with the idea that educators could then

maximise the positive effects of those sources" (Fortner & Wildman, 1980, p. 721). This study related oceanic knowledge and attitudes to marine experiences. Students were randomly selected from schools in Virginia and the analysis revealed a low state-wide oceanic knowledge level, and that males outscored females on the knowledge tests. A substantial linear relationship between marine knowledge and attitudes was shown to exist and white males who lived on the coast had the highest level of marine awareness for the sample (Fortner & Teates, 1980). Walter and Lien (1985) studied the attitudes of Canadian Year 5 (n = 1906) and Year 9 (n = 1984) students and found student knowledge levels were generally low and that students held utilitarian values concerning the ocean. The students in this study learned "most about oceans from television and direct experience with the sea" (p. 6), and those who were "taught about the sea in school and were taken on field trips to either the ocean or an aquatic area did show higher knowledge levels" (p. 6).

Fortner (1978, 1983) investigated the relationship between aquatic experiences, knowledge and attitudes scores among grades 5, 9 and 10 American school students tested in Ohio and Virginia. Her survey indicated, "high knowledge scores were accompanied by more positive attitudes about the oceans and other water environments" (1983, p. 8). The students regarded the entertainment media, such as TV nature documentaries, as the source of much of their knowledge about the world of water. Fortner found related experiences such as swimming and reading *National Geographic* and *National Wildlife* magazines improved knowledge, and that marine and aquatic experiences had a positive effect on aquatic knowledge and attitudes. However, Fortner cautions that this does not indicate that learning more about the world of water or experiencing it more frequently will necessarily foster more positive attitudes, because her survey methodology could not demonstrate cause and effect relationships.

In an unpublished experimental masters research project conducted in Hawaii with Year 8 students (n = 17), Stepath (1997) found a positive though statistically non-significant relationship between marine experiences, knowledge and attitude, when investigating learning in the classroom and gathering data at a coral reef site over a ten-week period. Members of the class were surveyed, interviewed and asked to write personal essays to establish whether their knowledge and attitudes about coral reefs changed because of their involvement in coral reef monitoring. Teachers were also surveyed, and were similar to the students in indicating reef experience can be linked to transformations in attitude as well as knowledge.

It has been argued that the effects of the lived experience of place, and hence its capacity for generating meaning, can be applied to all types of places (Fine, 1992, p. 156). In this body of work I explore the elements of one special sort of place called a coral reef, and it is a physical arena that is termed nature. I present here an argument "that 'being in nature' provides a lens for experiencing" (Fine, 1992, p. 156) the world around us, and this experience affects our learning, attitudes and actions.

2.6 Chapter Summary

The chapter presents literature relevant to the research question about whether increased experiential learning at a coral reef produces changes in high school students' environmental knowledge, attitudes and intention to act. A survey of the literature reveals limited availability of relevant publications addressing this particular research question. Consequently, it was necessary to survey the literature more widely in environmental and experiential education to evaluate different approaches to examining the awareness (knowledge), attitude and action nexus.

This research investigates relationships of environmental knowledge, attitudes and ecological action intention, adding a direct experience component, and considers student demographics on these dependent variables. The hypotheses are that direct reef experiential learning will result in improved consistency between attitudes and participatory action outcomes. Improved student learning techniques could enhance capacities for ecological action. The following chapter describes the research model to be tested and the theoretical framework.

Chapter 3

Theoretical Framework: Methodological, epistemological and ontological approaches

> *An urgent global communication and education campaign is needed to shatter myths about the ocean's limitless ability to withstand human neglect and abuse.* (Day, 2003, p. 190)

3.1 Introduction

This theoretical foundation chapter is a short addition to the literature review, and explains how my research is modelled. As an outside researcher instead of the classroom teacher performed this study, and the research did not directly improve personal teaching skills or "form a collective self-reflective enquiry" (Kemmis, 1994, p. 42), consequently, this is not a piece of action research.

Further explained is this chapter are the research problem, the knowledge-attitude-action relationship model, the model of responsible environmental behaviour, the new ecological paradigm, and the theory of planned behaviour. From there, I developed my own conceptual model, the model of ecological intention to act (MEIA). I developed the model for this project in order to answer the research question. The model is used to investigate a relationship between environmental attitudes of high school students and ecological intention when students learn through direct reef experience. After investigating a plethora of theoretical frameworks and project designs, I decided to use a combination of both quantitative and qualitative approaches. Both sets of data inform the usefulness of the MEIA.

In a discussion about experiential education research, Roberts and Yerkes (2000) argued that research methodology should consider various concepts in experiential learning, and "we must continue to search for ways to make our research and assessment tools more relevant to the practitioner" (p. 62). I have attempted to address this issue by utilising a suitable combination of methods and ideas which then developed into a marine education specific research design, with an eventual methodology evolving through my reading and thinking. Initially I tried to incorporate several research approaches into the project, introducing several theories and ideas from varied disciplines, at the same time navigating the gaps between different fields of study such as environmental studies, social science and education. I eventually ended up at MEIA, but in this chapter will take you through the steps it took me to arrive at this

model to illuminate student learning in marine environments. The empirical investigation's theoretical framework is initially discussed, and is followed by the qualitative framework.

This research investigates high school student learning and direct experiences with coral reefs located in the Great Barrier Reef offshore from the coastal mainland of Queensland. The relevance of an awareness-attitude-action modelled relationship applied to the context of tropical marine environments drove an investigative progress. What emerged was a model to evaluate the "Three A's" that would fit with current marine studies pedagogy practices in Queensland. What I discuss in this chapter is how I came to create the MEIA for this doctoral research in marine education.

3.2 Research Problem and Related Theories

3.2.1 Research Problem

This research has been designed to establish whether marine experiential education enhances student learning in relation to a number of researchable factors. The research problem addresses whether increased experience with coral reefs along with learning about coral reefs in the classroom produces changes in Australian high school students environmental knowledge, self-reported attitudes and ecological intention to act concerning reef ecology and conservation. This was done in alignment with implementation of Marine Education Society of Australasia's (2004) Three A's of coastal and marine education. I evaluate changes in marine studies students' environmental learning outcomes toward coral reefs when visits to the reef are added to their current classroom curriculum. This is investigated by using high school students in the separate learning situations of a classroom and at the Great Barrier Reef. A standardised protocol and procedure was developed to measure environmental knowledge, attitudes and ecological intention to act. Different learning interventions and their effects on the students' environmental learning and stated willingness to participate in future reef related conservation activities is explored. The objective of this study is to establish whether or not there is a significant statistical and educational learning effect on changes in high school students' environmental knowledge as well as self-reported attitudes and ecological actions when marine experiential education is included as part of formal marine studies.

3.2.2 Knowledge-Attitude-Action Relationship Model (K-A-A)

One model I initially considered is the Traditional Learning and Behavioural Change System (knowledge-attitude-action connection) (Figure 3). This linear model is currently in use in formal aquatic education systems (Marcinkowski, 2001) and is inherent in the framework of Australia's Three A's of coastal and marine education (Marine Education Society of Australasia, 2004). When examining a learning situation, it can be problematic to explain the cognitive process of acquiring knowledge in a linear fashion. But, in this learning and behavioural change model, it

Figure 3. Traditional learning and behavioural change system (from Hines, et al., 1986/1987 and Hungerford & Volk, 1990).

is understood that once there is knowledge, attitudes will change and, hence, there will be a change in actions (Hungerford & Volk, 1990). The problem is that students are being taught knowledge (Figure 4), and consequently they become aware, but the development of altered attitudes resulting in positive environmental actions has not been shown to occur in educational research (Gigliotti, 1990; Hart & Nolan, 1999; Hines, et al., 1986/1987; Hungerford & Volk, 1990; Klein & Merritt, 1994; Kollmuss & Agyeman, 2002; Lenzen, et al., 2002; Marcinkowski, 2001; Matthews & Riley, 1995; Rickinson, 2001).

Figure 4. Modified behavioural change system, from Hungerford & Volk, 1990.

It is questionable whether moving from knowledge to action skills can be thought of as a linear relationship, and much research has been done on linear models, but there have been considerable differences in results (Kaiser, et al., 1999). This issue has not been addressed in marine education concerning coral reefs.

3.2.3 The Model of Responsible Environmental Behaviour (REB)

The model of Responsible Environmental Behaviour was proposed in 1986 (Figure 5). It was theorised by Hines et al. (1986/87) and Hungerford and Volk (1990) that before an individual can have intention to act concerning a particular environmental problem, that individual must be cognisant of the existence of the issue. Thus, it does appear that knowledge of the issue is a prerequisite for intention to act (Frick, et al., 2004; Newhouse, 1990). An individual must also possess knowledge of courses of action that will be most effective in finding solutions.

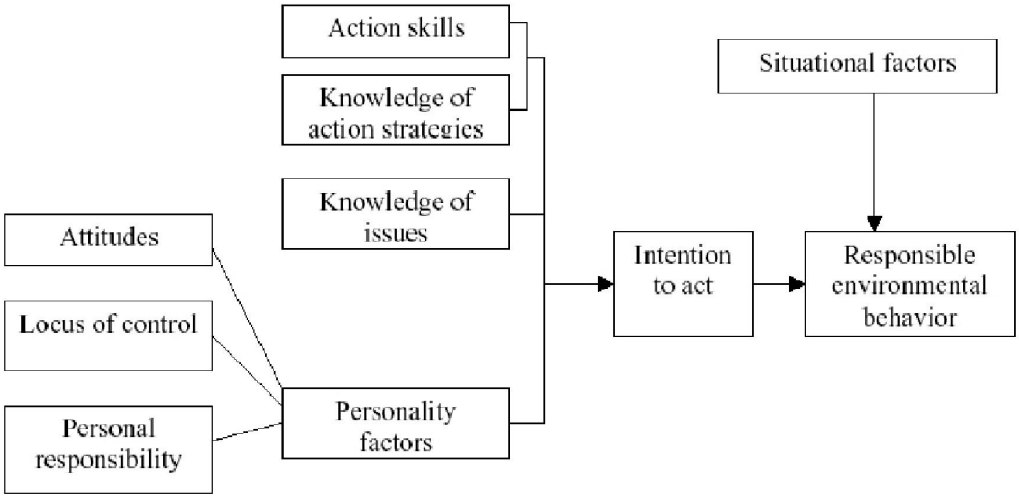

Figure 5. The model of Responsible Environmental Behaviour (from Hines, et al., 1986/1987 and Hungerford & Volk, 1990).

The Responsible Environmental Behaviour Model exposes the participant to singular learning situations, after which it is conceived that the participants will hold changed ideas because of this exposure. Hence, it is an educational situation where one is at once "informed by a set of guiding assumptions (the practitioner's theory) and informs (transforms) those guiding assumptions" (Robottom, 1991, p. 33) into an intention to act in accordance with the personality factors and other knowledge related variables. As problematic as it may seem, environmental educational research has found that knowledge does not always lead to a positive change in action, since "issue awareness does not lead to behavior in the environmental dimension" (Hungerford & Volk, 1990, p. 17) and an explanation could be situational factors as described in Figure 5. These situational factors include economic constraints, social pressures and opportunities to choose different actions. This model establishes the importance of

intention to act with respect to behaviour and becomes especially important if the knowledge (awareness)-attitude-action relationship is not linear, and participatory action or responsible environmental behaviour is a desired outcome of environmental education.

3.2.4 The New Environmental Paradigm Model (NEP)

The New Environmental Paradigm (Dunlap & Van Liere, 1978; Dunlap, Van Liere, Mertig & Jones, 2000) attempts to describe social pressure felt by individuals in society, and provides a scale for measuring environmental attitude performance along a dominant social paradigm - environmentally sensitive continuum. The paradigm is important since humans are social animals, and there has been an increased awareness of the environmental impact of human actions in many of the world's societies over the past three decades (Kurz, 2002). It is suggested that most people live either within the New Environmental Paradigm or in the Dominant Social Paradigm as described in the New Environmental Paradigm Model (Figure 6).

This NEP model proposes that one group in society believes in environmental sensitivity; there are people who support the assumption that human relationships are important with the natural environment and central to the conservation of planetary ecology. The dominant social paradigm describes another group in society who are modelled as supporting the status quo through the maintenance of existing power and financial structure, resource exploitation, economic growth orientations, consumptive materialistic action by citizens, and often operate with little concern for nature's welfare (Blaikie, 1992; Dunlap & Van Liere, 1978). Because members of the environmentally sensitive group recognise the centrality of moral values to the environmental attitude "It may be argued that the NEP represents a shift toward more evaluative conception of attitude" (Kaiser, et al., 1999, p. 2). Research results show that in many western countries a large number of people hold attitudes similar to those described by the New Environmental Paradigm Model (Dunlap, et al., 2000; LaTrobe & Acott, 2000; Milon, et al., 1998), while the dominant social paradigm is the prevailing way of actually living (Kaiser, et al., 1999; Knapp, 1999).

Social pressures influence environmental dimensions since "environmentalism requires courage on the part of individuals and groups to act against the politics of practice-as-usual" (Whitehouse, 2001, p. 71), and environmental attitude and ecological

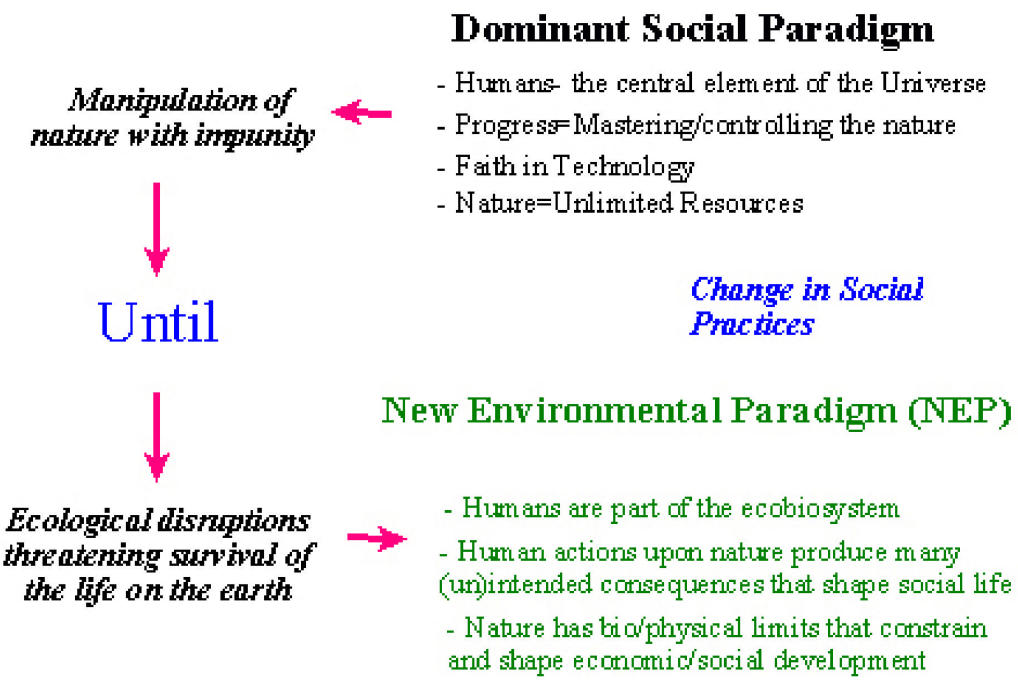

Figure 6. New Environmental Paradigm Model (modified from Catton & Dunlap, 1978).

actions can be shown to be at least moderately related (Dunlap & Van Liere, 1978; Hines, et al., 1986/87; Kaiser, et al., 1999). Nevertheless, this position has been challenged by other research, which claims the strength of the relationship between the NEP and ecological actions ranges from non-existent to weak (Eagly & Chaiken, 1993; Marcinkowski, 2001; Newhouse, 1990). This may be because people sense a compulsion to conform to the dominant social paradigm, the manipulation of nature with impunity because it is dominantly portrayed in mass media as the “correct” way to live in contemporary consumerist society (Cordano, Welcomer & Scherer, 2003; Dunlap, et al., 2000; Fien, 2003; LaTrobe & Acott, 2000; Thapa, 2001). This social paradigm effect could be even stronger than previously shown with past weak correlations being an artefact of the measuring instruments.

The binary categories created under the terminology of the Dominant Social Paradigm and the New Environmental Paradigm in the NEP model can be seen as opposing ends of an environmental attitude continuum. This NEP model provides a measuring scale in the environmental dimension, and focuses on sociological effects. There have been a number of problems with the NEP, especially since “the strength of the relationship between NEP and ecological behaviour ranges from nonexistent (Smith, Haugtvedt & Petty, 1994) to weak (Dunlap & Van Liere, 1978; Scott & Willis, 1994).

Using scaled answers on an environmental attitude survey questionnaire, the NEP makes it possible to position participants along a continuum concerning environmental attitudes such as perceived world ecological problems, support for proenvironmental policies, seriousness of regional pollution problems, and self-reported proenvironmental behaviours (Cordano, et al., 2003; LaTrobe & Acott, 2000).

The NEP also made it possible to compare results to other research. The problems with the NEP scale were addressed by utilising a supporting qualitative study to add convergent validity, and measuring change in the same students' from one survey questionnaire to the next. Six NEP questions and attitude questions were used on the survey instrument in this research. The reasons they were selected will be addressed in the design of survey questionnaire section, Chapter 5. The total number of questions was limited, since it was critical to maintain the amount of questions and variables to a manageable number. The students were all from schools in Queensland and the social pressure is assumed to have remained relatively constant over the five-week course of their project involvement.

3.2.5 The Theory of Planned Behaviour (TpB)

The Theory of Planned Behaviour (TpB) was developed by Ajzen (1988). Who postulated that action is primarily determined by a person's intention to perform that particular action. As visualised in Figure 7, this intention is determined by three major factors; person's attitude towards the behaviour (i.e., beliefs about the outcomes of the behaviour), the influence of the social environment that surrounds a person or subjective norm (i.e., beliefs of what others think the person should do, such as peer and social pressure), and perceived behavioural control (i.e., personal beliefs about one's control over resources, skills and opportunities necessary to perform the behaviour). Self-reported ecological intention to act is based on attitude toward the action, subjective norm, and perceived behavioural control, with each predictor weighted for its importance in relation to the behaviour and population of interest. This perceived behavioural control represents a person's readiness to perform a given behaviour, and it is considered to immediately precede behaviour (Figure 7).

Ajzen's Theory of Planned Behaviour (TpB) has been used extensively in contemporary social psychology theorising and research. I have taken up Ajzen's ideas to inform my own framework and experimental design to operationalise and test the variables of social pressure (subjective norm), attitude, and perceived behavioural

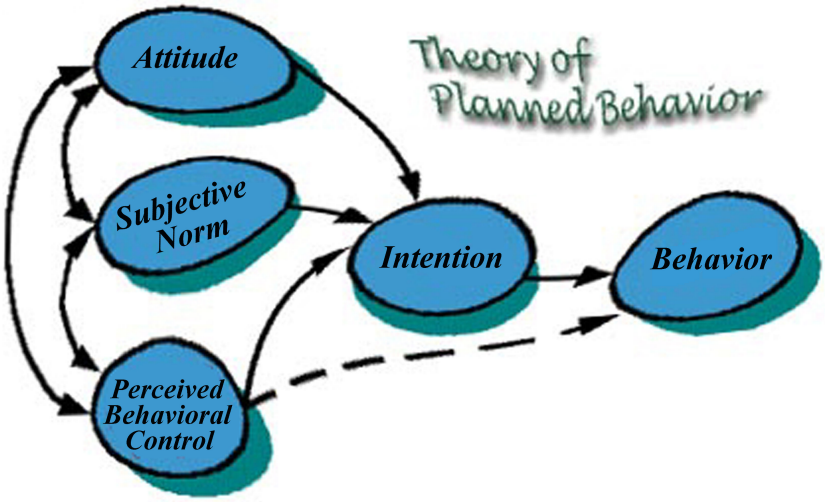

Figure 7. Theory of Planned Behaviour (Ajzen, 1988).

control as the main effects contributing to intention to act (see Figure 7). TpB was chosen as a theoretical basis for the evaluation process and many supporting research articles are available (see, Eagly & Chaiken, 1993; Hrubes, Ajzen, & Daigle, 2001; Kaiser, et al., 1999; Kaiser & Wilson, 2000; Kaiser & Fuhrer, 2003; Kuhlemeier, et al., 1999).

In this study, the TpB model was modified to investigate and evaluate the effects of classroom presentations and direct reef experience upon attitude and intention to act. An explication of these modifications is described in Figure 8. The large (thick) arrows note the variables specifically targeted in this study after the educational interventions

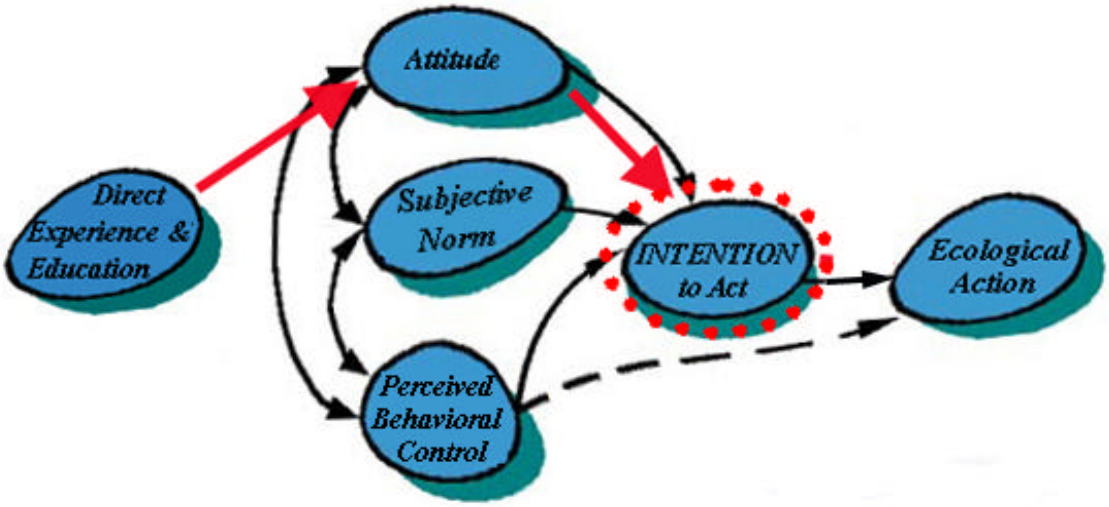

Figure 8. Direct experience, education and Theory of Planned Behaviour (modified from Ajzen, 1988).

of direct reef experience and a classroom presentation, and these are attitude and intention to act. As shown in the figure, the effect of direct experience and educational interventions was measured against high school students' attitude and intention to act. Ajzen and Fishbein (2005, p. 178) state "when appropriately measured, behavioral intentions account for an appreciable proportion of variance in actual behavior." In this study, I have had to assume the existence of this relationship between intentions and actions, and focused on the evaluation of intention to act. The limits of the research design are that this study investigates a student's stated intention to act, rather than investigating the actual (future) action itself.

3.2.5.1 The subjective norm.

A concept described as the subjective norm, is conceived as representing perceived societal pressure on individuals, to engage or not to engage in an action is the second predictor of behavioural intention in TpB. The model assumes that the subjective norm is determined by the total set of accessible normative beliefs a person has concerning the expectations of important others. Whatever may be constructed as the subjective norm is held to be a constant in this study, since the perceived social pressure for all students can be assumed not to change, or change only very slightly in the five-week time period of each group of students' participation.

3.2.5.2 Perceived behavioural control.

Perceived behavioural control, the third antecedent of behavioural intention in TpB (Figure 7), is constructed as referring to a person's perceptions of their ability to perform a given behaviour. Perceived behavioural control has been defined as an individual's belief concerning the ease or difficulty in performing behaviour, and it can be difficult to measure (Kaiser & Gutscher, 2003). Again, perceived behavioural control is held to be a constant because the period of research for each student group lasted only five weeks. These assumptions, of course, may be questioned, but in the context of this PhD, to identify and measure either construct, the subjective norm or perceived behavioural control, would have moved this thesis from the field of marine experiential education into the discipline of environmental psychology. It was my intention to remain focused on adolescent education in marine environments.

3.2.5.3 Environmental attitude.

Attitude is held to be a term that represents a summary evaluation of a psychological state captured by attribute dimensions such as good – bad, harmful – beneficial, pleasant – unpleasant (Ajzen, 2001; Eagly & Chaiken, 1993). Attitude can be considered as a personal degree of favourableness or unfavourableness with respect to a psychological entity (Ajzen & Fishbein, 1980, 2000), and has been defined as "an enduring positive or negative feeling about some person, object or issue" (Newhouse, 1990, p. 26). In this research, environmental attitude is considered as an enduring personal viewpoint or opinion concerning coral reefs and related marine issues. Thus, environmental attitude is the way in which a person may express concerns (or not) about the ecological state of marine environments, and is thought of as a learned predisposition to respond consistently, favourably or unfavourably, to ecological issues (Pelstring, 1997).

Attitude can be separated into three components of affect, cognition and behaviour (see Figure 9), and it is important to realise the different aspects of attitude when measuring and comparing (Ajzen & Fishbein, 1980; Eagly & Chaiken, 1993; Kaiser, et al., 1999). Attitude formation and change is the focus of attention in this research, however the role of cognition as an antecedent of attitude is also important. The relationship between changing cognition and changing overall evaluative attitude was observed and is discussed in terms of changes in environmental knowledge and ecological intention to act, as well as a number of students' existing background experiences.

As visualised in Figure 9, the separation of attitude into cognition, affect and behaviour are important here because they mirror how I came to research and analyse a similar separation in this study. I developed a research design, which compared the various components of attitude to similar components of knowledge and intention to act. In this research, the affects of the educational interventions of reef experience and classroom presentations (independent variables) are noted on the dependent variables of environmental knowledge, attitude and ecological intention to act, and this is measured across the appropriate components of cognition, affect or behaviour. Each dependent variable is separated into three components for evaluation, with the similar component of each variable being compared through the empirical investigation.

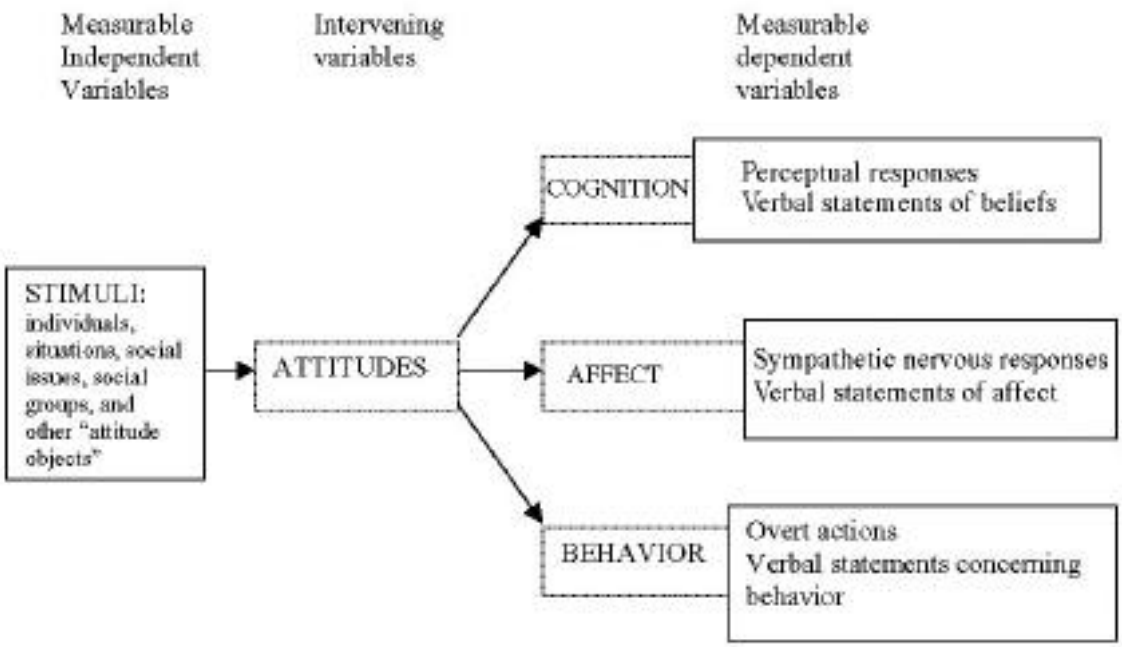

Figure 9. Three-component view of attitude (from Ajzen & Fishbein, 1980).

It is possible for a survey instrument to pose direct attitudinal inquiries or infer the respondents' evaluations from their expressions of beliefs about the focus on the attitude entity (Ajzen, 2001) – in this case a coral reef. These types of questions are found to have high levels of reliability and to correlate well with external criteria, and that is why they are used so often in attitudinal research. Single-item measures were formulated in the questionnaire given to all students, which correspond to the three components of attitude as described in Figure 9. Hence, I propose that knowledge, attitudes and intention to act will correlate highly with each other within the appropriate components of reef ecology and natural history, reef environmental problems and issues, and reef alternative solutions and action strategies. In addition, this will be tested statistically across all of the dependent variables.

3.2.5.4 Ecological intention to act.

The relationship modelled in the modified TpB model (Figure 8) moves from the educational intervention of classroom presentations and direct reef experience, to attitude, and then to intention to act. The Ajzen (1988) TpB (Figure 7) describes the relationships that affect behaviour, but intention is one's aim and desire to act in a particular situation. Ajzen's model is used in this research to formulate my model measuring ecological intention to act in determining whether a student has a strong

preference towards a certain type of action with reference to coral reefs. Fransson and Gärling (1999) noted there was a lack of success with interventions designed to change people's environmentally destructive actions. Thus, intention to act is an indicator of future personal actions, but as this is not a longitudinal study actions were unable to be measured; instead, self-reported ecological intention to act is measured in both questionnaires and interviews. Real actions can only be measured by a longitudinal study, which requires a lengthy research project and substantial funding, both of which were not available for this project. As there is theoretical support for ecological intention to act, it can be used as a variable to be measured in relation to the educational interventions, particularly the effect of direct reef experience.

3.2.5.5 Compatibility.

The principle of compatibility requires that measures of knowledge, attitude and intention to act involve the same target, context, and time elements, whether defined at a very specific or at a more general level, with empirical research showing that specific actions can be predicted with compatible measures of variables toward the action in question (Ajzen & Fishbein, 2005). This study attempts to measure changes in students' ecological intention to act, knowledge and attitude when compared across similar components. These comparisons were related to student learning with respect to the ecology of a natural entity (a coral reef), in the context of a marine snorkelling learning experience and set within a specific period designated by the study schedule. This was done in order to address the problem that, in general, attitudes have failed to predict a specific intention to act, and this could be because of a lack of compatibility in the focus, context, and time elements compared. An attempt is made in this study to address these incompatibilities.

Situations have been identified in the literature where people with similar attitudes can differ in their intention to act because people are theorised as holding two attitudes at the same time, one implicit and often unrecognised, the other explicit and under conscious control (Wilson, Lindsey & Schooler, 2000). Obviously, this complicates any attempt at measurement, especially since "the implicit attitude is assumed to be automatically activated whereas activation of the explicit attitude is said to require cognitive effort" (Ajzen & Fishbein, 2005, p. 217). In this study, the area of interest is the explicit attitudes, which are assumed to guide behaviour and intention.

Responses are collected from the high school student participants, compiled, separated into their respective components and measured for intention to act toward coral reefs.

There are critiques of the Theory of Planned Behaviour that include it being over simplistic, not addressing all of the many changing variables, and having an overemphasis on the individual. This type of model can be criticised for "disenfranchising *students* by its emphasis on *behaviour* over *thinking*, and for disenfranchising *teachers* by its conformity with top-down, objectivist approaches" (Courtney-Hall & Rogers, 2002, p. 289). I accept these problems but found in my study it was necessary to select a theoretical basis to test, even though it has flaws. The problems were mediated by utilising a strong quasi-experimental design and by having a parallel qualitative study for a broad pattern of student responses to augment the empirical data.

The quantitative survey was designed by using elements of the NEP, a modified Investigating and Evaluating Environmental Issues and Actions (IEEIA) scale, based on the work of Hungerford, Litherland, Peyton, Ramsey & Volk (1996), Ajzen's (2002) *Constructing a TpB questionnaire: conceptual and methodological considerations*, and the ecological behavioural scale from Kaiser, et al. (1999). The IEEIA scale has been used in previous studies measuring the effectiveness of environmental education programs (Marcinkowski, 2001; Mittelstaedt, et al., 1999). They appraise attitudes in environmental programs and predict trends for future actions. This study works in creating a testable model as an original contribution I am making to the field of marine education research. The original model and survey questionnaire was tested in pilot studies conducted in 2002 with high school students from one school, and university students enrolled in environmental studies and education programs at James Cook University. All elements of the questionnaire and interview strategies were refined before the research study took place. The actual questionnaire used is explained in detail in Chapter 5 (section 5.4.2).

3.3 Model of Ecological Intention to Act (MEIA)

As the research was conducted with 15-20 year olds in differing parts of Queensland, it was considered important for this research to be flexible and capable of incorporating diverse approaches, varying with each participant's response to the questions, and always being cognisant of being in a learning situation. A wide range of perspectives and approaches to learning are helpful in measuring changes in

environmental knowledge, attitudes and ecological intention to act. Thus, a number of difficulties arose in establishing clear relationships across the desired participants' learning outcome over a wide range of situational experiences in the reef environment. These situational experiences include student's age, education level, language spoken, as well as the similarities of one's teacher and location of the learning experience. This study addresses these difficulties with the use of different senior high school students from Queensland, controlled educational interventions with the same teacher, similar and replicable reef experiences and a pre- and post-treatment survey evaluation (Appendices B and C) within a structured quasi-experimental research design.

By modifying the work of others, I developed the Model of Ecological Intention to Act (MEIA) which models a situation where ecological intention to act is more highly correlated to environmental attitudes when students learn through a direct reef experience. It is developed to provide evidence that the research discovered real causal relationships between the phenomena of study (Hughes & Sharrock, 1997) as applied to marine education student learning. I hoped to develop a learning technique which could be added to conventional pedagogical situations and improve the learning outcomes of environmental knowledge, attitudes and ecological intention to act.

MEIA is a modification of Hines, et al., (1986/1987) and Hungerford and Volk's (1990) traditional learning and behavioural change system (Figure 3), and I attempt to illuminate pedagogical correlations between outdoor reef experience and positive ecological intention to act (Figure 10). The model conceptualises a direct relationship between ecological intention to act and direct experiences of the marine environment. It was designed to provide parsimonious descriptions of one or more sets of data. By parsimonious, it is meant that the model should be simple, but also complex enough to describe important features of the intervention process that claim to represent it (Sloan & Gorard, 2003). Direct experience is a common environmental education pedagogy, and it appears that it could improve the relationship between attitude and intention to act.

The research questions associated with MEIA address the issue of whether adding direct experience to conventional classroom teaching strategies improves the environmental education outcomes of environmental knowledge, attitudes and

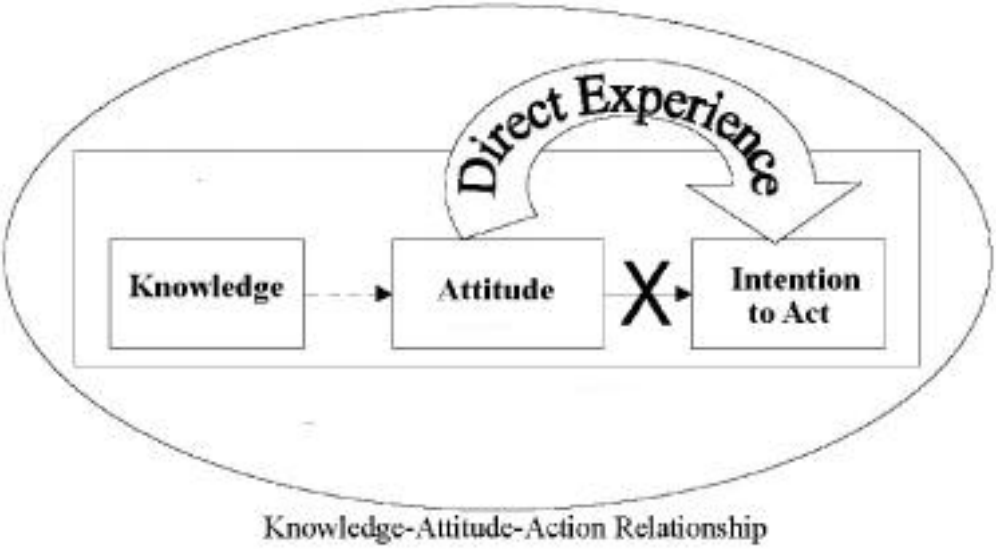

Figure 10. Model of Ecological Intention to Act (modified from Hines, et al., 1986/1987 and Hungerford & Volk, 1990).

ecological intention to act. I hypothesise that the students involved in classroom learning and direct experience with the reef will display an increase in environmental knowledge, attitude and ecological intention to act over those who receive only classroom presentations. The questions I tested are:

- Does the relationship between environmental knowledge, environmental attitudes and self-reported ecological intention to act become stronger when marine experiential education occurs?
- Does marine experiential education increase the environmental knowledge, attitudes and self-reported ecological intention to act more than classroom presentations alone?
- Does the student contrast group (those not exposed to the classroom presentation or coral reef experience) have the least increase in environmental knowledge, attitudes and self-reported ecological intention to act?

A number of studies have concluded that there is a significant relationship between knowledge and attitude, while the relationship between attitudes and action is weak. MEIA is designed to test the significance of these relationships and determine whether a reef experiential education intervention (direct experience with a coral reef environment) will improve the link, especially between attitudes and action. These hypotheses and how they were tested is explained in detail in Chapter 5 (Section 5.4.5).

Since outdoor and environmental educators consider environmental action activities important, my idea is to measure the self-reported effect of an outdoor reef learning activity. When study participants visit a reef to perform coral reef monitoring, they come into direct contact with the a coral reef. Direct experience has been found to improve the predictive validity of attitudes, and intention to act can be tested.

3.4 Multi-method Project Design

This research was designed to be "conducted with a mixture of quantitative and qualitative methods, mixing aggregate data gathered in statistically sound ways" (Albert, et al., 1998, p. 9) with descriptive data gathered through interviews. Interviewing was used since "it created opportunities to pause and reflect with participants about what they remembered, valued, liked, and disliked about their involvement" (Bell, 2003, p. 102). Using a multi-method more completely addresses my research questions. These two distinct methodological approaches have their own individual strengths.

This research project was an attempt to bring them together to examine reef experiential education in the context of current marine education practices. Instead of entering the well-worn debate about which technique is superior, it was decided to incorporate them both to provide information about learning from the student perspective, as well as strengthening the validity of the findings (Thomas, 2003).

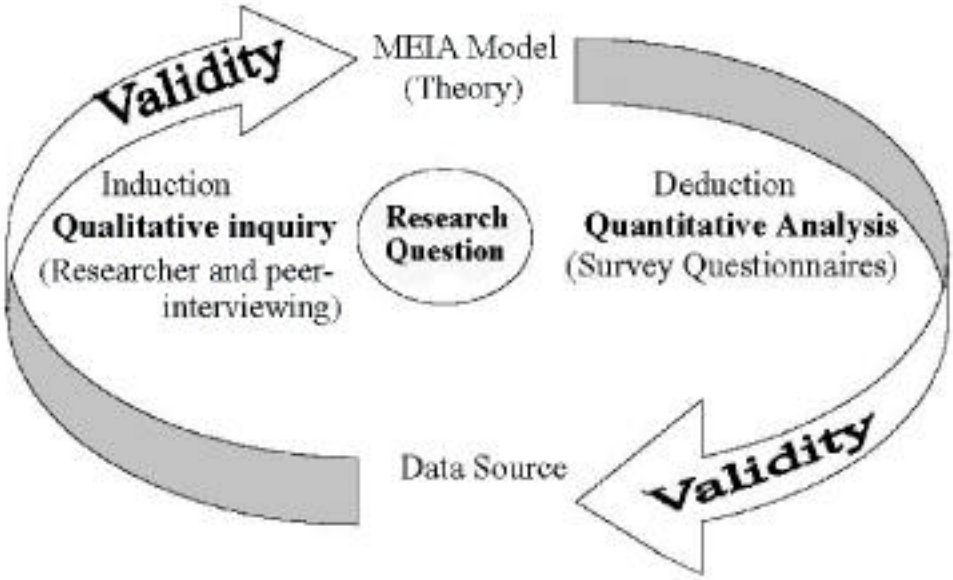

Figure 11. Quantitative – Qualitative research relationship (modified from Kantowitz, Roediger & Elmes, 1997).

Validity of research was examined by using data collected in a pilot study to develop the MEIA through inductive reasoning, and then testing the model in a deductive manner (Figure 11). While this model was being tested, additional interview information was also being collected to expand knowledge concerning students' impressions of the learning at the reef environments. Student responses are gathered and processed to provide data that improves situational pedagogy and contributes to new understandings.

3.5 Qualitative Theoretical Framework

One of the elements considered in the selection of a research methodology was the opinion commonly held by educational administrative and government bodies, that "'good research' must mean 'scientifically-based research'" (Yates, 2004, p. 13). It is important to pay attention to administrative, government and legal bodies since these are the institutions that decide policy, and teachers undertaking field experience with students have to conform to administrative policies. It can be a problem when government policy itself dictates research, but administrations are a real part of a teacher's responsibility when organising and arranging outdoor learning experiences. Researchers sometimes choose methods for strategic reasons, but this alone is not a sound rationale for methodological decisions. Educational research needs to be considered on a case by case basis. I felt that for these research results to be of use for both administrators and teachers, an empirical approach was necessary. It is also important to gain insights into the learning process from the participants themselves, and provide pedagogical results that are meaningful to the teaching community. Therefore, for my research to be of substance and significance, I need to think about whether or not my work contributes to new knowledge in the field, provides innovative approaches to methodology, and at the same time contributes to the discipline of marine education.

One way to achieve this is to combine qualitative and quantitative approaches. There is significant support in the literature for combining these two types of methodologies (Ewert, 1987; Neuman, 2004; Robottom & Sauvé, 2003; Rudestam & Newton, 2001; Salter & Hearn, 1996). Using quantitative analysis with firsthand information collected from the participants themselves adds depth of understanding to

the research. If we are to understand an educational situation more completely, engaging a number of perspectives can help. Thus, I chose to use two methodologies; the quantitative and the qualitative phases occurred concurrently.

Qualitative methods were utilised for collecting students' viewpoints through structured interviews after a lived reef experience. Their personal views and opinions were contained in the responses to the questions posed. A limited qualitative methodology was used to meet the study's specific needs. It provided a means of listening to what the students had to say about their learning experience in a constricted data collection phase on boats and islands. See a more in-depth explanation of this methodology in Chapter 5 (Section 5.6).

3.5.1 Summary-aided Approach to Analysis

The process of collecting interview data and interpreting it is best characterised by the summary-aided approach to analysis (Miles & Huberman, 1994). In this study, the practitioners work together to perform acts of reef monitoring at a reef site as the researcher attempts to monitor meaningful changes in student-to-reef relationships. The objective of the analysis is to capture descriptions of student interactions within coral reef environments in order to generate a more accurate idea of learning influences. The processes relating to the different steps in the data analysis are displayed in Figure 12. Data was collected in the field by structured interviews and summarised for consideration after subsequent field trips. The transcripts of the interviews were written up, coded and then summarised. The observations from the field trips, write-up, coding and summaries are combined and analysed to produce the initial reported results. The next process is to review the write-up, coding and summaries to ensure that once the coding is finalised, the interview reports accurately reflect what the interviewees said. Continued review of the interview data facilitates improvements in the accuracy of the result reporting process.

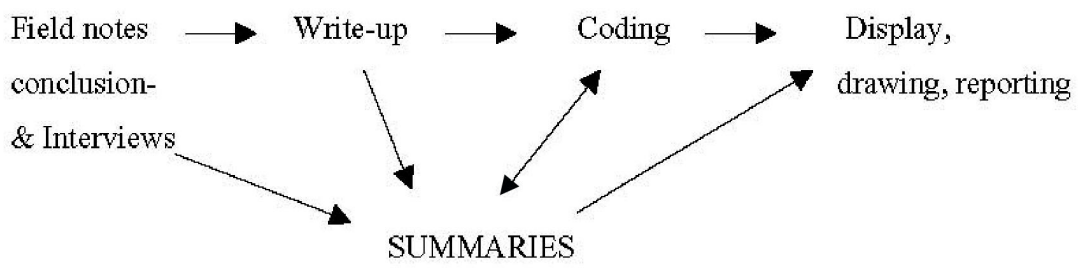

Figure 12. Summary-aided approach to analysis (modified Miles & Huberman, 1994).

3.5.2 Qualitative Data Analysis

In my research, the analysis was comprised of a combination of techniques associated with the summary aided approach to analysis (Miles & Huberman, 1994) and the Knowledge, Attitude, Action model (Hungerford & Volk, 1990), see Figure 3 on page 47. These two qualitative methods of examining the student interview responses further assist in answering the original research question about whether increased experience with a coral reef produces changes in high school students' environmental knowledge, attitudes and ecological action. This qualitative approach reveals whether the students prefer learning at the reef or the classroom, which is not investigated through the survey data.

Interview questions focused on how student attitudes can become modified within an action relationship (K-A-A), as they become an actor rather than an observer (Hovelynck, 2002) in the learning process. Hence, students can change their own understandings while they are given the opportunities to discuss with the interviewer. The actual student responses are analysed in Chapter 7.

3.6 Chapter Summary

After formulating the research question, the exercise of conceptualising a process to answer it began. Various research models germane to this question were investigated. In the field of educational research and responsible environmental behaviour, the work of Hines et al. (1986/1987) and Hungerford and Volk (1990, 2003) provided a foundation, augmented by the social psychologist, Ajzen's (1988) theory of planned behaviour. Since none of the models directly addressed the topic of marine experiential education directly, a new model (MEIA) was formulated to present a way of evaluating marine educational interventions, to provide a baseline research model to investigate coral reef education. The contribution of this research study is to investigate environmental attitudes and ecological intention to act in a real life-learning situation.

A set of procedures was designed to collect survey questionnaire responses and structured interviews as research tools. This study attempts to bridge a gap between qualitative educational research and the positivist scientific quantitative model. It advances ideas generated in previous research by Ballantyne, Connell & Fien (1998), Clarke (1996) and Connell et al. (1998) and Fien et al. (2002) to gain additional insights from Queensland high school students about their coral reef experiences. While,

positivist academic projects are consumed with scientific rigour and operationalisation of variables through the research question, sometimes the actual nature of the learning occurrence is overlooked (Lincoln & Guba, 1985). An integration of quantitative and qualitative research methodologies generates more comprehensive and satisfactory project results. The following chapter describes the students, educational interventions and procedures implemented to carry out this research.

Chapter 4

Procedures and Field Trips: The Students, Schools and Educational Interventions

Gift From The Sea

Let sea-discoveries to new worlds have gone,
Let maps to other, worlds on worlds have shown,
Let us possess one world; each hath one, and is one

Anne Morrow Lindbergh

4.1 Introduction

This chapter explains the approaches and procedures implemented in the conduct of my research. The chapter clarifies the research processes necessary for multi-method research, and to lay out the procedures in case a duplication of this study was desired at a future date. In this chapter I describe preparations, ethics and safety considerations, a pilot study, participating Queensland high schools, student study population characteristics, data collection, learning interventions, classroom presentation, reef experience, the conduct of one day reef trips and the interviews.

4.2 Preparations

4.2.1 Ethics and Safety Considerations

From the outset, a number of problems arose obtaining the various permissions necessary to work with high school students in Queensland, and research with them offshore in coral reefs. The organising of the pre-research support and administrative approvals was time consuming. One of the main challenges in this study was the ethics application for conducting research with high school students in unpredictable offshore environments. The combined ethics approval application for James Cook University, Education Queensland and the Catholic schools sector in two different dioceses was sixty pages long. The risk analysis alone ran to several pages and included item analysis for Irikanji and box jellyfish stings, sea snake bites, eel bites, shark attack, sunburn, dehydration, strong currents, panic attacks and anything else I could predict. The fact we gained ethics approval at the time remains an achievement still marvelled at by university faculty today. The approval process took eight months.

A number of procedural approvals were necessary prior to commencement. Approval and support from the education institutions involved was mandatory, with specific reference to researcher ethics, reef trip organisation and insurance, student snorkel protocol, as well as risk management and water safety considerations. Key endorsements were needed from the James Cook University Ethics Review Committee (Appendix D), and the Queensland Commission for Children and Young People (Appendix E). Additional approvals were needed from the Education Queensland (Appendix F), Cairns Catholic Diocese, the Brisbane Catholic Archdiocese, the James Cook University Dive Committee, and supporting boat companies (Appendix G) as well as the funding institutions; Cairns and Far North Environment Centre, Professional Association of Dive Instructors (PADI) and Perpetual Trust, and their associated insurance carriers. Permissions were needed from the school principals (Appendix H), teachers, students and parents (Appendix I and J). Gaining all these necessary approvals took considerable effort and time.

This study investigating learning with minors created additional problems in the approval process at several levels. The university was concerned about liability issues pertaining to students' snorkelling and performing underwater coral reef monitoring. The approvals procedure was constantly changing, so each time a university post-graduate student goes through it, there appears to be a differing set of rules and an ever-expanding criteria to conform to. Though all the precautions are necessary for the protection of the young, it became frustrating. And every agency wanted approval from the other before giving permission to proceed with the research.

Many times I would complete a necessary requirement, only to find new stipulations had evolved and became necessary for the research. For example, the Commission for Children and Young People approval only became compulsory during my Ethics Committee application process, and then the Commission's huge backlog made it very difficult for it to process my application, and neither JCU nor Education Queensland could proceed without it. Volumous paperwork was generated through correspondence and meetings, application procedures, and designing risk management and safety systems forms. I began to think I would spend my whole candidature trying to procure the necessary approvals.

The authorising agencies had to be assured that the study and interventions did no harm to students, participation was voluntary, students could withdraw at anytime and confidentiality arrangements protected participants and the researcher. All data was

treated as confidential, and the anonymity of participants was preserved. Before ethics approval was granted the JCU Ethics Committee wanted to ensure that: Education Queensland approval had been received; and letters of approval/support had to be provided to the Committee from all schools, other than those covered under Education Queensland approval, indicating who from the school would accompany and supervise the study's participants. Information sheets and informed consent forms were developed that stated precisely what the participants were required to do, i.e., how many trips to the reef, how much class time will this take up, time commitment for the survey, how much time was going to be spent interviewing and snorkelling, how the students were to be transported to and from school to the reef trips, who will pay, and who will provide food for the trip. It was necessary to describe the standard of swimming required for this study, and to provide details of supervision in the water and on boats; and which persons were qualified in first aid. Copies of all first aid certificates were provided to the Ethics Committee.

Ethics approval addressed issues presented by the James Cook University Human Ethics Sub-Committee, the National Health and Medical Research Council's *National Statement on Ethical Conduct in Research Involving Humans*, 1999, and the Application to Conduct Research in Education Queensland State Schools. Since the sample size approached 400 students, a huge amount of paperwork was generated, and the university became especially concerned about liability issues pertaining to research with large numbers of young adults, in offshore environments. This presented huge logistical problems for the solitary research student; following up on late consent forms, keeping conflicting meeting schedules at geographically separate schools, maintaining continued phone contact, sending emails and attending meetings to ensure cooperation from the participants, checking the status of some students as they moved from one school to the next, and making sure all the necessary consent and field trip forms were completed for every trip to the reef.

While waiting for authorisations and approvals, I developed a number of documents; the snorkel and dive related risk management form (Appendix K), a list of medical facilities available offshore at the reef (Appendix L), letter containing particulars for informing parents and students about the project, as well as designing pre- and post-test survey questionnaires, and a list of structured questions for the researcher (Appendix M) and peer-to-peer interviews (Appendix N). These represent a considerable amount of research effort. The time for approvals exceeded 11 months, so

it is unlikely a study of this type will be repeated as PhD research in the near future given Australian students are now required to complete within 3 years.

Meetings were held with marine educators from the study schools to ensure proper coordination of the project, and a number of organisational, risk management and procedural questions were addressed. Schools were identified by the following process. I made a presentation to the annual MTAQ Conference in Cairns in July of 2002, to inform and solicit feedback from marine teachers about the feasibility and acceptability of the project. This meeting established communication with marine teachers, and provided a forum for constructive criticism. The project was well accepted, and teachers were identified who supported the research and could supply students for the research sample, and the class time necessary. Once teachers volunteered, their schools were contacted and the central administrative bodies approached for the individual school approvals. In order to generate procedures and interventions necessary for the project, to check survey questionnaires, interview techniques, and ensure the project was realistic, a pilot study was conducted.

4.2.2 Pilot Study

Temporary JCU Ethics Committee permission was granted for a pilot study, while I was waiting for permission to conduct the entire study. The pilot study commenced in August of 2002 and was conducted with second year environmental studies (n = 20) and third year education (n = 12) tertiary undergraduate students from James Cook University, Cairns, and Year 11 high school students enrolled in the marine studies program at St. Mary's Catholic College (n = 19). A total of 32 university students and 19 high school students volunteered to participate in the pilot study. Contact was made through JCU networks.

The pilot commenced in September and was completed by December 2002, and provided an opportunity to apply the experimental design, test the survey questionnaires, and generate constructive feedback from both teachers and students. I also evaluated differing classroom presentations, the suitability of boat operations and reef monitoring locations by taking pilot study students on boat trips with different carriers to different offshore sites. When teachers suggested certain reef sites for the monitoring, that advice was followed. The entire process of presenting and implementing the educational interventions was practised and reviewed to make sure these would work in the designated timeframe.

Feedback indicated the classroom exercises and PowerPoint presentation were too long, so these were shortened. Pilot study students found some survey questions were redundant or even silly, so these were either modified or deleted. Modifications to questionnaires, interview structures and classroom presentations were made in preparation for the research to begin in February 2003. The purpose of the pilot study was to use volunteers to refine the research process. In return, the university students were given a free trip to a reef site and given reef-monitoring training. The high school students were the pace-setters for their school, with research conducted with students in following years.

4.2.3 Participating Queensland High Schools

Five Queensland high schools are partners in the project. St. Mary's Catholic College, Woree State High School, Cairns State High School, are all located in Cairns. Good Counsel College is located in Innisfail, a coastal town approximately 100 km south of Cairns. The fifth school was Southern Cross Catholic College, which is located in Scarborough, a coastal suburb north of Brisbane. These five partnership schools enabled the generation of a statistically appropriate sample size of over 320 students. The participant schools were selected based on support from administrators, key teachers, who were members of MTAQ, and the relevant central administrative bodies. They were, Education Queensland for Woree and Cairns State High Schools, the Cairns Catholic Diocese for St. Mary's Catholic College and Good Counsel College, and the Brisbane Catholic Archdiocese for Southern Cross Catholic College.

Meetings were held with staff from the participating schools from November 2002 to February 2003 in preparation for the main study. The principals and teachers were supportive of having a doctoral research student on campus taking a close interest in their students' learning outcomes. This was a positive relationship and I was the first researcher in each of these schools to investigate dimensions of experiential education in their respective marine studies programs. The participating teachers spent considerable time on the project providing institutional letters of support, gaining parental signatures, collecting responses from two student survey questionnaires (the pre- and post-test surveys) and making the preparations necessary for safe and well-organised reef field trips. Teacher support was invaluable to the conduct and completion of this research.

The project proper began in March 2003 with Woree State High School. For each school, the timeline for the survey questionnaires, classroom presentation and reef

trip went according to a five-week schedule (Table 1). I would drop the survey questionnaires off with the marine teacher, and they were completed by the students in all the participating classes on or about the same day. In the second week, I would conduct a classroom presentation and collect the pre-test surveys. In the third week, the students would visit an offshore reef and learn coral reef monitoring techniques. One week after the reef trip, the post-test questionnaires were distributed to students. One week following this, the researcher would again visit the class to thank the students for their involvement, hand out pictures of the students snorkelling in the monitoring exercise and give them each a Reef Check Coral Monitoring Certificate.

Table 1. *Project Implementation Timeline*

Week 1	*Week 2*	*Week 3*	*Week 4*	*Week 5*
Pre-test	Classes 1&2	Reef trip (interviews)	Post-test	Final school visit

4.3 Student Study Population Characteristics

Data was collected from a convenience sample of senior high school students attending five coastal area schools in Queensland from the same age groups and education levels, and included students of both sexes from differing socio-economic backgrounds. Both the quantitative and qualitative study groups were composed of the same students and represented a cross-section of Queensland coastal community high school students. Most of the students in the sample were taken from Marine Studies subjects at the five participating schools. Other participating Year 11 and Year 12 students were selected by the teachers and school administrators to increase the size of the sample, and to include students outside of marine studies. A total of 389 students participated in the project.

The students were divided into different groups. The groups included students who would go on the reef trip and have a classroom presentation, go on the reef trip only or just have a classroom presentation. Included in this total number were a group of students in other classes taught by the participating teachers, who did not receive any of the learning interventions. These students made up the contrast group, and were roughly the same age, same education level, and from the same schools as the participating students. This contrast group did not take part in any aspect of this study except for

answering the pre-test and post-test survey questionnaires. Their responses were later compared to the students who participated in the various educational interventions associated with the study, and the answers were compared.

4.4 Learning Interventions

4.4.1 Introduction

The data collection for the full study began in March 2003. The data was collected by using pre- and post-educational treatment survey questionnaires, and personal interviews. The classroom teacher administered the pre-test and post-test student survey questionnaires before and after the educational interventions. Students completed pre-test surveys prior to meeting the researcher in class. The completed surveys were returned to the researcher and the student responses entered into a project data set. The teachers received no training in administering the surveys, and they had the students complete the surveys in class time on the prescribed day. This phase was completed one week before the researcher came into the school to conduct a classroom presentation.

4.4.2 Classroom Presentation.

One week following an initial pre-test survey administered by the classroom teacher, the researcher conducted two 30-minute classroom presentations or one 50-minute classroom presentation on the topic of marine ecology and a brief introduction on how to monitor a coral reef using a Reef Check coral reef monitoring method (Hodgson & Stepath, 1998; Reef Check, 2005), for all students receiving this intervention. The classroom presentation consisted of a standardised Microsoft PowerPoint slide show and a simulated transect line demonstration complete with handouts of pictures of the reef animals. The presentation concluded with a coral polyp role-play dance involving all the students.

The PowerPoint presentation, presented to all participating students in Groups 1 and 2, was developed from materials available from Reef Check (2005); Great Barrier Reef Marine Park Authority (GBRMPA) Tourism Staff Training Program and GBRMPA Reef Ed materials; and coral reef education materials from the Environmental News Network (Environment News Network, 2003). The objective was to introduce students to concepts of reef ecological interactions, generate knowledge of indicator species used in reef monitoring and provide a brief overview of reef ecology.

Two interactive learning scenarios augmented the MS PowerPoint slide show presentation. The first was a demonstration of coral reef monitoring. A 5m portion of the 50m transect line, was laid on the floor of the classroom. This simulated the reef monitoring procedure of proceeding along a transect line, and observing and recording data about species presence on underwater slates. While the tape was stretched out on the floor, large photographs of Pacific Ocean marine species were circulated around the class for all the students to learn to identify key animals that live on the reef within the monitored area. Students were asked to familiarise themselves with these fish and invertebrate species.

Photographs laid along the practice tape transect line represented 9 fish categories, Butterfly fish, Sweetlips, Snapper, Barramundi Cod, Grouper, Humphead Wrasse, Bumphead Parrotfish, other Parrotfish, and Moray eels; and 9 invertebrate categories, Banded Coral Shrimp, Diadema Urchins, Pencil Urchins, edible Sea Cucumbers, Crown-of-Thorns sea star, Giant Clams, Triton Shells, Collector Urchin and Lobsters (see Appendix O). All indicator species were derived from Reef Check (2005) materials and adapted and simplified for inclusion in a monitoring methodology for large student groups (Appendix P). The combined experience of the PowerPoint presentation, the simulated transect line and the coral polyp dance constituted the ecological knowledge portion taught in the classroom. Approximately half of these students then went on to an associated reef trip as part of the study group.

The coral polyp dance was the second interactive educational activity and involved a role-playing exercise, where students imitated reef dwelling organisms. In the centre is the coral polyp (four or so students holding hands if they wish), which is filled with zooxanthellae algae (2-3 students with hands waving in the air) surrounded by organisms of the reef (the remaining students playing the various creatures around the reef, such as crabs, fish, shrimp, sea cucumbers, etc.). The aim of the role-play is to demonstrate how reef organisms congregate around and through the reef substrate, and that they would have no home except for work done by coral polyps in building a huge reef. The interactive role-playing dance was an attempt to improve students' personal knowledge about the diversity of life on the reef.

The interactive exercises, presentations, visual aids and coral reef related props made up the classroom educational intervention, and were used in an attempt to generate cognitive understanding of reef environments. All these exercises aimed to teach concepts of diversity and marine ecology associated with the Great Barrier Reef.

4.4.3 Reef Experience

The trips that make up the reef experiential education component of this study had to be conducted in a logical, safe and timely manner to facilitate maximum student learning. Students from the three Cairns high schools, Woree State High School (WSHS), St. Mary's Catholic College (SMCC), and Cairns State High School (CSHS), as well as Good Counsel College (GCC), from Innisfail, made trips to offshore reef sites. Southern Cross Catholic College (SCCC) students (55 participants) attended a weeklong program on Northwest Island off Gladstone. This program is discussed in section 4.6, and the Southern Cross Schedule for Northwest Island and a brief synopsis is described in further detail in Appendix Q. Day reef trips typically started at around 0830 returning at approximately 1700, with groups going to two different reef sites on the same day. Reef trip scheduling (Table 2) was contingent upon high school schedules and favourable weather conditions. These reef trips were conducted approximately one week after the classroom presentation for students in Group 1. Students in Group 3 attended the reef trip without a prior classroom presentation.

Table 2. *Schools and Reefs Visited 2003*

School	Students	Boat	Reef
WSHS	26	Noah's Ark, too	Michaelmas Cay, Breaking Patches
SMCC	52	Compass	Hastings, Breaking Patches
SCCC	55	Northwest Is.	Northwest Island Fringing
GCC	27	Compass	Hastings, Breaking Patches
CSHS	70	Great Adventures	Green Island
Total:	230		

The aim of introducing a structured reef monitoring exercise was to provide a focussed reef experience, to engage the students' senses, cognition, and motor skills simultaneously. To perform reef monitoring the students wore snorkel equipment, were submerged in the water and moved along the reef substrate. They followed a transect line in a prescribed manner, while recording the presence of indicator animals they observed. Reef monitoring is an outcome oriented, structured outdoor learning activity, which asks more of the students than just aimlessly snorkelling over the reef. Reef monitoring is also a training exercise for the students to observe reef species, while following a prescribed monitoring protocol.

4.4.4 The Conduct of One-day Reef Trips

The day-trips for each school group were very similar. All day trips from Cairns exited and returned from the Marlin Jetty, Cairns. The students arrived at the commercial tour boat early in the morning of a school day. Once on the boat, everyone went through the normal introductions to safety precautions, trip information and boat orientation by the crew. Each boat excursion visited two separate coral reefs in one day. During the two-hour boat ride to the reef sites, I met with the teachers and the coral reef monitoring assistants who were undergraduate and post-graduate university students. Plans for the day were reviewed with suggestions about how to best work with individual high school students, as well as ways to safely and effectively perform the coral reef monitoring exercise given the conditions of the day. The best locations for the transect lines were established by me on earlier reconnaissance of the reefs as part of the research planning process.

The boats used were from different local companies, and were of varying sizes. The reefs visited were Breaking Patches, Michaelmas Cay, Hastings Reef and Green Island. The first school group from Woree State High School went out on a boat that was suitable for the research purposes, although with a class of 26 students, 2 teachers, 2 university student helpers and one researcher, the boat was fully loaded. By comparison, on reef trips conducted with St. Mary's Catholic College, Good Counsel College and Cairns State High, the students, teachers, assistants and researcher travelled aboard larger boats, holding more than 150 passengers. Conducting instructional meetings and organising fifty or so students was difficult on the larger tourist boats because it was difficult to keep track of them, and we could not find adequate spaces away from tourists for briefings on reef monitoring, safety and snorkelling issues. These day trips were conducted as pre-scheduled school trips for Marine Studies students. The groups also included non-marine studies students as part of the research, and these students formed part of the study group.

When the boats neared the reef sites, the students were gathered together to review safety precautions and snorkel protocol (see Appendix R). This pre-snorkel presentation covered: 1) the snorkel safety plan and explanation of the snorkel protocol for the day; 2) a review of the sampling design and review of fish and invertebrate identification; 3) a review of the data recording format, and underwater writing slate preparation; and 4) an explanation of how to avoid damaging reef corals with correct

snorkel fin use. Before going into the water, students again reviewed the snorkel plan and were buddy-paired.

Students were arbitrarily divided into an equal number of invertebrate and fish counting groups, with one half of the students monitoring with snorkel gear first, and the other half monitoring later in the day. Once in the water, students snorkelled along the transect line collecting observational data which was recorded on underwater slates. Research assistants were responsible for laying a 50m transect line along a reef flat following a shallow water depth contour of approximately 1.5 - 2m. All students were required to monitor along this transect line. When the students finished monitoring, they could stay in their buddy pairs and snorkel around the reef at their own pace. As the researcher, I documented the entire learning event with photographs, while also answering student questions concerning reef ecology. Oral interviews took place *in situ* on the beach or during the boat ride back to port after completing the snorkelling and reef monitoring exercises. The conduct of interviews is further described in Chapter Five. Only students undertaking reef trips were interviewed in this research.

4.5 Southern Cross Catholic College Week-long Excursion to Northwest Island

Southern Cross Catholic College is located in Scarborough, a small community just north of Brisbane, on the Redcliffe Peninsula. The Southern Cross Catholic College student group participated in a seven-day school organised trip to Northwest Island off the coast of Gladstone, Queensland, at the southern end of the Great Barrier Reef. The trip to the island took place between August 9th and 16th, 2003. I arrived in Scarborough on August 5th and returned to Cairns on August 17th. Arrangements were made for my classroom presentation and the completion of the remaining student pre-test survey forms for the day after my arrival. Certain classes were not ready, since they needed to fill out their questionnaires. I made the presentations shorter and taught the students in small groups while on the island.

The marine teachers were extremely busy since there were an infinite number of things to do preparing for the trip. A tremendous amount of logistical preparation went into the trip, especially since everything had to be taken to the island, including our own drinking water, food, boats, fuel and SCUBA air compressors. The island has no facilities except for composting toilets. Everything for the 50 students and 9 staff had to be loaded into buses, trucks and boats and hauled up to Gladstone for barge transport to the cay.

The students assisted with loading and unloading the barge. Once on the island, we set up camp and had a barbeque before going to bed in our tents in anticipation of an action-packed seven days. Small groups of six to eight students rotated from one activity to another throughout each day. These activities included: walking across and around the cay, identifying flora, fauna, geography, botany and human impacts; performing a reef flat transect to identify, counting and graphing marine creatures; snorkelling skill assessment over the edge of the reef; as well as coral reef monitoring along the edge of the reef flat at high tide. Consequently, the time for the monitoring exercise changed daily for the different student groups. One group had to monitor very early one morning just after sunrise: they were very sleepy and hungry, and got a little chilled.

Other activities included learning first aid, boating, radio operation, manta towing, night walking around the reef, and astronomy. I conducted interviews on the beach while waiting for the tide to come up so the barge could return for us after sunset. It was a very busy time, but we all got on well, with the boys feeling free enough to tease me about my American accent. The excursion went as planned, and this trip is explained in more detail in Appendix Q.

Our parting was somewhat emotional the following morning, with one of the students giving me a necklace as a memento. Upon my return to university, I received a number of emails and mobile phone text messages. The post-test was answered at the Scarborough campus after the student group returned from the island. Even though, the Southern Cross excursion was different from other students' experiences, I did not think it was problematic in terms of research design because the interventions were very similar, and because of the focus of the research on the value of underwater snorkelling and monitoring experiences. However, some researchers may wish to disagree with this assertion.

4.6 Chapter Summary

This chapter discusses the approvals, processes and contexts for data collection, and description of the study groups and the conduct of the research in marine environments. It can be appreciated, that this research required extensive organisation, collaboration and cooperation with the teaching staff and students of five Queensland high schools. It would have been impossible without the high-level of cooperation and good will I received. The next chapter discusses the quantitative and qualitative methodologies used.

Figure 13. Teacher and researcher meeting at Cairns State High School, November 2002. Photo by unidentified staff member.

Figure 14. PowerPoint presentation in classroom by Carl Stepath, October 21, 2003. Photo by unidentified Cairns State High School Student.

Figure 15. Woree State High School classroom presentation by Carl Stepath on March 25, 2003. Photo by Alan Williams.

Figure 16. Carl Stepath in classroom presentation at St. Mary's Catholic College on April 8, 2003. Photo by Meg Kennedy.

Figure 17. Good Counsel College students and teacher, Tom Jones, on Compass upper deck to Hastings Reef and Breaking Patches, August 29, 2003. Photo by Carl Stepath.

Figure 18. Carl Stepath reviewing marine ecology with Woree State High School students before the coral reef monitoring at Michaelmas Cay on board Noah's Ark, too, April 3, 2003. Photo by Allison Hoskin-Kain.

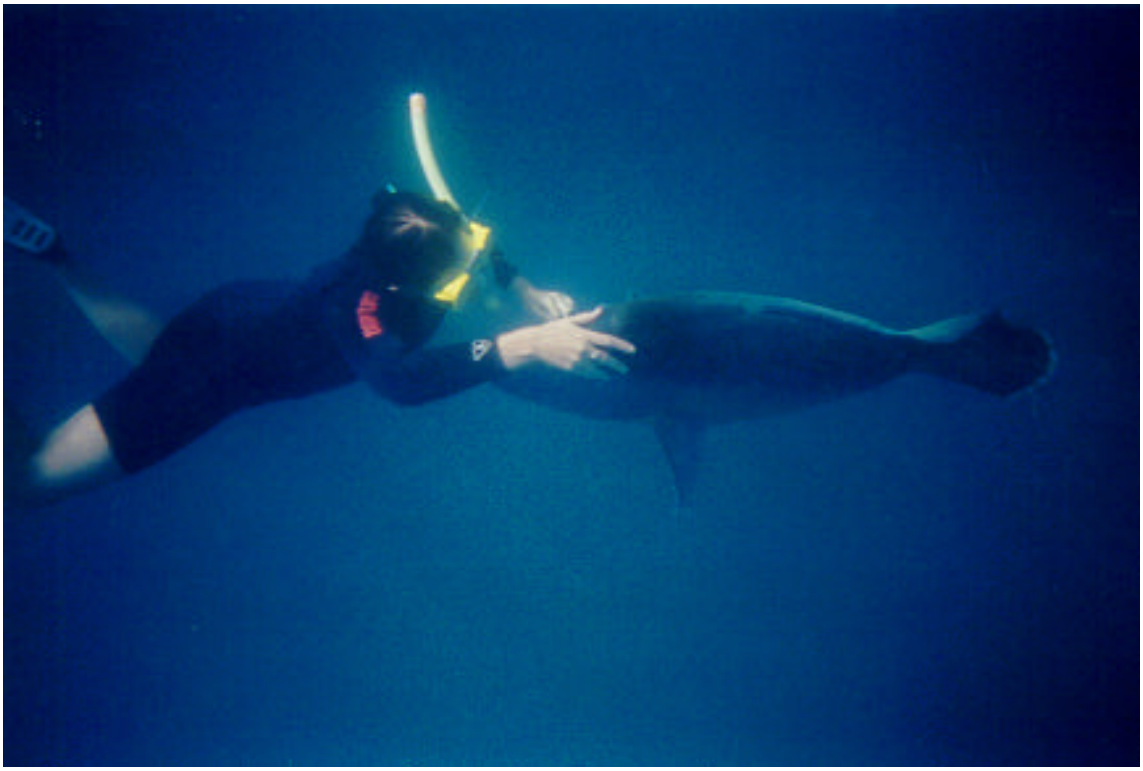

Figure 19. Good Counsel College student with Humphead Wrasse at Hastings Reef on August 29, 2003. Photo by Carl Stepath.

Figure 20. Southern Cross Catholic College students reef monitoring at Northwest Island, August 12, 2003. Photo by Carl Stepath.

Figure 21. St. Mary's Catholic College student coiling up the transect line after monitoring Breaking Patches reef, April 15, 2003. Photo by Carl Stepath.

Figure 22. Southern Cross Catholic College students snorkelling at Northwest Island, August 13, 2003. Photo by Carl Stepath.

Figure 23 Woree State High School students videoed by a JCU research assistant, Allison Hoskin-Kain, April 3, 2003. Photo by Carl Stepath.

Figure 24 Woree State High School students and teachers returning from Michaelmas Cay, April 3, 2003. Photo by Allison Hoskin-Kain.

Chapter 5

The Research Approach

A wider or more altruistic attitude is very relevant in today's world. If we look at the situation from various angles, such as the complexity and inner-connectedness of the nature of modern existence, then we will gradually notice a change in our outlook, so that when we say 'others' and when we think of others, we will no longer dismiss them as something that is irrelevant to us. We will no longer feel indifferent.

The Dalai Lama

5.1 Introduction

This chapter describes the methodological processes used to investigate the effects of coral reef experiential education on high school students' environmental knowledge, environmental attitudes and self-reported intention to act skills. This research asks the question whether experience of coral reef environments enhanced learning in measurable and identifiable ways. To do this I asked the following questions:

d) Does increased direct experience of a coral reef with high school students participating in coral reef monitoring produce significant positive change in their environmental awareness, attitudes and self-reported ecological action strategies?

e) Does previous experience of the Great Barrier Reef influence significant positive change in the environmental awareness, attitudes and ecological action strategies of student participants?

f) Do classroom presentations in addition to reef visits produce a higher degree of change in their environmental awareness, attitudes and self-reported ecological action strategies?

The research employed a quasi-experimental survey methodology (Kerlinger & Lee, 2000), as well as an accompanying qualitative semi-structured interview methodology. The quantitative study contrasted the two educational interventions with respect to three dependent variables (2x3) using a before and after treatment data collection design. The independent variables are (1) classroom presentations and (2) coral reef experience, and the dependent variables were (1) changes in environmental

knowledge, (2) reported attitudes and (3) reported intention to act. A convenience study population of senior high school students was used to examine the interrelationship of effects from the educational interventions described in the research design. Various quantitative analysis techniques were employed to investigate correlations and relationships and the results are presented in Chapter 6. Results from the limited qualitative investigations, which present student accounts of their learning experiences in situ reef environments, are presented in Chapter 7.

Demographic factors concerning the participants were also investigated quantitatively. A result similar to triangulation (Cobb, et al., 2003; Neuman, 2004; Sowell, 2001) can be achieved by using both quantitative and qualitative data collection methods to secure a more in-depth understanding of the phenomenon in question. Employing differing methodologies to investigate the same phenomena has been shown to expand and add depth to empirical findings (Denzin & Lincoln, 1994), while providing a perspective on how the participating students were able to give accounts of their learning experiences. In this chapter, I first explain the quantitative and then the qualitative methodology.

5.2 The Study Population

The quantitative study involved 389 students identified by participating schools as shown in Table 3. A sizeable population (or study size) was desired since larger studies are more likely to provide statistically significant results than smaller studies (Sowell, 2001). The senior high school students were predominately Year 11 (88%), 3% being of Aboriginal descent. The representations of Year 12 students are shown in a separate column in Table 3. Over half the students were enrolled in Marine Studies and Marine & Aquatic Practices subjects, while 43% were selected by teachers in other science, religious education and accounting classes, which are shown in the ‘Other courses’ column. Incorporating schools from geographically different areas provided a fairly representative group of high school students in Queensland. Members of the study group were as consistent as possible from one school to the next in the categories of age, course of study, cultural background, education levels and reasons for going to the reef. A small sample of these senior high school students provided an effectual contrast group of roughly the same age and education level from different classes at the same schools.

Table 3. *Study Group Make-up by School and Course of Study*

School	Marine Education (Yr 11/12)	Other Courses (Yr 11/12)	Older Students (Yr 12)	Total Students
Woree State High School	53	21	24	74
St. Mary's Catholic College	66	33		99
Southern Cross Catholic College	38	17		55
Good Counsel College	20	27	22	47
Cairns State High School	43	71	2	114
Total students	220	169	48	389

The quantitative study population was divided into four groups. The four categories (Figure 25) are: (1) the marine experiential education group, Group 1 (n = 85, 7 in year 12) who received both the new classroom presentation and an offshore reef monitoring experience; (2) Group 2 (n = 64, 6 in year 12) who received a classroom presentation, but were not taken to the reef; (3) Group 3 (n = 97, 9 in year 12) who received only research related reef experience, and did not have the associated classroom presentation; and (4) Group 4 (n = 74, 26 in year 12) who, as the contrast group, were surveyed over the same time period as the other students in their respective schools but were not given a classroom presentation or a reef trip. This group had no contact with the researcher. Separation of participating students into groups provided the possibility of comparing the effect of different educational interventions as evidenced by survey responses.

		Reef visit	
		New reef visit	No new reef visit
Classroom presentation	New classroom presentation	Group 1 – Class presentation and reef visit	Group 2 – Class presentation and no reef visit
	No new classroom presentation	Group 3 – No class presentation and reef visit	Group 4 – No class presentation and no reef visit

Figure 25. Study groups and respective educational interventions.

Table 4 shows the number of students in each group from each participating high school. The final study group was divided into four groups depicted in the Table respectively as Gp 1, Gp 2, Gp 3 and Gp 4. The students whose responses were used in the statistical analysis totalled 320, of which 195 were male and 125 were female with an average age of 16.0 years (ranging from 15 to 20 years), 15% of the 320 (48 individuals) being from year 12. This sample was 69 less (Non-Part.) than the total number of participants (Total Students), because certain responses were not used for the following reasons: the surveys were inaccurate, students were not in class on the day of the survey, students had changed schools; all answers to the survey questions were not completed, or students declined to fill out the survey questionnaire on the day.

Table 4. *Study Group Make-up by Participation of Students from each High School and Group*

School	Gp 1	Gp 2	Gp 3	Gp 4	Total Group	Non-Part.	Total Students
Woree State High School	19	11	4	25	59	15	74
St. Mary's Catholic College	23	20	27	15	85	14	99
Southern Cross Catholic C.	15	3	20	11	49	6	55
Good Counsel College	18	10	5	11	44	3	47
Cairns State High School	10	20	41	12	83	31	114
Totals:	85	64	97	74	320	69	389
	Both ed & reef visit	Ed only	Reef visit only	No ed or reef visit			

A power analysis was employed at an early research stage to determine the approximate number of subjects necessary. The power analysis program used was G-Power (version 2.1.2, shareware available at http:www.psychologie.uni-trier.de:8000/projects/gpower.html). The type of power analysis used was A priori, for an F-Test (ANOVA), with a medium effect size (f) of .25. The alpha was 0.05, with a power (1 – beta) of 0.95 and 4 groups. The total sample size determined by the G-Power analysis for this research was n = 280, for an actual power of 0.9510, critical value F (3,276) of 2.6373 and Lambda of 17.5000. The actual sample size used in this project

was n = 320, which was 14% higher than the G-Power determined size of n = 280. The group sizes varied (n = 64 to n = 97), but this was unavoidable. Classes of different sizes were made available for the research by the participating schools. The unusable survey questionnaires, revealed variables in student literacy and perhaps cooperation that were beyond the researcher's control.

5.3 Pilot Study

The pilot study took place in 2002 with a small group of 19 Year 11 and Year 12 students and teachers from St. Mary's Catholic College and 32 James Cook University second-year environmental studies and third year education students. Educational interventions followed the procedures outlined in Chapter 4. The pilot study provided a mechanism for tweaking the interview questions and research techniques, and for evaluating the logistics of the educational interventions and procedures. The questionnaire and interview responses from the pilot group were analysed to ensure both reliability and validity of the survey instruments. Pre-test and post-test survey responses were statistically processed to ascertain whether they measured what was intended. Survey questions were derived from other surveys using a similar methodology. These questions were separated into different categories corresponding to the three components to ensure they applied to the appropriate category; the pilot study was used as a trial. A Cronbach's *alpha* was calculated using the response data. Interview responses were compared on a question-by-question basis to survey responses to determine consistency and depth of understanding. Similar questions were presented in the pilot survey, and the student responses on each were compared to make sure they gave equivalent responses.

Reflections and suggestions from pilot study students were incorporated into final study procedures, and the conceptual formations of the Model of Ecological Intention to Act metamorphosed as praxis. The pilot study findings shaped the interview and survey questions used to collect data on marine experiential learning while complying with the ethical concerns of the university and Education Queensland when using a large student sample.

5.4 Quantitative Methodology

5.4.1 Experimental Design

My study hypothesis is that students in Group 1 involved in both a classroom presentation and a direct reef experience would display greater positive change in environmental knowledge, attitudes and ecological intention to act responses on the survey questionnaire from the pre-test to the post-test than students in other groups. The research was designed to test the learning value of direct underwater reef experience compared with classroom learning interventions against a contrast group of students as set out in Figure 26.

5.4.2 Design of Survey Questionnaire

Reported changes in environmental knowledge, attitudes and intention to act, were surveyed in the following way. Knowledge was tested using a multiple choice answer format. In comparison, attitude and intention to act questions employed a six-point response scale: 6=strongly agree, 5=somewhat agree, 4=mildly agree, 3=mildly disagree, 2=somewhat disagree, and 1= strongly disagree. The higher the score from 1 to 6, the more positive was the student's attitude or intention to act. The pilot survey determined a six-point response scale was preferable to a five-point scale as

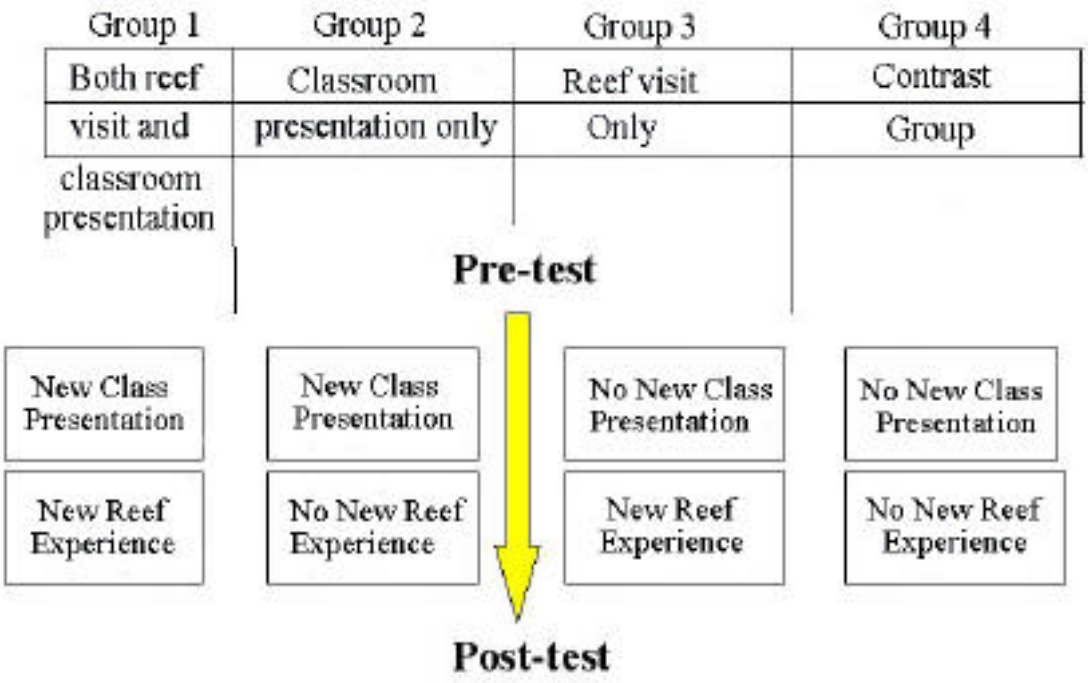

Figure 26. Project experimental design.

participating students had a tendency to answer a high percentage of the questions in the middle, and make the 'no opinion' selection. A six-point response scale requires participants to choose to be either positive or negative, since there is no middle or no opinion response available. Demographic information was collected from the participants on the pre-test survey.

In designing the surveys, a number of factors had to be considered. One limitation was that surveys could take no longer than 20 minutes of class time to complete. Others were that the surveys had to incorporate questions on knowledge of coral reef ecology, environmental attitudes, ecological intention to act, as well as demographic information, and had to be designed to answer the research question. In all, there were 47 questions, which included 39 knowledge, attitude and intention to act questions and 8 demographic questions. The reef ecology component contained 19 questions; 9 pertaining to knowledge, 5 to attitudes, and 5 to intention to act relating to reef animals, plants, aesthetics, the reef system, relationships to other ecosystems, governmental actions and personal actions that affect the reef. A human impact component, concerning impacts on the reef through personal actions, contained 10 questions with 5 pertaining to attitudes, and 5 for intention to act. An alternative solutions component consisted of 10 questions, 5 on attitudes and 5 on intention to act, relating to personal actions that students intended to take with respect to the reef. Demographic information referring to gender, age, education level, watching nature documentaries on TV and previous reef, snorkelling and camping experience was collected in the initial pre-test survey.

To survey students' knowledge, questions had to be specific, but not too difficult. To compile the knowledge questions, I modified questions from the Coral Reef Quiz listed on the Environment News Network website (retrieved 22 November 2001 from www.enn.com), and questions from the Great Barrier Reef Marine Park Authority Reef Ed materials. There were 13 true/false knowledge questions on the original pilot surveys, but I reduced it to 9 multiple-choice questions for the full study.

To create questions to investigate attitudes and intention to act, I consulted the following: Investigating and Evaluating Environmental Issues and Actions (IEEIA) work by Hungerford et al. (1996), the *New Environmental Paradigm* (Dunlap & Van Liere, 1978), *Constructing a TpB questionnaire: conceptual and methodological considerations* (Ajzen, 2002), the Ecological Behaviour Scale from Kaiser et al. (1999) and Kaiser, Fuhrer, Weber, Ofner & Bühler-Ilieva (2001), and the Millward-Ginter

Outdoor Attitude Inventory (MGOAI) utilised in Ohio adolescent outdoor education research by Mittelstaedt et al. (1999). My pre-test and post-test survey instruments were tailored to the specifics of Australia and tropical marine education.

The reliability was checked by using thirteen similar questions, three of which were negatively biased. Negative questions were posed to avoid situations where questions were all answered similarly (Babbie, 2004), and a number of questions were restated in different ways throughout the survey. More than 10 unanswered items made a survey unfinished, and it was not counted in the analysis. It is possible for diligent participants to miss a few items, and this is not examined in this research. It is also probable that some of the items on the survey questionnaire did not make sense to a number of the participants, and this issue was not addressed since I had no way of measuring this. There were likely to have been literacy issues involved that affected students' ability to complete questionnaires. These issues could not be addressed in this research, as students' literacy histories were not available to me on privacy grounds.

There were a total of 19 environmental attitude questions asked in the survey, and 15 were used in the analysis. Six New Environmental Paradigm questions (Dunlap & Van Liere, 1978; Dunlap, et al., 2000) were used on the survey instrument (question numbers: 17, 30, 37, 39, 41, 47), with only one question being used in the component one analysis, and that was 37. The intention to act section had 20 questions initially, but was trimmed down to 15, with one being negatively worded, after the pilot study. The questions were modified for coral reefs, again from the work of Ajzen (2002) and the ecological behavioural scale (Kaiser, et al., 1999). Intention questions were covered in three components (reef ecology, human impacts and alternative solutions) and were modified to be relevant to coral reef environments. It became obvious after the pilot study that my initial surveys were too long and many questions too complex to read quickly. These questions were modified or removed completely.

5.4.3 Research Orientation

The research attempted to test the Model of Ecological Intention to Act as outlined in the Chapter 4. The experimental design (Figure 26) employed quantitative techniques for examining causal relationships and effects of marine experiential, education within a five-week period of time. The dependent variables were evaluated by responses to survey questionnaires, and measured changes in environmental knowledge

attitude and self-reported intention to act as shown in Table 5. The independent variables were direct reef experience and classroom presentations.

Table 5. *Independent – Dependent Variable Relationship to Educational Interventions*

Dependent Variables	Independent Variables	
	Direct Reef Experience	Classroom Presentation
Reef Knowledge		
Environmental Attitude		
Ecological Intention to act		

The three dependent variables were divided into three components each (Table 6), so the variables could be compared to each using consistent components across these variables. According to Hines et al., (1986/87), Hungerford and Volk (1990), Marcinkowski (2001), and Frick et al., (2004), there are distinct categories of environmental knowledge. These are: (1) knowledge of ecology and natural history (how the world works); (2) knowledge of environmental problems and issues (human impacts); and (3) knowledge of alternative solutions and action strategies (for protection and restoration). In this research, I consider knowledge, attitudes and intention to act with respect to reef ecology (component 1), and consequently only this component is fully investigated.

Table 6. *The Three Components of the Dependent Variables*

	Knowledge (K)	Attitude (A)	Intention to act (Ac)
1. Reef ecology and natural history (how the world works)			
2. Reef environmental problems and issues (human impacts)			
3. Reef alternative solutions and action strategies (for protection and restoration)			

Few studies have differentiated between the three areas of environmental knowledge (Frick, 2001; Frick, et al., 2004), yet these relate differently to how people learn (T. Marcinkowski, 12 March 2002, private correspondence). I only investigate one

of these areas, namely knowledge of ecology and natural history, and this is one limitation of the research.

Table 7 sets out the dependent and independent variables in a matrix. When making the dependent variable comparisons, K is the acronym for knowledge, A for attitude and Ac for intention to act, as long-term action could not be measured in the context of this study design. The type of knowledge, attitude and intention to act questions relating to reef ecology are designated with an 'X' in Table 7.

Table 7. *Component Relationships to Independent and Dependent Variables*

	Independent Variable (IV)	
Dependent Variable (DV)	New Ecological Knowledge	New Environmental Experience
Environmental Knowledge (K)		
1. Knowledge of reef ecology	X	X
2. Knowledge envir. problems		
3. Knowledge of solutions		
Environmental Attitude (A)		
1. Attitude to reef ecology	X	X
2. Attitude to envir. problems		
3. Attitude toward solutions		
Ecological Intention to Act (Ac)		
1. Intention to act toward ecology	X	X
2. Intention to act to envir. problems		
3. Intention to act toward solutions		

Table 8 sets out the survey questions that correspond to attitude (A) and intention to act (Ac) as related to reef ecology, human impacts and alternative solutions. In analysis, the attitude and intention to act scale-responses from each component were added together to establish an environmental attitude and ecological intention to act scale. Then correlations were investigated between changes in survey answers from the pre-test to the post-test. Each correlation was compared to the other correlations within the same component. This determined whether or not a relationship existed between the experience of reef environments and the effect of educational interventions.

The issues of reliability, validity and degrees of freedom were considered. Reliability is the accuracy or lack of distortion of a measuring instrument, (Kerlinger & Lee, 2000), in other words it refers to the consistency of measure. It was critical to ensure the adolescent participants were interpreting and responding to the questions

consistently, so a number of questions were restated in varying ways throughout the survey, and then the results of the questions were compared if the surveys appeared

Table 8. *Attitude (A) and Intention to Act (Ac) Question Numbers per Component on the Survey Questionnaire*

Components	Attitude Survey Questions
Reef Ecology (1)	14,16,21,37,42
Human Impacts (2)	18,30,35,40,41
Alternative Solutions (3)	19,23,36,38,48
Components	**Intention to act Survey Questions**
Reef Ecology (1)	20,22,27,28,32
Human Impacts (2)	29,31,44,49,50
Alternative Solutions (3)	33,34,43,45,46

unusual. To calculate the internal consistency of the pre-test and post-test, the alpha reliability co-efficient (Cronbach's *alpha*) was computed. This test indicated whether participants responded to the questions consistently. Responses from the pre-test and post-test were examined for sufficient reliability, and dependable results were indicated by a score greater than 0.7 (Pollant, 2001), with the closer to the numeric 1.0 the better (Sowell, 2001). The alpha reliability coefficients (Cronbach's alpha) for responses on the pre-test and post-test were 0.830 and 0.839, respectively. The test/re-test reliability was 0.90, and these reliability coefficient scores indicated that the participants responded to the questions consistently, from the pre-test to the post-test.

The validity of measurement refers to truthfulness of information generated by an instrument (Sowell, 2001). The types of validity considered in this analysis were content validity, construct validity, convergent validity and face validity. Content validity, the representativeness or sampling adequacy of the content (Kerlinger & Lee, 2000), covered the Marine Studies and Marine & Aquatic Practices students in the schools surveyed. The study population was not randomly selected. Therefore statistically, the results may not be generalisable to students outside of the schools involved. However, the results can be seen as educationally significant, as there is so little fieldwork conducted into high school students' experiences of marine

environments. There are no other educational studies of this type on coral reef education in Australia.

Construct validity is significant because it links psychometric notions and practices to theoretical notions (Kerlinger & Lee, 2000), and relates to which factors or constructs account for variance in test performance. This is not simple to validate, since it is validating the theory behind the test. Theoretical constructs informing the research design can be read as valid since they have been used in a substantial number of previous research projects, and have been discussed in numerous journal articles over the years. There is no known mechanism to quantify construct validity, but it does measure the concepts as described by the literature.

Convergence considers how that evidence from differing sources, gathered in disparate ways, is then combined to indicate the same or similar meanings of the construct (Kerlinger & Lee, 2000). Separate empirical and interview methods address the dependent variables, providing a means for creating construct validation. A dual methodology provides dual perspectives to establish whether results are empirically differentiated from one another. Convergence was addressed in this study by using quantitative and qualitative data collection techniques, to give dimension to the research.

Face validity refers to how well the test appears to measure what it is supposed to. This study was designed to lessen the influence of extraneous variables as much as possible. The variables of education, age, reason for going to the reef and socialisation were addressed by using Australian English speaking students in the same year (when possible) who were approximately the same age and had similar reasons for going to the reef (a school excursion). Dissimilarities generated by uncontrollable extraneous variables did exist, but the effects of these differences were minimised by the use of a large sample size, using multiple measures and a number of varied data collection techniques.

5.4.4 Schedule of School Research

The five participating high schools were each available at different times throughout the year, and data collection coincided with each school's scheduled reef trip. The project proper started with Woree State High School in March 2003 and the data collection phases of this work were continued until November 2003 (Table 9).

Table 9. *Schedule of High School Research by School in 2003*

School	Pre-test	Class Present	Reef Trip	Post test
Woree State High School	18-Mar	25-Mar	3-Apr	14-May
St. Mary's Catholic College	28-Mar	7-Apr	15-Apr	26-May
Southern Cross Cath. College	29-Jul	6-Aug	9-Aug	6-Oct
Good Counsel College	18-Aug	25-Aug	29-Aug	23-Oct
Cairns State High School	13-Oct	21-Oct	13-Oct	21-Nov

5.4.5 Educational Effects and Hypotheses

Figure 27 sets out my initial hypotheses. I predicted students from Group 1, who experienced both a classroom presentation and direct experience with a coral reef would record the highest increase in environmental knowledge, attitudes and ecological intention to act compared to other groups. By testing the effects of classroom presentations and coral reef visits separately in Groups 2 and 3, I predicted the student data would be able to demonstrate the measurable educational effects of each intervention. Group 4 serves as the contrast group, and these students were expected to show little change in knowledge, attitudes or intention to act.

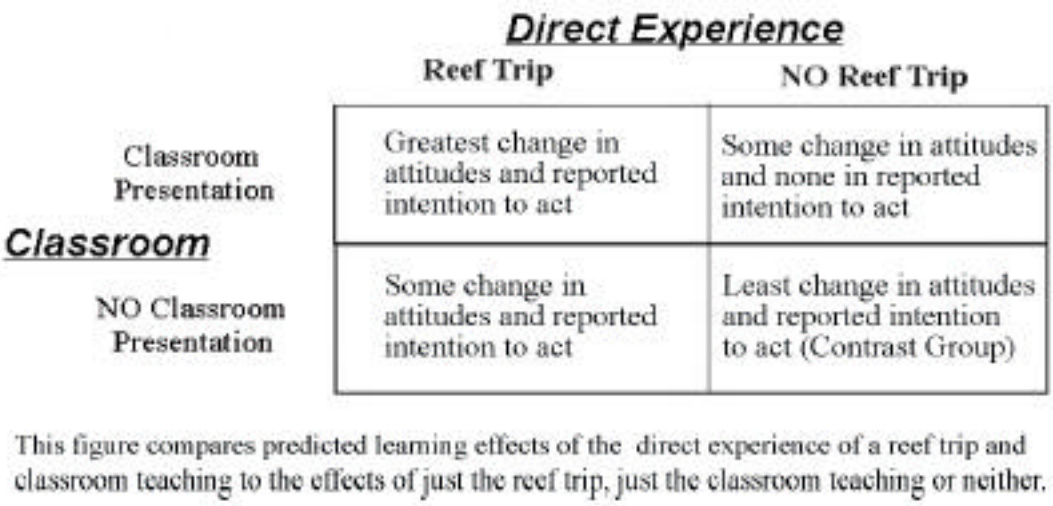

Figure 27. Predicted outcomes of experiential education.

The research hypotheses are:

1) The relationship between environmental knowledge, environmental attitudes and self-reported ecological intention to act would be stronger when marine experiential education (direct experience of coral reefs) occurred;

2) Marine experiential education at the reef would increase the environmental knowledge, attitudes and self-reported ecological intention to act of participants more than classroom presentations alone;
3) The student contrast group (those not exposed to the classroom presentation or coral reef experience) would have the least increase in environmental knowledge, attitudes and self-reported ecological intention to act;
4) There would be a difference in the students' environmental knowledge, attitudes and ecological intention to act with respect to reported amounts of previous reef experience, snorkelling, camping and watching nature documentaries on television;
5) There would be a difference in the effect of experiential educational interventions with respect to gender: related to change in environmental knowledge, attitudes or self-reported ecological intention to act.

The following hypotheses were generated from the research hypotheses with regard to the dependent variables of ecological reef knowledge, environmental attitude and ecological intention to act:

a. Marine experiential education (coral reef education and direct reef experience, together) increases the environmental knowledge of participants;
b. Marine experiential education increases the self-reported environmental attitudes of participants;
c. Marine experiential education increases the self-reported ecological intention to act of participants;
d. Marine experiential education increases the environmental knowledge of participants more than classroom presentations alone;
e. Marine experiential education increases the self-reported environmental attitudes of participants more than classroom presentations alone;
f. Marine experiential education increases the self-reported ecological intention to act of participants more than classroom presentations alone;
g. Reef learning excursions increase the environmental knowledge of participants;
h. Reef learning excursions increase the self-reported environmental attitudes of participants;
i. Reef learning excursions increase the self-reported ecological intention to act of participants;

j. The relationship between ecological knowledge, environmental attitudes and ecological intention to act becomes stronger when marine experiential education classroom and reef interventions occur;

k. There is a relationship between self-reported ecological knowledge, environmental attitudes and ecological intention to act;

l. There is a relationship between self-reported environmental attitudes, ecological intention to act when direct reef experience occurs.

Demographic information extracted from pre-test questionnaire responses examined previous reef experience, swimming frequency, snorkelling frequency, past experience of camping, and watching nature documentaries on television and gender. The following demographic hypotheses were generated:

m. Previous experience at the Great Barrier Reef influences change in self-reported 1) environmental knowledge, 2) attitudes or 3) ecological intention to act;

n. Swimming frequency is related to change in self-reported 1) environmental knowledge, 2) attitudes or 3) ecological intention to act;

o. Past experience of snorkelling is related to change in self-reported 1) environmental knowledge, 2) attitudes or 3) ecological intention to act;

p. Past experience of camping is related to change in self-reported 1) environmental knowledge, 2) attitudes or 3) ecological intention to act;

q. Watching nature channels on TV is related to change in self-reported 1) environmental knowledge, 2) attitudes or 3) ecological intention to act;

r. Gender is related to differences in self-reported 1) environmental knowledge, 2) attitudes or 3) ecological intention to act.

5.5 Quantitative Data Analysis

Associations between experiential education and environmental knowledge, attitudes, and ecological intention to act as identified on pre- and post-test summary results were analysed to determine if quantifiable evidence of changes existed after classroom and coral reef site learning experiences. Interrelationships were explored by utilising the statistical procedures of SPSS11 exploratory statistics, Spearman's *rho*, and the two-tailed Mann-Whitney U test, a non-parametric technique for unmatched and ranked data. This test assessed whether the means of the dependent variable for each group defined by the independent variable were asymptotically significant.

Comparisons of responses from the survey instrument were used to test the premise that the contrast group (Group 4) would not have increased awareness, attitudes or intention to act in regard to coral reefs, and Group 1 with new reef experience and class presentation would have the most increased awareness, attitudes or intention to act of all the groups. The variables of knowledge (K), attitude (A) and intention to act (Ac) were compared and contrasted through the use of arithmetic means and SPSS11 exploratory statistics (including histograms and box plots), which display central tendency and normalcy, and causal relationships. Each of the attitude and intention to act answers were added together within each component to construct an environmental attitude and ecological intention to act scale to search for associations between changes in survey answers from the pre-test and the post-test.

A correlation coefficient was used to express the significance of relationships between groups and researched factors in the research data set. Spearman's *rho* was chosen since this correlation is robust and ordinal data can be analysed (Miller, Acton, Fullerton & Maltby, 2002). The two-tailed test was utilised since it was a more powerful correlation and it determined whether the variables were not only correlated, but also whether they were negatively or positively linked, and significant to the 0.05 level (2-tailed).

Relationships between groups were determined using the Mann-Whitney U test. This non-parametric test compares the efficiency of two test statistics and represents the asymptotic limit of the ratio of sample sizes needed to achieve equal power. It compares two equal groups against a null hypothesis to establish whether a p value exists less than .05. The data was ordinal and nominal, not randomly selected, and with a limited number of distinct levels, so it was not suitable for parametric analysis techniques. This procedure examined the effects of two independent variables on three dependent variables listed as student learning effects, as well as the effect of gender.

A causal comparative analysis was performed to inquire into how demographic factors affect dependent variables. The demographic factors are previous reef experience, previous swimming experience, previous snorkelling experience, previous camping experience, propensity to watch nature channels on TV, and gender. Previous reef experience was included since the effect of reef experience is a focus of this study. Gender was selected because there are other Australian studies on the topic and because of its importance to current educational research studies; and camping was chosen because it appeared to be important in the exploratory pilot research for this project.

Swimming, snorkelling, and watching nature channels on TV were also used in this study because they were referred to in earlier USA marine education research by Fortner (1978, 1983), so it was decided to also investigate their effects in Australia**.** All this demographic data is ordinal, except for gender and this is nominal.

5.6 Qualitative Research Methodology and Analysis

5.6.1 Qualitative approach

It became apparent to me that expanding the research study could provide additional insight into students' learning experiences with respect to coral reef environments. In order to investigate this conceptualisation, a set of interviews was used to provide information concerning the symbolic content relating to student reef experience and learning.

As "the reference point in experiential learning is the learners' [experience]" (Greenburg, Rice & Elliot, 1993, p. 21) then qualitative research enables the presentation of the participating students' perspectives on their experiences of a coral reef including coral reef monitoring. Students were not asked to participate in interviews concerning their experiences of the classroom presentation. Interviewing is a central component in qualitative research (Baker, 2004; Bell, 2003; Berry, 1999; Denzin & Lincoln, 1994; Huberman & Miles, 2002; Sowell, 2001; Strauss & Corbin, 1998). The model of analysis followed in the qualitative aspect of this research was that of comparative method (Huberman & Miles, 2002). Thus, by using a limited qualitative methodology in this study, evaluation by limited thematic interviews augment the empirical data on the coral reef experience.

In social research, qualitative interviews "are very widely used in the context of quantitative research projects " (Hopf, 2004, p. 203). These interviews generate additional perspectives and insights about students' environmental knowledge, environmental attitudes and intention to act. I used two interview techniques, researcher and peer interviews, in an attempt to secure a better understanding of student perspectives. A triangulation of the interviews was used to validate and extend empirical findings (Cobb, et al., 2003; Neuman, 2004; Sowell, 2001). My own training as a quantitative researcher placed limitations on my ability to understand the nuances of qualitative methodology. Indeed, I had no formal training in qualitative methods and stayed with the foci of the quantitative study rather than tap into student generated concerns and emphases.

I conducted short *in situ*, and as a consequence, limited interviews rather than a few detailed and extensive discussions because I decided that with only one opportunity to interview the students, it would be preferable to have many answers from a number of students in order to investigate the consistency of their experiences. We were in outdoor situations, such as on-board boats, and these situations are not conducive to longer more personal, detailed accounts. The time available to interview students on the occasions I was with them was limited, leaving little opportunity to delve into their themes and meanings as did earlier adolescent researchers such as Walker (1988) and Willis (1977). Nonetheless, this firsthand information collected from the participants themselves increases the accuracy of findings and depth of the research as a whole, and presents accounts of the student participants on the immediacy of their underwater learning experiences.

It is probably fair to say that qualitative methods generally share the three fundamental assumptions of a holistic view, an inductive approach, and naturalistic inquiry (Patton, 1990; Rudestam & Newton, 2001). This combination of assumptions produces a methodology where relationships between factors involved in the phenomenon/phenomena are being investigated through an inductive approach to collecting evidence, and a naturalistic inquiry that is collecting evidence in a real life setting in which participants are disturbed by the researcher as little as possible. The holistic approach stresses the whole as more than the sum of its parts, and seeks to understand phenomena in its entirety. By contrast, the experimental paradigm aims to "isolate and measure narrowly defined variables ... where understanding is tantamount to prediction and control" (Rudestam & Newton, 2001, p. 37). In the inductive approach (Denzin & Lincoln, 2000), research begins with specific examinations and moves to develop general patterns between factors that emerge from different cases.

In student interviews, I used questions similar to those informing the empirical research. Interview questions (which are reproduced in full in Appendices M and N) were specific and consistent for all student interviews, in an attempt to create a basic interpretive technique for understanding how students derive their own meanings from their reef experiences. I had hoped interview questions would provide opportunity for the students to articulate their ideas in detail. Of course, this did not always occur, as adolescents are not always forthcoming with an adult interviewer.

To enable the students to feel more comfortable with the interviewing, I conducted group rather than individual interviews, involving 2 to 4 students. One

advantage of this method was the intention that students could build upon and gain confidence from each other's words and stories (Bell, 2003). The interviews took place after the reef experience, with the tapes transcribed and the transcripts analysed later.

Students were also given the opportunity to conduct peer interviews in front of a video camera, where they asked each other scripted questions. This interview process was intended to illuminate student perspectives, with minimal researcher control. A university student assistant operated a video camera, while students interviewed each other in groups of two to four. The students used a set of structured questions furnished by the researcher to interview fellow students, similar to news reporters on television. In some instances, the same students participated in both researcher and peer interviews. Records were kept of these student names to avoid duplicity of response data. There was no set number of students interviewed per trip as students were chosen as a matter of convenience. If a student did not feel comfortable with the interview process he or she would not be interviewed. The peer video interviews gave students an opportunity to give an account of their own experiences in front of their classmates. These videotaped interviews were subsequently transcribed and the transcripts analysed.

Designing a methodology for appraising and evaluating changes in students' learning was difficult (Whitehouse, 2001), particularly as all interviews were to be conducted in the field, on boats and on the beach, in marine environments. The interview questions had to be specific enough to focus on distinct differences, as the objective of interviewing a large number of students was, in the first instance, to reveal relevant differences or similarities, and provide an expanded base of students' opinions about coral reef experiences. The time available with each student was short, with some time and interview quality being lost, if students were distracted by their fellow students, or by the numerous positions and weight shifts generated by the wave motion on a boat at sea. Many qualitative researchers work in depth with small numbers of students and, more time with each participating student may have been preferable. However, because I wanted to expand the investigation to incorporate student accounts concerning situational reef experience, I accepted that short interviews were preferable to no interviews at all. The number of students interviewed was limited by the time taken for the return trip to port on day trips, or by the timetabling for daily activities with regard to the week-long trip to Northwest Island.

The combination of the quantitative and qualitative methodologies can be difficult to implement at times. These two investigative procedures approach a problem

from completely differing perspectives, and the act of mentally moving from one to the other can be extremely confusing for the researcher (Lincoln & Guba, 1985, p. 37). However, for the most comprehensive results, I felt that meeting the difficulties associated with this combined form of research design, which was capable of engaging a number of different elements, was worthwhile. A reflexive stance with respect to experiential education is necessary, as marine education actually deals in a plethora of complex real-life situations that are adisciplinary in nature.

On the basis of findings from the pilot study, some interview questions were changed so they were more easily understood by the high school students and were easier for them to answer. The ideal is for the researcher not to impose an organising structure or make assumptions about the inter-relationship among the data before asking the questions, although this was not possible in this research. This is "quite different from the hypothetico-deductive approach to experimental designs that prescribes specification of variables and hypotheses prior to data collection" (Rudestam & Newton, 2001, p. 37). The naturalistic inquiry investigates phenomena as they happen in real life, unlike, experimental research, which uses controlled conditions, and a limited set of outcome variables (Rudestam & Newton, 2001).

5.6.2 Interviews

In order to investigate the conceptualisation of an actual reef visit, interview procedures were designed by the researcher to provide information relating to the symbolic content regarding student experience and learning. This section describes the framework with which this naturalistic inquiry was based. The method evolved through connection with the use of interview inquiry to clarify key conceptual images and support the quantitative foundation of this study. The use of structured interview in this situation was an approach, which attempted to assess the meaning of events through alternating processes of inductive reasoning and linear logic. This transpired because the research process involved both the researcher and participants as they examined the educational construction of a shared experience (Imel, Kerka & Wonacott, 2002), The research process itself was reflected upon as well as the possibilities and responsibilities inherent in the act of writing this thesis.

Structured interviews were conducted using a standard set of questions to inquire into students' experiences of learning in coral reef environments. Question prompted answers were intended to provide a mechanism for capturing the verbal

accounts of the students' experiences, and intertwining these data into the research story (Bell, 2003). Complications associated with the interviews, came from the limited nature of the structured interviews and standard set of questions derived from the quantitative framework. Utilising structured questions produced insufficient data for a truly inductive narrative study. The fact that these students were adolescents and the researcher was only with them briefly, made accurate and significant communication difficult (Huberman & Miles, 2002). Interviews were analysed with an understanding of these factors.

In the recorded interviews, the students gave brief, but accurate accounts of their learning in reef environments. These, I suggest, were generally consistent with their lived experiences (Rudestam & Newton, 2001). Interviewing took place on the return trip when the weather was calm enough to do so. Some students refused to be interviewed for undetermined reasons.

It is important (although at times extremely difficult in qualitative research) for researchers to put aside their prior beliefs concerning the research phenomenon, which could interfere with seeing or intuiting the elements and relationships properly. Interview data can enable a reader to empathetically share thoughts and emotions associated with students' reef trip experiences. In addition, interview responses collected from students with very different backgrounds may show how much they have in common (Thomas, 2003). These interviews are central to understanding the student viewpoints about learning at a coral reef and what the coral reef learning experience meant to them. From interviews, however short, we get a glimpse of students as active constructors of their own learning as they attempt to articulate their impressions.

The interviews all took place immediately following the reef site experience, on the beach or during the boat ride back from the reef. This created opportunities for the participants to recall their reef experiences after the shortest possible time elapsed. Students had an opportunity to discuss what they valued, liked, and disliked about their coral reef visit and monitoring exercise while it was still fresh in their minds. Many empirical studies have been conducted concerning environmental knowledge and attitudes of high school students, but there is very limited research concerning the viewpoints and perspectives of the students themselves (Rickinson, 2001).

The interviews offered insights about the meaning of marine experiential learning outside of empirical explanations. Structured interviews were used for a number of reasons. The same questions on all the trips were used to maintain a degree

of reliability between different schools and student groups. Structure was necessary in order to complete the interview process successfully in the short time available. It minimised opportunities for a lack of concentration that might disrupt the process. From a large number of interviews, it was anticipated that general patterns of responses would emerge. A comparative method of analysis was utilised (Miles & Huberman, 1994) as shown in Figure 28, and involved reading and re-reading the transcripts to establish whether patterns of repetition and differentiation could be found.

These transcripts of student responses were read and sorted, with no data processing program used to analyse the scripts. Analyses were conducted twice - first to make subjective but consistent judgements of responses to the structured questions according to question topic and then further analysed and sorted looking for concepts of proximity in student accounts to assess whether students were able to locate their experiences in space and place. Proximity is defined as attachment, kinship and nearness in space or time. Proximity as a relationship between learners and marine environments is promoted in the Queensland Studies Authority (2005b) Marine Studies Syllabus, as teachers are encouraged to treat marine environments as sites of learning and not just as objects of study.

Central to the qualitative analysis is a question posed by Rose (1999, p. 252) who asks, “what kinds of space articulate what kinds of corporealised relation?” On the premise that environmental education research is an investigation of relations and relationships between differing bodies, both social and physical, the research questions do concern the actual sites of learning. The first question addressed in this qualitative analysis is, how do senior high school students relate their learning within classrooms to their experiences of learning within coral reefs in the context of marine studies pedagogy? The second question is, how do senior high school students come to understand the corpo/realities of coral reefs through their underwater immersion experiences? The third question is how do senior high school students express a further ecological intention to act as a result of their immersion experiences on the Great Barrier Reef? These inductively developed themes were re-checked against the entire list of interviews, looking for confirming or disconfirming evidence. The texts (as data) were categorised into 3 questions. The results of the qualitative part of this study are presented in Chapter 7.

5.7 Limitations

There were limitations relating to the methodology, data collection and analysis. The methodological limitations were present in both quantitative and qualitative approaches.

5.7.1 Limitations of the Research Methodology

The time allotted by the teachers and schools for the educational interventions in both the classroom and at the reef was short. The classroom presentations were approximately fifty minutes and there was only one reef visit per school on the day trip. The classroom presentation and reef experience interventions were not fully developed temporally. One fifty minute classroom presentation and one visit to the reef per school was not what I would have selected if I had been allotted more time with the students, but this was all that was possible. With more time, a more methodologically developed series of interventions could have been implemented. This may have had a bearing on results, but all educational research conducted in school time and within the limitations imposed by school timetables is so affected.

Attempts were made to lessen the effects of extraneous variables within the experimental design incorporating real students in real learning situations. This was accomplished with students in approximately the same education level (Years 11 and 12), being of approximately the same age (average = 16.0) and living in the same Australian society attending Queensland high schools. Disparity in age, culture and educational attainment did exist, but effects were minimised as much as possible. The high school students did not all monitor the same reef, or travel on the same boat. It was hoped to use the same location for all reef monitoring, but this was not possible because of funding restrictions and marine teachers selecting various reef locations. Even though consistency was a major aim, the classroom presentations did differ from school to school because of varied student engagement, time constraints and logistical limitations. Some effects of uncontrollable differences were minimised by the large population size.

Logistical and time-management problems arose for me as the solitary researcher, especially with the collecting of late consent forms, conflicting meeting schedules at geographically separate schools, while making sure all the necessary consent and field trip forms were completed with every reef trip, and collecting interview data from the students. Scheduling became a problem on a few occasions, with classes being at different times, on different days of the week, which did require

substantial travelling. The differing reef sites had to be surveyed prior to visits and the schools had to be contacted for the selection of the contrast group. The monitoring and organisational duties at the reef required total concentration. Nonetheless, I was sometimes distracted or tired and the quality of my interview data collection may have suffered. Using qualitative and quantitative research methods concurrently did cause me confusion at times. There were limitations in the qualitative research design as stated earlier, but analysis of the interview data I was able to collect was done to the best of my ability.

5.7.2 Limitations of the Research Data Collection

Limitations in the data collection phase of this research are that the total student group selected for the research was not truly random, with the participants being a statistically described convenience sample. A number of students were in marine studies programs and clearly self-selected, because they were interested in ocean related studies. This might imply that they came to the study with a positive attitude toward the environment. Nonetheless, all the students were tested at the beginning of the project to evaluate this bias, including those from outside marine studies.

The contrast student group was selected by school staff from similar available classes without researcher input. These students generated a high amount of inappropriate answers, wondering, “why answer questions, when there is no reward for me?” These are perfectly understandable responses for adolescents, and I am grateful to all the staff and students who provided the contrast group data.

Some of the student groups visiting the reef were large with over 56 students, 6 teachers, 3 JCU student helpers, and one researcher. Even though the weather was generally good and the students well mannered, it proved difficult to teach and keep so many students focused whether they were on the boat or in the water. On some trips with large classes, it was possible to keep only sixty percent or so of students actively participating in reef monitoring, even though the remainder were still actively snorkelling around the reef-monitoring site.

On a few occasions the pre-test and post-test survey questionnaires were administered late, and there were some problems getting the finished post-test surveys delivered back to the researcher in a timely manner. This problem of delinquent survey completion occurred a number of times and could have been avoided if I had provided more support for the teachers. Leaving it up to the teachers on their own was not wholly

appropriate since they have so many other school and job responsibilities. In retrospect, as a researcher, I should have gone into the classroom to administer the post-test on the last classroom visit myself, rather than further burden the teachers with this task.

More time probably needed to be spent with the students during the interview phase following up on ideas as they were expressed. This was not predicted from the pilot study, as tertiary students and small high school groups of students provided expanded answers to the study's structured interview questions. Once the high school student groups on the day trip became large, the students' answers to the questions became short and sometimes repetitive. Thus, a limitation on data collection may have been that this project was similar to many other qualitative research studies that were "based on the same realist and objectivist assumptions as quantitative studies" (Imel, et al., 2002, p. 6).

5.7.3 Limitations of the Research Analysis

Limitations exist in the research analysis used in this study. Two limitations were: 1) the use of only one of the three components available for analysis; and 2) the use of arithmetic means for investigating relationships between environmental attitudes and ecological intention to act across components. Therefore, in the framework of this study it became impossible to determine if certain components had more impact on the variables than other components.

A student can hold more than one attitude simultaneously about the same phenomena (Ajzen, 2001), and these can change from moment to moment (Azjen & Fishbein, 2005). Hence, when a response is given, different attitudinal responses can be assumed depending upon the situational constraints or timing involved in the person's particular feeling at any given moment in time during the survey process. I addressed this by utilising at least two data collection points and then comparing the answers, which were collected at differing times and locations. But these limitations remain extant.

The size of the different student treatment groups was dissimilar and could have affected final results, but the sample was statistically demonstrated to be large enough to compensate for this limitation. The long-term learning effects, attitudinal change and intention to act were not studied in this research project. The scope of this work did not allow for a longitudinal study, nor did it allow for ascertaining the effects of family, school, peer groups and predisposing factors. All of these can have an impact on the

formation of adolescent attitudes and actions.

When conducting a study of this type, the results can become a self-fulfilling prophecy. Because this work only measures and analyses the variables of knowledge (awareness), attitude and intention to act, these results alone are the only ones generated. Since it was found that broad or situation-specific variable relationships were relatively weak there is little else to which to attribute the effects. One problem in the research design is that other variables are missing from the model and there is no indication which of these unknown variables could be responsible for any effect. The experimental design attempts to control for this, but it is extremely difficult to incorporate every possible variable into this type of study. Since we are not measuring variables, other than knowledge (awareness), attitude and intention to act, it is not possible to include others in the analyses, and therefore there is no basis to determine if the knowledge-attitude or attitude-action relationships are stronger or weaker than other relationships. The scope of this PhD was limited to logistically available options. Consequently, this work is a baseline study in Australian marine education and if it is determined to be sound, more variables can be investigated in future research, should any researcher be prepared to spend the considerable time necessary to gain administrative approval to conduct research with students in offshore marine environments.

5.8 Chapter Summary

This chapter described the methodological processes employed to investigate the research question. The quantitative methods used were pre- and post-test survey and statistical treatments to survey four different study groups. Evaluating the Model of Ecological Intention to Act required the dependent variables to be divided into three components each. The variables were then compared in a manner consistent with their individual components. Change was measured within the same component from one variable to the other. Dependent and independent variables were operationalised concerning environmental knowledge, attitude, and intention to act. Knowledge scores were calculated by using the number of correct responses, while attitude and intention to act scale-responses from each component were added together in order to establish an environmental attitude and ecological intention to act scale. These results were then compared before and after the educational interventions. The issues of reliability and validity were addressed. The large sample size as well as the use of multiple measures

and varied data collection techniques were employed to validate and add depth to the results.

The research hypotheses were established. It was predicted that students who experienced both a classroom presentation and direct experience with a coral reef would record the highest increase in scores for environmental knowledge, attitudes and ecological intention to act compared with other groups. Data on students' previous reef experience, swimming frequency, snorkelling frequency, past experience of camping, and watching nature documentaries on television were collected and tested for their effects. Gender was also considered.

Qualitative research was utilised to better understand students' perspectives concerning their coral reef learning experiences and the particular effectiveness of coral reef monitoring. Structured student interviews generated student accounts of learning experiences. All questions were consistent for all students in an attempt to improve understanding of how the students derived meanings from their reef experiences. Videoed peer interviews were used in an attempt to gain more objective student viewpoints. All interviews took place on the beach or on the return boat trips. Limitations to quantitative and qualitative data collection and analyses were discussed.

SECTION TWO: QUANTITATIVE AND QUALITATIVE RESULTS – ANALYSIS OF EDUCATIONAL OUTCOMES

Chapter 6

Quantitative Results: Unpacking the Knowledge-Attitude-Action Relationship

Reefs

High by the long island's side
the rubble banks swim in the evening light
death-gray and bleached white, speckled together.
The Wind sings over the coelenterate dead
the hallow-gutted stone-sheath-dwellers
the lace-masons, the spicule shapers
the island makers.

Mark O'Connor

6.1 Introduction

This chapter provides the empirical analysis and results that explore learning relationships, marine educational outcomes and student demographics. The framework design of this quantitative analysis is taken from an experimental design (Figure 27) and explores interactions put forward in the Model of Ecological Intention to Act (Figure 10). It is an educational research project investigating a number of learning constructs, and considering indicator patterns covariation and interrelationship descriptions based on natural environmental interaction and past experience. This process evolved from adaptations and modifications of existing education and social psychology theories, and the formulation of a model to explain patterns in the responses (Hughes & Sharrock, 1997; Neuman, 2004). Furthermore, empirical relationships to specific learning outcomes and student backgrounds are explored with respect to environmental knowledge, attitudes and ecological intention to act.

Dependent variables are analysed after an explanation concerning variables, sample make-up and the survey instrument. The first variable considered is environmental knowledge (section 6.2.4.1), followed by the analysis of environmental attitudes (section 6.2.4.2) and ecological intention to act (section 6.2.4.3). Demographic variables, including previous reef experience of the Great Barrier Reef (GBR), swimming, snorkelling, camping and watching nature documentaries on television are

investigated (section 6.2.4.4). Then gender is considered with respect to the educational outcomes (section 6.2.5). The final sections incorporate a discussion and chapter summary.

The research question asks whether experiential reef education enhances student learning. This question is examined by measuring changes in student responses relating to environmental knowledge, attitudes and ecological intention to act between a pre-test and post-test. Related hypotheses address a number of issues concerning learning and the students' self-reported environmental knowledge, attitudes and ecological intention to act relationship, and how they are affected by student demographics. Educational interventions of a classroom presentation and a reef visit were implemented to discover whether relationships became stronger with marine experiential education. The experimental design was structured to determine if classroom presentations about coral reefs, actual reef visits or the combination of the two produced the greatest positive change in the dependent variable responses for student participants.

Exploratory statistics, Spearman's *rho*, t-tests, one way ANOVA, Kruskal-Wallis, Tukey's post-hoc test and the Wilcoxon/Mann-Whitney U test from SPSS11 (Statistical Package for the Social Sciences, version 11) were used to analyse the data. Exploratory statistics, including box plots, histograms and other normality information such as Q-Q plots, t-tests, ANOVA and post-hoc tests investigated pre- to post-test interactions for environmental knowledge responses and provided comparative information concerning students and groups. With the dependent variables of environmental attitude and ecological intention to act, this comparative information was generated with the Wilcoxon related samples and Kruskal-Wallis non-parametric tests. Spearman's *rho*, exploratory statistics, was used to calculate correlation tables for this ordinal survey data. Correlations compared numerically valued associations, as well as evaluating the intensity of relationships. The Mann-Whitney U test and Spearman's *rho* were used to examine the survey data relating to gender and demographic information. These analyses compared the answers given on the pre-test survey questionnaire and the post-test survey. Both Spearman's *rho* and the Mann-Whitney U test were used to analyse the variables and develop correlation tables from the data.

6.2 Data for Analysis and Interpretation

6.2.1 Independent and Dependent Variables

This research investigated student learning by describing changing parameters according to the experimental design. Dependent variables were environmental knowledge (K), attitudes (A), and ecological intention to act (Ac) (Tables 10 and 11). The independent variables included the educational interventions and demographics. A reef ecology classroom presentation and student visits to the reef for coral reef monitoring made up the educational interventions. Demographic information (as answered on the pre-test) consisted of students' existing reef environmental knowledge (awareness), previous reef experience, as well as previous experience pertaining to swimming, snorkelling, camping, watching nature television shows and gender. When considering interrelationship between changes in educational outcomes, it is critical to ensure that correct components are compared across the dependent variables (Table 11).

Table 10. *Independent Variables (IV) and Demographic Variables Shown in Relationship with the Dependent Variables (DV) of Environmental Knowledge (Awareness), Attitude and Ecological Intention to Act*

IV's	DV: Environ. Knowledge (K)	DV: Environ. Attitude (A)	DV: Ecol. Intention to act (Ac)
Class presentation			
New Reef Exper.			
Demographic Var.			
Pre-test knowledge			
Past experience:			
At the GBR			
Swimming			
Snorkelling			
Camping			
Nature TV			
Gender			

Table 11. *Independent Variables and Dependent Variables Shown in Relation to the Different Components that are Compared to Same Component Across Variables*

Dependent Variables	IV: New Learning Knowledge in Class	IV: New Exper. Monitoring at Reef
Environmental Knowledge (K)		
1. Knowledge of reef ecology		
Environmental Attitude (A)		
1. Attitude to reef ecology		
2. Attitude to human impacts		
3. Attitude toward solutions		
Ecological Intention to act (Ac)		
1. Intention to act toward ecology		
2. Intention to act: human impacts		
3. Intention to act toward solutions		

Reef ecology, the first component (Table 11), is fully analysed across three variables, but not the other components because knowledge information was not collected as in the first component. Table 12 lists the number of questions from the survey questionnaire relating to each component. Components under study were separated into the four student groups from the experimental design (Figure 26). The reef ecology component contains 19 questions pertaining to student opinions about reef animals, plants, aesthetics, the reef system itself, relationships to other ecosystems, and personal actions that affect reefs.

Table 12. *Survey Questions per Variables and Components*

Components	K questions	A questions	Ac questions
Reef Ecology (1)	9	5	5
Human Impacts (2)	0	5	5
Alternative Solutions (3)	0	5	5

6.2.2 Study Population Description

Quantitative survey data was collected exclusively from a convenience sample of high school students attending five Queensland coastal area schools. A sample for this marine education research was made up of senior high school students (Years 11 and 12) who were from Marine Studies and other programs as shown in Table 13. The

data obtained were survey and interview responses from predominately Year 11 students (88%). Most students were enrolled in science as well as Marine Studies subjects with a substantial percentage of the participants attending religious education and accounting classes (43%). Investigation of these Years 11 and 12 students minimised effects from extraneous and latent variables such as age, education level, culture, language spoken, and reasons for going to the reef. Many of the students were already participating in school arranged reef trips. The sample was selected by the participating schools, and was as consistent as possible from one school to the next.

Working with Education Queensland, the Catholic Diocese and the Marine Teachers Association of Queensland made it economically possible to visit the reef with hundreds of students, since they were transported and insured through their local school programs. The total number of high school students involved was 389. The total number of participating students (Tot. Students) and schools they attended are shown in Table 13.

Table 13. *Total Student Population Make-up by School and Course of Study*

School	Marine studies	Other courses	Tot. Students	Year-12
Woree SHS	53	21	74	24
St. Mary's CC	66	33	99	0
Southern Cross CC	38	17	55	0
Good Counsel C	20	27	47	22
Cairns SHS	43	71	114	2
Total	220	169	389	48

The student sample size used in the quantitative analysis was 320 (n = 320), as shown in the Total Gp column (Table 14), and all participating students completed a pre-test questionnaire. However, a number of students did not complete the post-test surveys for various reasons (non-part, see Table 14), so it was not possible to analyse the total number of 389. This group of 69 students (Table 14) included students who were not in class on the survey day, had changed schools, left a large number of blank answers to survey questions, or filled out survey questionnaires in an inaccurate juvenile manner. These students answered the questionnaires by making designs on the answer sheet, or writing crude and insensitive remarks in the margins.

Table 14. *Student Population Make-up by Participation of Students*

School	Gp 1	Gp 2	Gp 3	Gp 4	Total Gp	Non-part	Tot. Students
WSHS	19	11	4	25	59	15	74
SMCC	23	20	27	15	85	14	99
SCCC	15	3	20	11	49	6	55
GCC	18	10	5	11	44	3	47
CSHS	10	20	41	12	83	31	114
Total	85	64	97	74	320	69	389

6.2.3 Interventions and the Survey Instrument

Learning interventions such as classroom presentations and direct reef experiential education were investigated for effectiveness in achieving learning outcomes associated with marine education and Queensland Marine Studies programs (Marine Education Society of Australasia, 2004; Queensland Studies Authority, 2005a; Queensland Studies Authority, 2005b; Queensland Studies Authority, 2005c) and Environment Australia education goals (Department of the Environment and Heritage, Government of Australia, 1998; Department of the Environment and Heritage, Government of Australia, 2002). Quantitative data collected from the surveys contained 47 questions specifically designed for use in an educational experiment concerning knowledge, attitudes and intention to act as well as eight demographic questions. The information was separated and categorised by using ideas developed for measuring adolescent students' environmental attitudes and actions derived from the IEEIA (Investigating and Evaluating Environmental Issues and Actions from Hungerford, et al., 1996) and MGOAI scales (Millward-Ginter Outdoor Attitude Inventory from Mittelstaedt, et al., 1999).

In this study, attitude and intention to act questions were answered on a 1-6 graduated scale (strongly disagree to strongly agree). They were then correlated relating to changes from pre- to post-test by group. Data information showed reliability with a Cronbach's *alpha* score of 0.830 and 0.839 on the pre-test and post-test respectively, with a test/re-test reliability of 0.90. Student participants, whose ages ranged from 15 to 20 years, included 195 males and 125 females, with an mean age of 16.04 years.

6.2.4 Exploratory Statistical Analysis

Initially, the relationship between the dependent variable, environmental knowledge, and student groups was examined. Marine education was investigated by comparing the results from the groups that experienced varying educational interventions. Changes in responses from the pre- to post-test surveys were examined to determine whether or not marine experiential education increased environmental knowledge more than classroom presentations.

The students' mean score was 4.87 correct out of 9 on the pre-test knowledge portion: their scores ranged from 1 to 9. On the post-test, for students receiving educational interventions the mean score was 6.17 out of 9, an increase of 26.70%. A number of approaches were used to evaluate this phenomenon.

6.2.4.1 Environmental knowledge.

An SPSS11 exploratory analysis (Figure 28) produced a histogram (a) and Q-Q plot (b) that graphically depict the range of student responses on the knowledge portion of the questionnaire (n = 320). In the histogram (a), central tendency is

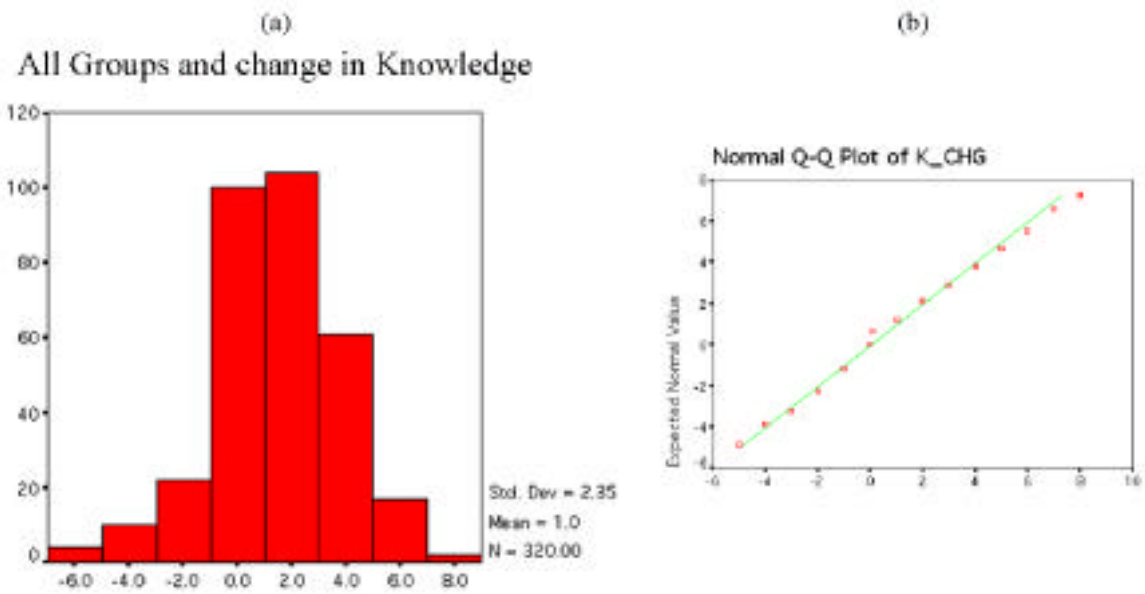

Figure 28. Normality of student responses for change in knowledge for all student groups from survey questionnaire.

positive of zero, with the vertical axis portraying numbers of respondents and the horizontal axis change in score. In a Q-Q plot (b) points represent student knowledge

responses and lie along a designated normality line. This histogram and Q-Q plot together show approximately normally distributed data.

Total knowledge scores were computed by adding up correctly answered knowledge pre-test and post-test questions, and then calculating the difference between scores. Figure 29 depicts knowledge change for various treatments by comparing the standard error of the means (±1 se) between different groups. Changes in positive answers for nine knowledge questions from pre- to post-test are shown along the vertical axis, with different groups along the horizontal axis. Group 1, which had both a reef ecology classroom presentation and reef experience, had the most change in survey scores and the highest post-test score, while Group 4 (contrast group) had the lowest. Group 1 percentage change was 44.73% to a mean score of 7.11 and Group 2 (classroom presentation) had a high mean score of 6.20 for the second largest increase of 28.70%. A one-way analysis of variance (ANOVA) was calculated for the groups for the pre-test survey ($p = 0.347$) and the post-test survey ($p < 0.001$) as the average value of their means from group to group differed significantly in the post-test and not in the pre-test (Miller, et al., 2002). A one-sample t-test was calculated to compare the means in each of the groups, and they all changed significantly except for the contrast group.

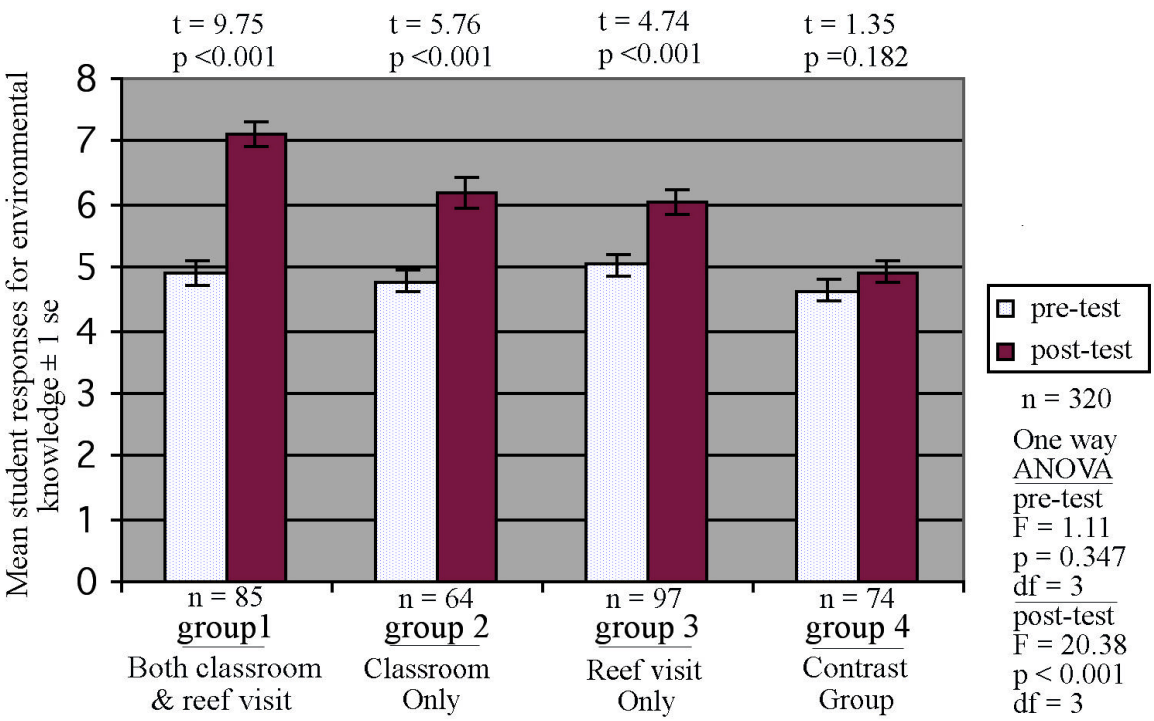

Figure 29. Knowledge changes for student responses per group, component one.

In order to evaluate significant differences between the individual group means a Tukey post-hoc test was calculated for the post-test responses (n = 320), and it showed

Group 1 (p = 0.010), Group 2 (p = 0.010), Group 3 (p < 0.001), and Group 4 (p < 0.001) at a 95% confidence interval. This post-hoc test described Group 1 as significantly different from all three other groups. Group 2 was significantly different from Group 1 and Group 4, and not significantly different from Group 3. Group 3 was significantly different from Group 1 and Group 4, and Group 4 was significantly different from all other groups. Group 1 received both interventions of a classroom presentation and reef visit, and had the highest positive knowledge score as well as the largest amount of change between the pre- and post-test. Effects of a classroom presentation is represented in Group 2, where the scores are higher than Groups 3 and 4, so a positive outcome was displayed for all groups receiving an educational intervention.

6.2.4.2 Environmental attitudes.

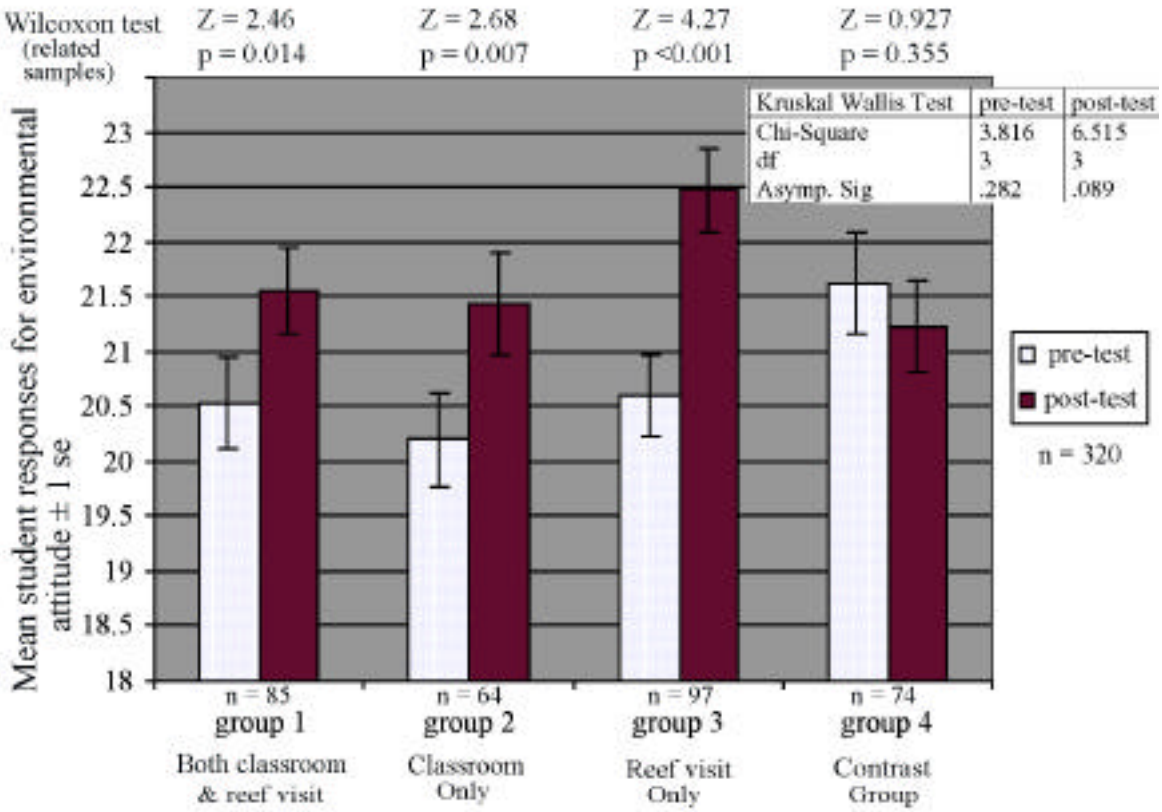

Figure 30. Changes in student attitude responses for the pre- to post-test per group for component one.

Overall, the environmental attitude portions of this work were more difficult to

calculate than the knowledge segment (Hungerford, et al., 1996; Mittelstaedt, et al., 1999). Knowledge questions were scored as correct, but all attitudes were ranked answers per question and were totalled per student for each component. The students' one-to-six (1-6) point survey response scores range from 5-30, since components each have five questions. A final measurable score was calculated from survey data and shown in Figure 30, and an arithmetic mean was calculated. Ratings of 27 and above were strongly positive, 22.5 and above somewhat positive, 17.5 and above mildly positive, 12.5 and above mildly negative, and 7.5 and above somewhat negative.

Figure 30 shows the highest environmental attitude score (22.47) and the largest change (9.11%) occurred in Group 3, with Group 1 showing the next highest positive score. Determined scores reflect students' attitudes toward coral reefs as the mean of the five questions considered per component. A Kruskal-Wallis non-parametric test for independent samples ($n = 320$) shows the pre-test ($p = 0.282$) and post-test ($p = 0.089$) with no significant difference between the means of the groups except on the post-test. A Wilcoxon related samples test ($n = 320$) shows that within the groups there is a significant change from the pre- to the post-test, except for the Contrast Group, and the values for each group are shown along the top of Figure 31, above the respective group bars representing the mean scores (± 1se) of the pre-test and post-test.

The total number of attitude questions on the survey is 15. The components relate to (1) reef ecology, (2) attitudes toward human impacts, and (3) attitudes toward alternative solutions. Figure 31 shows mean attitude score changes from pre- to post-test for each of the three components. Thus, while all the pre-test scores are mildly positive, mean attitudes (±1se) of students increased from pre-test to post-test in all components, with component one ($p < 0.001$) and component two ($p = 0.008$) showing significant changes between the two tests ($n = 320$). Post-test means for components one (21.73) and three (21.61) remained mildly positive, while component two (23.16) moved higher to somewhat positive after the interventions. Highest student scores were in attitudes toward human impacts on reefs (component two), and this component did show a significant change ($p = 0.008$). The lowest amount of change (0.20) was in component three (attitudes toward alternative solutions), with no significant change between the pre- and post-test as the responses remained mildly positive.

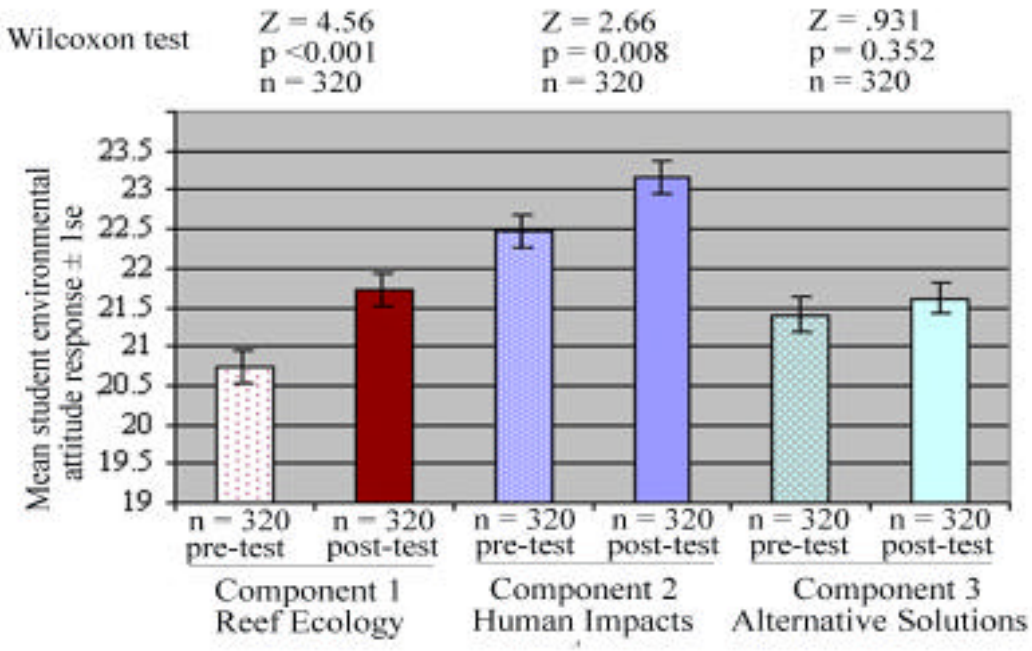

Figure 31. Changes in student survey responses for environmental attitude from the pre- to the post-test by component.

Knowledge to attitude correspondence showed significant associations between pre-test environmental knowledge scores (K_pre) and pre-test attitude questions EA16 and EA42 (Table 15). The only significant correlations found between attitude and knowledge variables are listed, consequently, there were no significant correlations seen between pre-test knowledge (K_pre) and changes in attitude responses so they are not shown. Variable change in knowledge (ΔK) was significantly correlated to pre-test attitude question responses for EA16 and EA37, and ΔK like K_pre, did not have any significant correlations to any change in attitude question (ΔEA). The significant negative relationships shown implied that as change in knowledge increased, attitudinal change decreased. The knowledge portion of the survey data had mild correlations with

Table 15. *Significant Correlations Between Environmental Knowledge (K) and Environmental Attitudes (EA)*

	EA16	EA37	EA42
K_pre	.164*	.055	.130*
ΔK	-.154*	-.129*	-.048

Spearman's *rho* (significant to *.05); n = 320

attitude survey questions (EA16: The Great Barrier Reef is in healthy condition, EA37: The idea of One Earth [‘Spaceship Earth’] is important to me, EA42: The concern about environmental problems has been exaggerated), and no significant correlations with change in attitudes from component one, thus a relationship does not appear to exist between changes in environmental knowledge and change in environmental attitudes.

6.2.4.3 Ecological intention to act.

This section investigates which educational intervention has the greater impact on ecological intention to act, both a classroom presentation and reef visit, or classroom presentation alone. Ecological intention to act (Ac) answers were totalled per student for each component as with attitudes, and then a total component score was generated. Intention to act scores were observed through arithmetic means, with answers being totalled per student for each component as they were with environmental attitudes. Mean intention to act scores (Figure 32) show a positive change in student pre- to post-test responses in all three components (n = 320), with the Wilcoxon test showing a significant change in all three components (p <0.001, p <0.001, p <0.001) between the two tests. Ratings of 27 and above were strongly positive, 22.5 and above somewhat positive, 17.5 and above mildly positive, 12.5 and above mildly negative, and 7.5 and

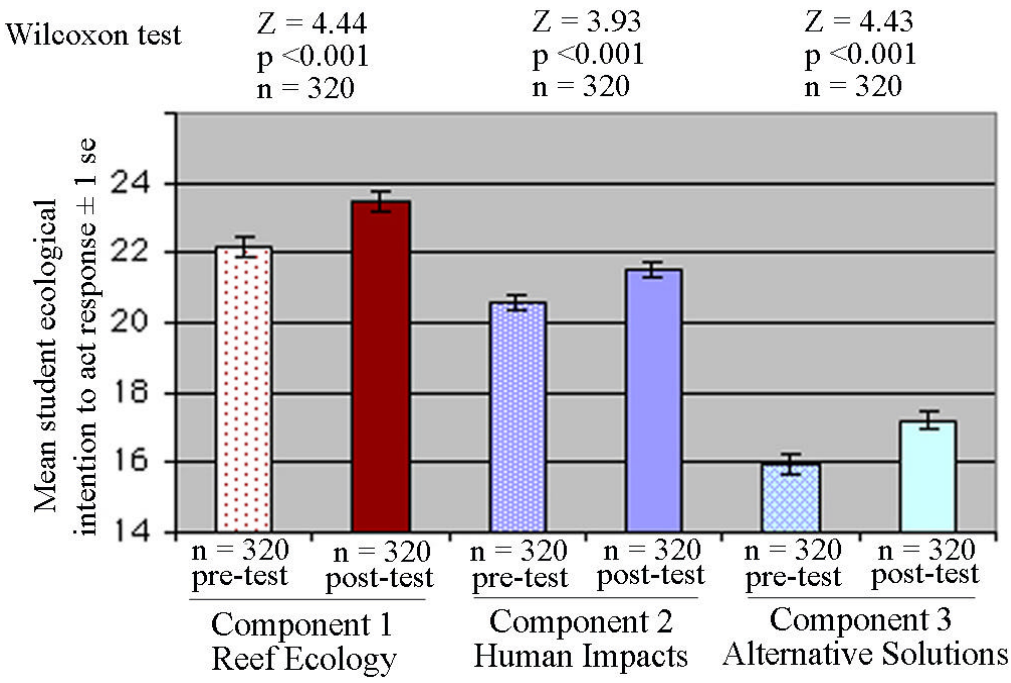

Figure 32. Changes in student survey responses for ecological intention to act from the pre- to the post-test by component.

above somewhat negative. Students responded with mildly positive (17.5+) ecological intention to act towards the reefs in components one and two on the pre-test, but the lowest score was mildly negative (12.5+) on component three (taking action towards alternative solutions). These scores all increased on the post-test, with component one moving into somewhat positive category (22.5+), the highest score of any component. All component responses increased after the educational interventions.

The means of component one positively changed from 22.15 to 23.45 (1.3), component two from 20.57 to 21.49 (.92) and component three from 15.94 to 17.2 (1.26). This showed that component one, which started with the highest mean of positive responses also had the highest amount of positive change, but component three (intention to act with respect to alternative solutions) which started out the lowest of the three, also had a high amount of change. All three components changed significantly from the pre- to the post-test.

Ecological intention to act (Ac) data was separated into student educational intervention groups (Figure 33). Students' mean pre-test and post-test scores are noted and calculated per group. Determined mean scores (±1 se) reflected students' intention

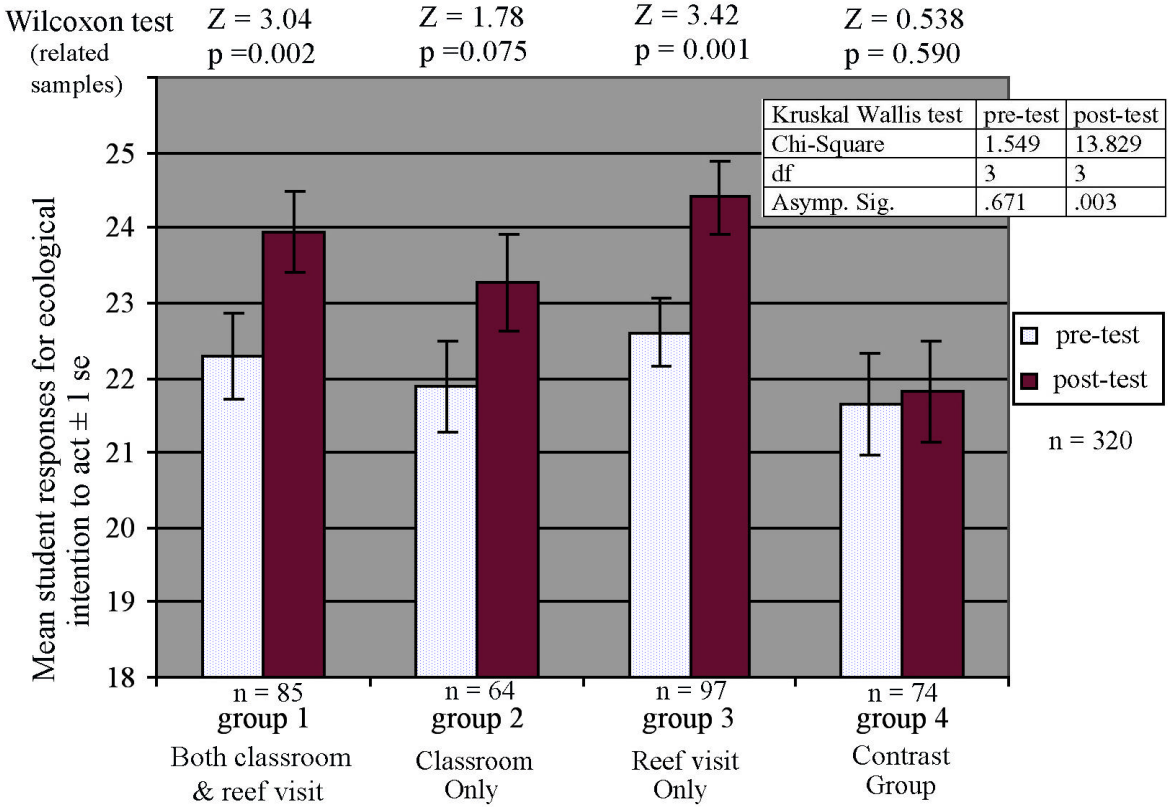

Figure 33. Changes in student ecological intention to act responses from the pre- to the post-test per group for component one.

to act toward coral reefs and were scored the same as environmental attitudes. Percentage change reflected change in student questionnaire responses for intention to act. Group 1 scored 23.94 (7.44% increase), Group 2 scored 23.27 (6.28% increase) and Group 3 scored 24.40 (7.98% increase). A Wilcoxon test (n = 320) was performed and showed Group 1 (p = 0.002) and Group 3 (p = 0.001) to have significant changes from the pre- to the post-test. A Kruskall-Wallis test (n = 320) was also performed and it showed no significant differences between the group scores for the pre-test (p = 0.671), but a significant difference was noted for the post-test (p = 0.003). The table displays improvement in ecological intention to act for all students who received educational interventions, while Group 4, the Contrast Group, remained relatively stable. Highest post-test score (24.40) and largest percent change (7.98%) was accrued by Group 3, with Group 1 having the second highest change (7.44%). Effects on ecological intention to act were moderate to weak, without the extremely significant differences in student groups as noted for knowledge in Figure 29. However, Group 3 students had the highest percentage change of intention to act for component one (as with attitude in Figure 30), and the highest post-test intention to act score with significant differences between the pre- and post-test and across the groups. Marine experiential education had somewhat of an impact (6-8%) on ecological intention to act during this research, and intention to act scores rose in all groups.

Significant component one intention to act to knowledge relationships are displayed in Table 16. The pre-test knowledge variable (K_pre) was significantly correlated to two pre-test intention to act questions, and two changes in intention to act questions (Δ20ac: My daily actions can cause damage to the reef, Δ28ac: My personal health has an impact upon the future of the Great Barrier Reef) were significantly correlated to K_pre. Thus, K_pre was associated with both intention to act facets (pre-test and change). Change in environmental knowledge (ΔK) was **not** significantly correlated to any intention to act survey response. Thus, knowledge had a correlation with intention to act questions (Ac20, Ac22: The coral polyps that live on the reef need my help, Δ20ac, Δ28ac). Relationships of students' knowledge scores on the pre-test (K_pre) and change in knowledge scores (ΔK) was a strong -.438* (Spearman's *rho* at 0.01) when all student groups were combined (n = 320). This showed a high pre-test knowledge generated a lower change in knowledge.

Table 16. *Significant Correlations of Environmental Knowledge (K_pre and ΔK) to Ecological Intention to Act (Ac) and Changes in Ecological Intention to Act (Δac)*

	K_pre	Ac20	Ac22	Δ20ac	Δ28ac	Δ32ac
K_pre	1.000	.161*	.113*	-.117*	.114*	-.041
Δ*K*	-.438*	-.033	.002	.088	-.076	.102

Spearman's *rho* (significant to *.05); n = 320

The next relationship explored was between pre-test environmental knowledge, attitudes and ecological intention to act for component one in Table 17. Significant correlations exist between pre-test survey responses for environmental knowledge and environmental attitude (EA16, EA42), environmental knowledge and ecological intention to act (Ac20, Ac22), and environmental attitude to ecological intention to act (EA14 [Coral reefs are not important to other life on the planet Earth]: Ac27 [I can do things to help coral reefs], Ac32; EA16: Ac20, Ac28; EA21: Ac20, Ac22, Ac27, Ac28, Ac32 [My own actions affect coral reefs]; EA37: Ac22, Ac27, Ac28, Ac32; EA42: Ac20, Ac22, Ac27, Ac32). The large number of significant correlations between environmental attitude and ecological intention to act shows a definite relationship between pre-test environmental attitudes and students' ecological intention to act responses.

Table 17. *Correlations in Pre-test Environmental Knowledge (K_pre), Attitude (EA) and Ecological Intention to Act (Ac)*

	K_pre	EA14	EA16	EA21	EA37	EA42
K_pre	1.000	.056	.164*	-.033	.055	.130*
Ac20	.161*	.109	.114*	.191*	.099	.166*
Ac22	.113*	.108	.075	.337*	.206*	.157*
Ac27	.084	.135*	.076	.284*	.199*	.227*
Ac28	-.012	-.037	-.143*	.142*	.204*	-.092
Ac32	-.010	.159*	.-.091	.376*	.274*	.131*

Spearman's *rho* (significant to *.05); n = 320

Once this pre-test relationship was established, the correlations to change intention to act were calculated (Table 18). Significant correlations do exist between pre-test environmental attitudes and changes in ecological intention to act (EA14: Δ32ac; EA16: Δ28ac; EA21 [Living near the Great Barrier Reef makes me realise the importance of coral]: Δ27ac, Δ32ac; EA37: Δ32ac; EA42: Δ20ac). Environmental knowledge was also included in this inter-relationship and it showed significant correlations to both attitudes and change in intention to act (K_pre: EA14, EA42, Δ20ac, Δ28ac). Change in environmental knowledge (ΔK) was also linked to environmental attitudes (ΔK: EA16, EA37), but negatively and not as strongly, since it was only related to pre-test attitudes and not to change in intention to act. This shows pre-test knowledge and attitudes are not as strongly correlated, as pre-test knowledge and changes in intention to act (Tables 18, 19).

Table 18. *Correlations in Environmental Knowledge (K_pre and* ΔK*), Attitude (EA) to Change in Ecological Intention to Act (*ΔAc*)*

	K_pre	ΔK	EA14	EA16	EA21	EA37	EA42
K_pre	1.000	-.438*	.056	.164*	0.033	.055	.130*
ΔK	.438*	1.000	-.004	.154*	-.002	-.129*	-.048
Δ20Ac	.117*	.088	-.019	-.003	-.032	-.032	.118*
Δ22Ac	.035	-.009	.064	.040	-.070	-.008	.034
Δ27Ac	-.065	.068	-.103	-.023	-.116*	-.085	-.065
Δ28Ac	.114*	-.076	.008	.110*	-.017	-.019	.045
Δ32Ac	-.041	.102	-.160*	-.072	-.144*	-.203*	.057

Spearman's *rho* (significant to *.05); n = 320

Relationships between changes in dependent variables (Table 19) were also investigated. Change in environmental knowledge was not significantly related to any other change variables in component one, but change in environmental attitudes had a number of significant relationships to changes in ecological intention to act (ΔEA14: Δ27ac, Δ32ac; ΔEA21: Δ22ac, Δ27ac, Δ32ac; ΔEA37: Δ20ac, Δ22ac, Δ28ac, Δ32ac; and ΔEA42: Δ27ac). Thus, change in attitude showed significant correlations to a number of changes in intention to act responses. This points to a significant relationship between environmental attitudes (EA) and ecological intention to act (ac), but none for

Table 19. *Correlations in Changes in Environmental Knowledge (ΔK), Environmental Attitude (ΔEA) and Ecological Intention to Act (Δac)*

	K_pre	ΔK	ΔEA14	ΔEA16	ΔEA21	ΔEA37	ΔEA42
K_pre	1.000	-.438*	-.037	-.080	-.024	.003	-.045
ΔK	-.438*	1.000	.006	.084	.077	.067	-.010
Δ20ac	-.117*	.088	.078	.058	.089	.113*	-.038
Δ22ac	.035	-.009	-.010	.017	.236*	.135*	.084
Δ27ac	-.065	.068	.134*	-.009	.247*	.085	.114*
Δ28ac	.114*	-.076	-.007	-.029	.058	.219*	-.030
Δ32ac	-.041	.102	.165*	.078	.176*	.245*	-.099

Spearman's *rho* (significant to *.05); n = 320

either pre-test or change in environmental knowledge (K). A real discrepancy with the K-A-A being linear theory is shown here, since neither changes in attitudes nor intention to act (Table 19) follow changes in knowledge (awareness), The three do not appear to be commonly linked. My conclusion is that they are weakly correlated initially on the pre-test, but changes in knowledge (awareness) do not produce any related changes in either attitude or intention to act in this study.

6.2.4.4 Demographic relationships.

A number of demographic variables other than dependent variables were also considered (Table 20). Students were surveyed about their previous reef (GBR) experience, swimming, snorkelling, camping, and watching nature channels on TV. Student responses were recorded according to frequency of past personal involvement. These questions were compiled as noted in Table 20, with a response score of one being the lowest ranked answer. These demographic variables were selected for a number of reasons. Swimming, gender and watching TV nature documentaries were investigated by Fortner (1983), and Fortner and Teates (1980) in this 1970s marine education research. Previous reef experience, camping and snorkelling experience, were related to the student study group with both a classroom presentation and a reef visit as I observed in the pilot study findings. The variable of previous reef experience is of particular importance as it directly relates to the research question.

Table 20. *Demographic Survey Questions, Number of Total Answers Used for the Analysis and the List of Possible Answers*

Demographic Question	Possible Answers	Total
Previous reef experience	Never, Once, Twice, 3-11, 12+ (GBR trips)	5
Swimming ability	Can't, can-but never do, seldom, sometimes, often	5
Snorkelling experience	Never, seldom (1-5), often (5-9), very often (10+), SCUBA diver	5
Outdoor camping experience	Never, little, sometimes (once per year), often (more than once per year), very often	5
Watch nature TV channels	Rating in questions JJ6 & JJ7 - watch nature channel and/or other nature documentaries on TV	20

Demographic variables were correlated to environmental knowledge (K_pre and ΔK) in Table 21. The table depicts relationships of students' knowledge scores on pre-test (K_pre), and changes in scores from pre-test to post-test (ΔK) and strength of correlations with demographic information. Items examined were previous reef experience (GBR), as well as participants' history of swimming, snorkelling, camping and watching nature shows on TV. Correlations noted between the demographic variables and environmental knowledge (K) were in component one. Pre-test knowledge (K_pre) was significantly correlated to reef experience (GBR), swimming and snorkelling. Thus, students who had previous GBR, swimming and snorkelling experience performed higher on the knowledge pre-test. Change in knowledge (ΔK) was negatively related to previous reef experience, which means that as reef experience increased change in knowledge scores decreased (Figure 34, p. 129). The students who had more reef visits also had a lower positive change in knowledge and this might be

Table 21. *Demographic Information and Significant Correlations to Environmental Knowledge (Pre-Test and Change)*

	GBR	Snork	Swim	Camp	TV
K_pre	.173*	.169*	.107	.027	-.037
ΔK	-.106*	.037	-.044	.025	-.083

Spearman's *rho* (significant to *.05); n = 320

because they were more familiar with reef environments. This area needs further study, as there is no way to effectively determine reasons for the relationships in the framework of this research.

Correlations of demographic variables to environmental attitudes are shown in Table 22. The table depicts relationships of student attitude responses on pre- and post-test, and the strength of their correlations compared to demographic information. Previous reef experience (GBR) had the highest amount of significant correlations with environmental attitude (pre-test and change), and this was followed by camping, swimming, snorkelling and watching nature documentaries on TV.

Table 22. *Demographic Information and Significant Correlations to Pre-Test and Changes in Environmental Attitude (EA)*

	GBR	Snork	Swim	Camp	TV
EA14	.120*	-.055	-.045	-.034	-.062
EA16	.096*	.069	.024	-.018	-.034
EA21	.288*	.263*	.145*	.180*	.097
EA37	.021	.102	.087	.196*	.137*
EA42	-.029	-.032	-.001	.051	-.081
Δ14	-.026	.096	.088	.107	.046
Δ16	-.061	.014	.006	.029	.043
Δ21	-.188*	-.068	-.074	-.127*	-.072
Δ37	-.068	-.043	.013	-.107	-.007
Δ42	.101	.103	.121*	.013	.030

Spearman's *rho* (significant to *.05); n = 320

Ecological intention to act (Ac) relationships are depicted in Table 23. This table shows significant relationships of student responses on pre-test and changes from pre- to post-test, with strength of correlations with demographic information. The table shows previous reef experience (GBR) again has the highest number of significant correlations (5) along with snorkelling experience, followed by camping (4). It should be noted that students' snorkelling and camping experience both have significant correlations five and four respectively for the pre-test intention to act questions (Ac20, Ac22, Ac27, Ac28, Ac32), but **no** significant correlations with change in intention to act responses. Thus, previous experience of snorkelling and camping are associated with intention to act, but

this does not translate to a correlation with change in intention to act responses. These relationships are discussed in more detail later in this section.

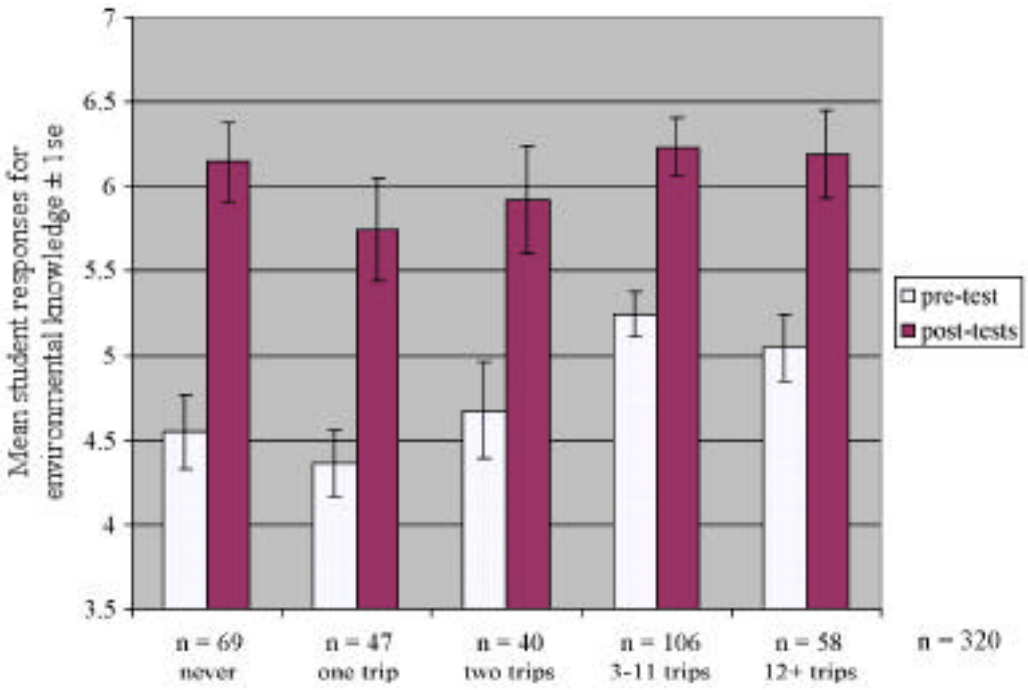

Figure 34. Previous reef experience and change in environmental knowledge.

· *previous reef experience*

Previous reef experience is relevant because of the added effect it may have on students' learning about the reef and any changes associated with environmental attitudes and intention to act. The highest number of significant correlations in Tables 21, 22 and 23 are with previous reef experience. This relationship has been separated out and is shown in Table 24. Students' pre-test of previous reef experience was significantly correlated to knowledge, attitude and intention to act variables. Previous reef experience correlations are also significant to pre-test environmental knowledge (K_pre) and changes in knowledge (ΔK). The minus sign for ΔK indicates these factors have a negative association with one another (as previous reef experience increases, the change in knowledge scores decreases). The environmental attitude question with the strongest involvement (EA21), contributed 8.18% (.286 squared) of the variability in responses explained by participants' previous reef experience (GBR). There is also a number of significant ecological intention to act (Ac) relationships to previous reef experience (Table 25). GBR is the only variable to have a significant correlation to

Table 23. *Demographic Information and Significant Correlations to Pre-Test and Changes in Ecological Intention to Act (Ac)*

	GBR	Snork	Swim	Camp	TV
Ac20	.182*	.139*	.091	.069	.084
Ac22	.091	.148*	.071	.126*	.048
Ac27	.195*	.188*	.067	.170*	.054
Ac28	.044	.165*	.085	.139*	.041
Ac32	.231*	.150*	.051	.139*	.013
Δ20	-.159*	-.025	.019	.005	-.038
Δ22	-.012	.058	.084	.000	.047
Δ27	-.101	-.039	.049	-.090	-.022
Δ28	-.040	-.007	.063	.041	.047
Δ32	-.127*	.017	.051	-.102	.001

Spearman's *rho* (significant to *.05); n = 320

knowledge, attitude and intention to act questions at both pre-test stage and change stage. This means that past reef experience influenced students' pre-test attitudes and intention to act, and is a key demographic factor. The more past reef experience a student had, the less change there was in his/her knowledge, attitude and intention to act and it also had a negative correlation with an environmental attitude (Δ21, Table 24),

Table 24. *Previous Reef Experience (GBR) and Significant Correlations to Pre-Test and Changes in Environmental Knowledge (K) and Attitude (EA)*

	K_pre	*ΔK*	*EA14*	*EA16*	*EA21*	*Δ21*
GBR	*.173**	*-.106**	*.120**	*.095**	*.286**	*-.185**

Spearman's *rho* (significant to *.05), n = 320

but it also influenced the most positive responses on the pre-test for all three dependent variables.

Table 25. *Previous Reef Experience (GBR) and Significant Correlations to Pre-Test and Changes in Ecological Intention to Act (Ac)*

	Ac20	Ac27	Ac32	Δ20	Δ32
GBR	.183*	.195*	.231*	-.159*	-.127*

Spearman's *rho* (significant to *.05); n = 320

Previous reef experience shows a significant relationship to mean knowledge scores (vertical axis) in Figure 34 representing pre-test and post-test survey scores. The knowledge survey scores were positively related to the amount of previous reef experience (horizontal axis). The figure shows that as amounts of reef experience increase (± 1 se), so do pre-test environmental knowledge scores. The mean change in knowledge score decreased as the overall amount of past reef experience increased, with the largest amount of change in scores appearing in the never category (1.594) and the least change occurring in the 3-11 trip category (.991). Positive changes in scores are shown in all post-test categories, with the higher pre-test scores coming from students having more reef experience entering the research, and therefore showing less improvement from the learning interventions.

Figure 35 depicts the relationship between environmental attitudes and previous reef experience, with the pre-test attitude responses of the student participants (vertical axis) and the amount of previous reef experience (horizontal axis). Ratings of 27 and above were strongly positive, 22.5 and above somewhat positive, 17.5 and above mildly positive, 12.5 and above mildly negative, and 7.5 and above somewhat negative. The error bars (± 1 se) on the left represents the mean for student pre-test responses, and the bar on the right is the post-test. Environmental attitude responses became more positive as the number of reef visits increased. The post-test improved in all cases from the pre-test score, but the highest amount of change was for the categories with one trip (1.489) or never having previous reef experience (1.13), the two trip group having a change of 1.0. It can be seen there is a direct relationship between positive attitude response and previous reef experience, since as previous reef experience increases (going from left to

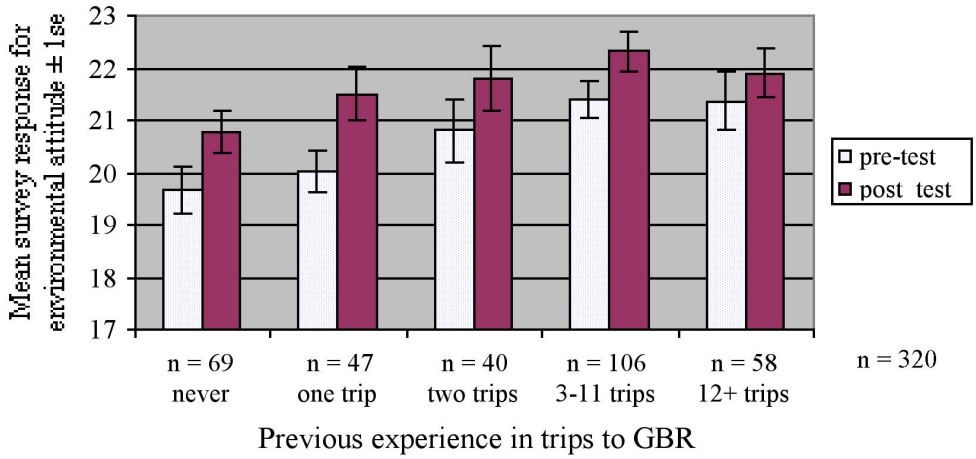

Figure 35. Previous reef experience and change in environmental attitude.

right) mean attitudinal scores also continue to increase except at the 12+ trip category. Thus, the amount of positive change for students decreases with increased number of reef trips (12+), and it could be they have seen it many times before, so are not thinking it is new and interesting.

Ecological intention to act comparisons are shown in a similar manner as attitude questions. Ratings of 27 and above were strongly positive, 22.5 and above somewhat positive, 17.5 and above mildly positive, 12.5 and above mildly negative, and 7.5 and above somewhat negative. The change in the mean of students attitude responses are on the vertical axis and previous reef experience is on the horizontal axis in Figure 36. The pre-test intention to act scores (± 1se) are shown in the left bar and the post-test scores are in the right bar (± 1se). Ecological intention to act scores all increased with increased reef visits, and the highest amounts of change in intention to act scores occurred in the two trips (1.475) or less categories with the largest change being for students with no previous reef experience (2.508). Figure 36 and Table 26 show a direct relationship between improved positive responses for ecological intention to act and previous reef experience, because as the number of previous reef visits increased the intention to act arithmetic mean also increased, except for a dip at the 12+ mark.

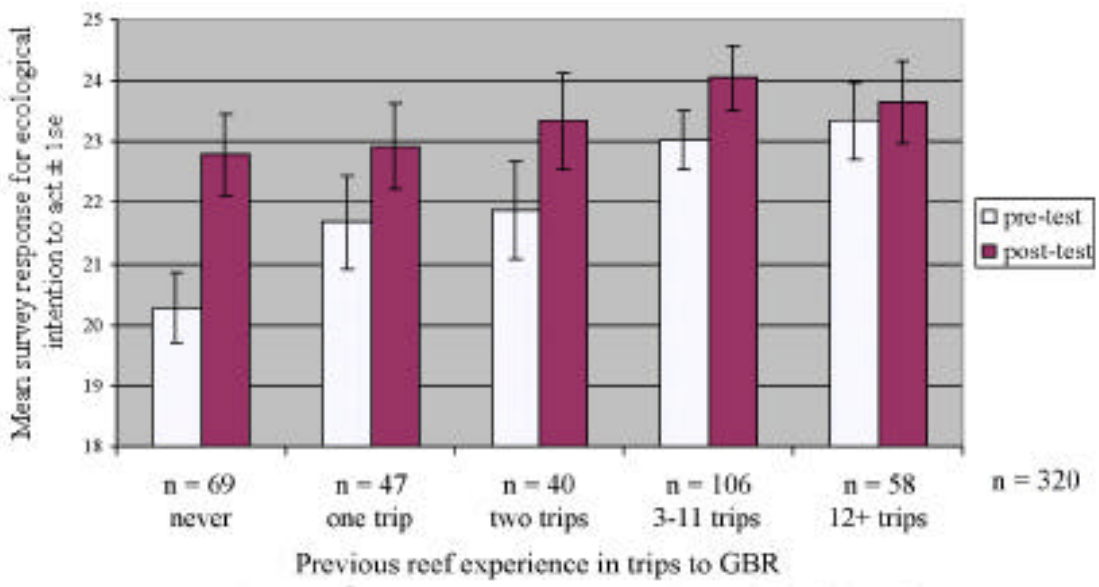

Figure 36. Previous reef experience and change in ecological intention to act.

Table 26. *Previous Reef Experience and Existing Environmental Knowledge (Awareness), Attitudes and Ecological Intention to Act*

	Previous reef experience
Pre-test K (mean comp 1)	.173*
Pre-test attitude (mean comp 1)	.176*
Pre-test Intention (mean comp 1)	.224*
Pre_EA14	.120*
Pre_EA16	.096*
Pre_EA21	.288*
Pre_Ac20	.182*
Pre_Ac27	.195*
Pre_Ac32	.231*

Spearman's *rho* (significant to *.05); n = 320

· *swimming*

Past swimming experience had a number of significant relationships to component one variables and other demographics. Swimming was noted to be significantly correlated to environmental attitudes in earlier marine education research (Fortner, 1983). In this study it is significantly correlated to both pre-test and change in environmental attitudes, but not to ecological intention to act (Tables 21, 22, 23 and 27). Swimming was also significantly correlated to GBR experience, snorkelling and camping (Table 27). It appears these strong correlations exist because swimming is necessary for snorkelling trips to the GBR, and it could be that a similar type of people go on such trips to the GBR and camp as significant correlations exist between camping, snorkelling and previous reef experience. In the rest of this section, swimming will not be discussed as it is so closely related to snorkelling.

Table 27. *Significant Correlations Between Swimming, Environmental Knowledge (K), Environmental Attitude (EA), Ecological Intention to Act (Ac) and Other Background Demographics*

	K_pre	EA21	Δ42	GBR	Snork	Camp
Swim	.113*	.144*	.120*	.252*	.298*	.241*

Spearman's *rho* (significant to *.05); n = 320

· *snorkelling*

Past snorkelling experience had the second highest number of significant relationships in component one behind previous reef experience. Its correlation to previous reef experience (GBR) was particularly strong, representing 21.25% (.461 squared) of the variability in responses for the previous reef experience results (Table 28). It was also associated with camping, environmental attitudes and changes in environmental attitudes. Snorkelling was also correlated to students' environmental knowledge survey responses. A significant correlation to pre-test knowledge scores related snorkelling to the students' knowledge or awareness.

Table 28. *Snorkelling and Correlations with Environmental Attitude and Demographic Variables*

	K_pre	GBR	Camp	EA21
Snork	.169*	.461*	.308*	.263*

Spearman's *rho* (significant to *.05); n = 320

A direct relationship is shown between snorkelling and environmental attitude responses in Figure 37. This figure shows relationships between change (± 1se) in student responses for environmental attitudes (vertical axis) and amounts of past snorkelling experience (horizontal axis). The change in means between the pre-test (left bar) and post-test (right bar) scores were the highest in the often (5-9 times) category

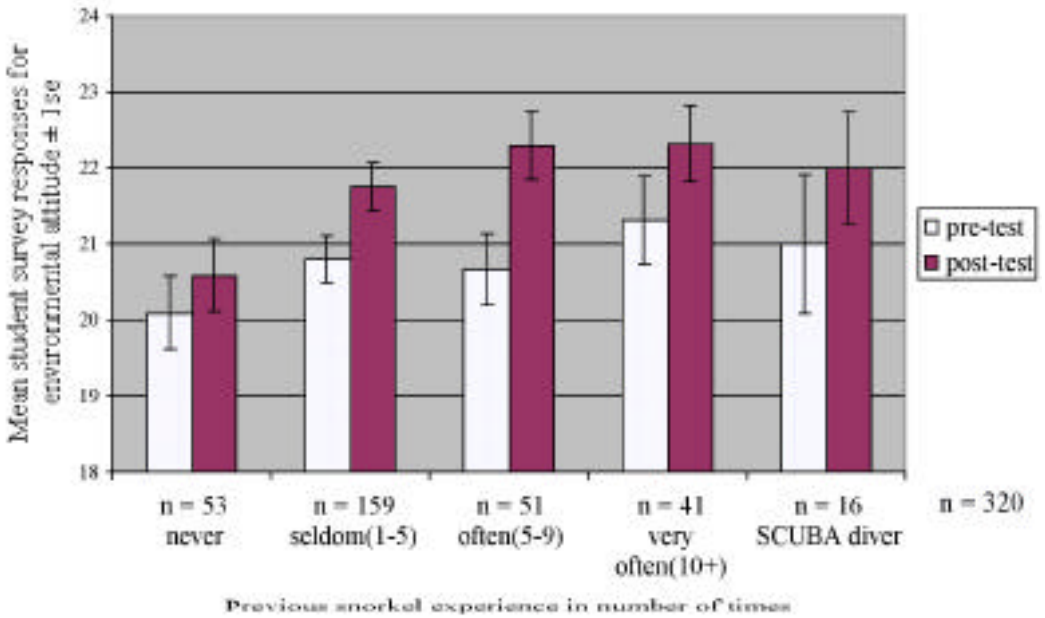

Figure 37. Previous snorkel experience and change in environmental attitude.

(1.627), which is in the middle of the error bar figure, with positive environmental attitude responses increasing as the amount of snorkelling experience increased. There was an increase in positive environmental attitude responses from the pre- to the post-test in all categories with respect to increases in previous snorkel experience. The never category (.491) did not show the highest mean change for snorkel experience, and there was a lessened increase in mean positive response rates for SCUBA divers, even though there was an increase of 1.0 from the pre- to the post-test. It is difficult to ascertain why the SCUBA divers had a lower total for positive mean responses, but the sample size was small (n = 16).

Snorkelling was significantly correlated to all pre-test intention to act responses in component one (Table 29), and no change in intention to act responses. This was an unusual aspect of the relationship since there was total association with pre-test intention to act responses and no significant correlations with change in intention to act.

Table 29. *Significant Correlations Between Snorkel Experience and Pre-Test Intention to Act*

	Ac20	Ac22	Ac27	Ac28	Ac32
Snork	.139*	.148*	.188*	.165*	.150*

Spearman's *rho* (significant to *.05); n = 320

Figure 38 shows mean change student responses for ecological intention to act (± 1se), along the vertical axis, as compared to previous snorkel experience (horizontal axis). The error bars on the left represent pre-test scores with the post-test scores shown with the right bar. All the groups had a positive change in responses from the pre-test to the post-test with no clear pattern of significant increases appearing. There was a general trend for the scores to become more positive with an increase in snorkel experience, with the SCUBA divers having a very large increase.

· *camping*

Past camping experience had a number of significant relationships. In Tables 22 and 30, camping was observed to be significantly associated with three attitude responses, previous reef experience, snorkelling and swimming (Table 27). Significant relationship with previous camping experiences occurs in attitude questions EA21 and EA37, and change in attitude (Δ21).

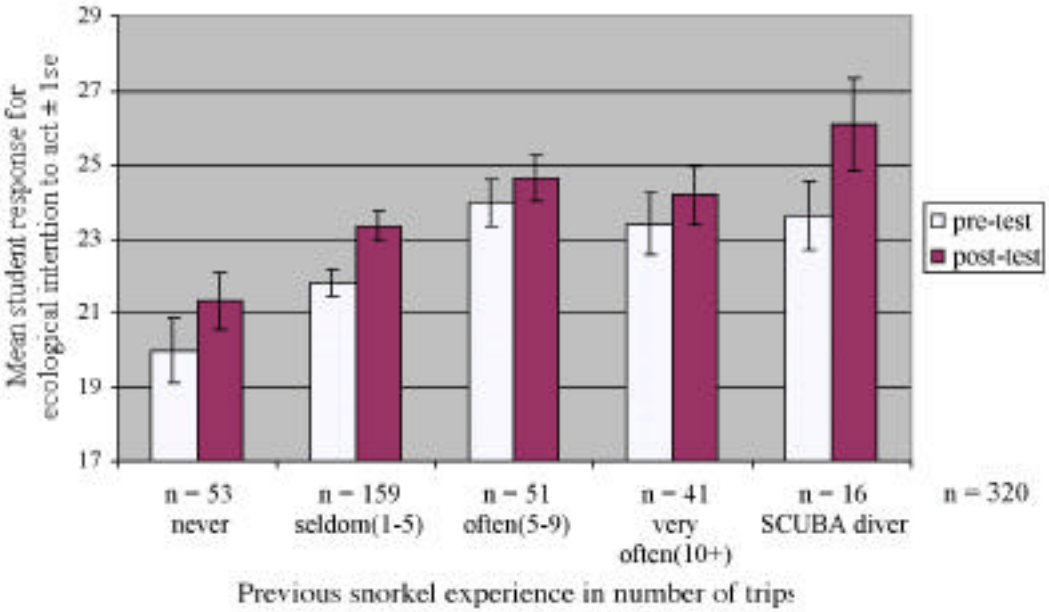

Figure 38. Previous snorkel experience and change in ecological intention to act.

Table 30. *Significant Camping Experience and Attitude Relationships*

	GBR	Snork	EA21	EA37	Δ21
Camp	.198**	.308**	.180*	.196*	-.127*

Spearman's *rho* (significant to *.05); n = 320

There are no significant correlations with either pre-test or change in environmental knowledge to camping. There is a direct relationship to changes in camping and changes in environmental attitudes as represented in Figure 39 until the highest level of camping experience is reached. In this figure, the mean of student pre-test responses to environmental attitudes questions (vertical axis) was compared to previous camping experience (horizontal axis). As the amount of camping experience increases, so does the mean of positive pre-test responses (left bar). The post-test scores (right bar) all showed an increase from the pre-test, and while the highest amount of change from the pre-test to the post-test was high for the never camping group, there did not appear to be a direct relationship between the amount of previous camping experience and change in environmental attitude. There are no significant correlations with either pre-test or change in ecological intention to act and camping (Table 23, p.

130). However, even though not shown in a figure, as the mean of camping experience increases students' pre-test and post-test environmental attitudes responses increase.

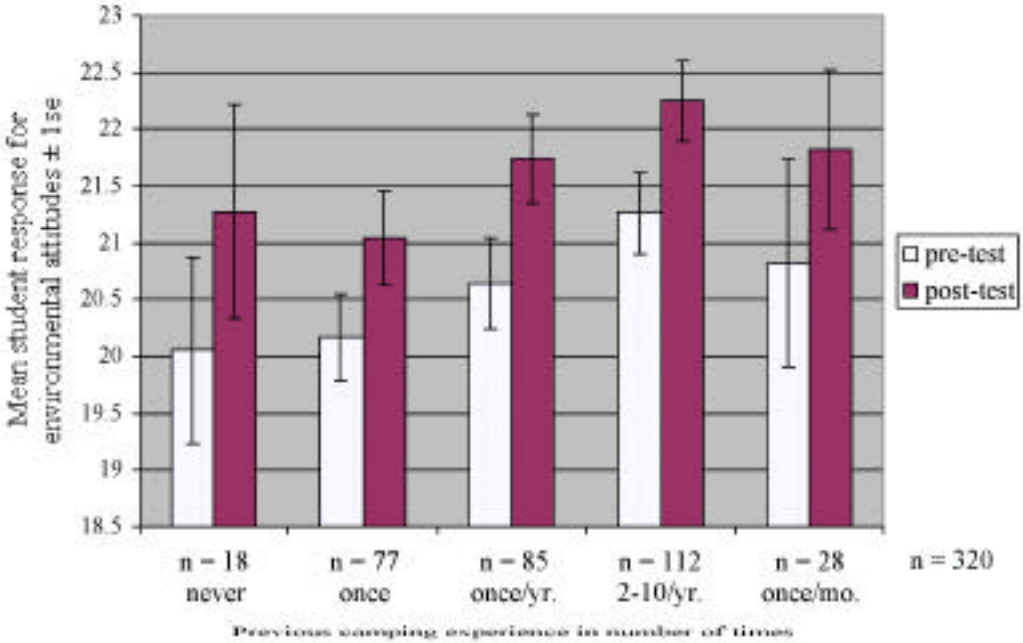

Figure 39. Previous camping experience and change in ecological intention to act.

· *watching nature channels on TV*

Watching nature documentaries on television was investigated because it was mentioned in earlier studies (Fortner, 1983, 1985), and many references show it as the most important source of environmental education for students (Fien, et al., 2002; Walker & Loughland, 2003; Walter & Lien, 1985). Watching nature channels on TV had the lowest number of correlations in Tables 21, 22 and 23. It was found to be only significantly correlated to one pre-test attitude EA 37, and had no significant correlations to either pre-test environmental knowledge (awareness) or change in knowledge. No relationship was seen between watching nature documentaries on television and ecological intention to act.

6.2.5 Gender

6.2.5.1 Environmental knowledge.

Gender is the next variable addressed. Gender difference for students is an important issue with respect to education (Connell, et al., 1998; Fien, et al., 2002; Rickinson, 2001). Of the 125 female and 195 male students in the selected sample of 320, females had a higher knowledge mean score on pre-test. Female mean scores on

the pre-test survey were 5.07 (se 0.1455) and the male mean score were 4.72 (se 0.1109). A one-way ANOVA was performed on these results and showed there was a significant difference between the means of the female and male scores (F = 3.717, p = 0.055).

The change in environmental knowledge for students receiving at least one intervention between the pre and post-test for females was 1.420 (n = 246, se 0.207) for a 28.0% change, and for males it was 1.560 (n = 246, se 0.170) for a 33.1% change. Figure 40 depicts change in environmental knowledge responses per gender with respect to student intervention groups (n = 246). The vertical axis represents change in mean student knowledge responses on the survey questionnaires, with the horizontal axis representing the student intervention group. It is interesting to note that the females (right set of bars in each group) performed best in Group 1, and males (left set of bars in each group) performed best in Groups 1 and 2 for change in knowledge (awareness), while males also had the highest rate of change for Groups 2 and 3. Interestingly, females were expected to perform best with a classroom only presentation (Group 2), and males were expected to perform best in a situation with both a reef visit and classroom presentation (Group 1) (Stepath, 1997, 1998). The females recorded the

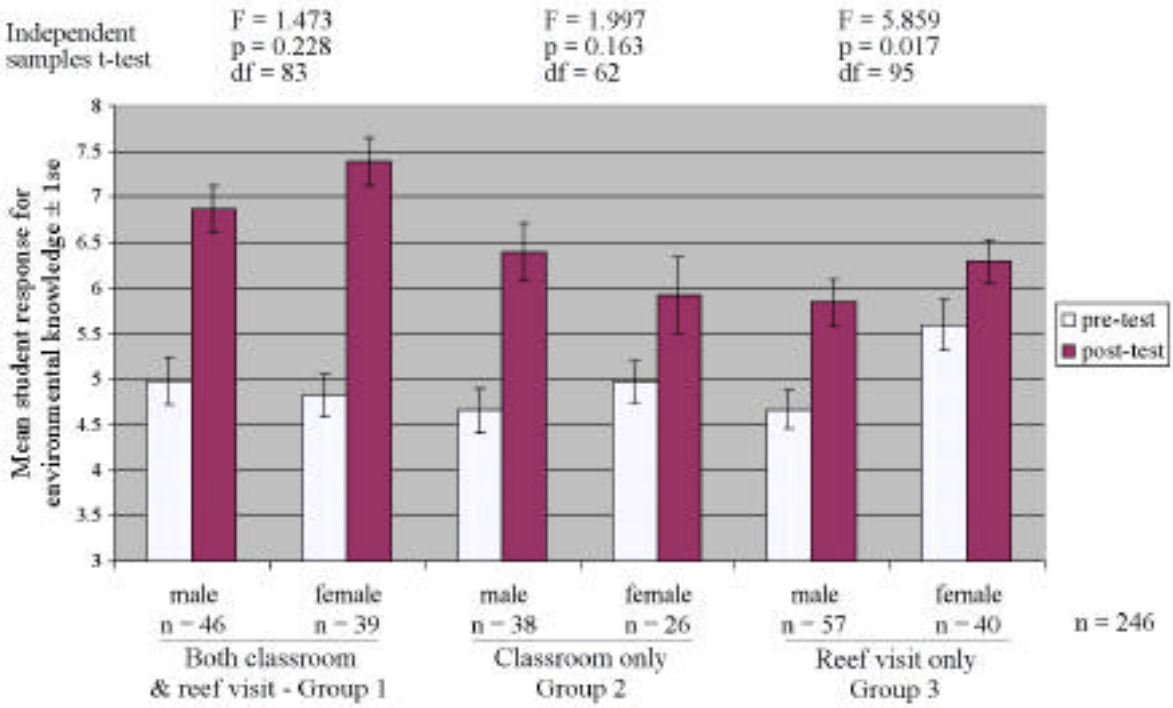

Figure 40. Change in student environmental knowledge responses per gender and group.

highest scores overall, and the males recorded the highest changes in scores from the pre- to the post-test in both Groups 1 and 2. An independent samples t-test was used to analyse the three groups for combined male and female scores, and only the reef visit group (Group 3) had a significant change from the pre- to the post-test ($p = 0.017$). A Tukey post-hoc test was performed on the three groups and it was found that on the pre-test there was no significant difference between the groups. On the post-test, Group 1 was significantly different than Groups 2 ($p = 0.007$) and 3 ($p < 0.001$); Group 2 was significantly different than Group 1 ($p = 0.007$); and Group 3 was significantly different than Group 1 ($p < 0.001$). When a Mann-Whitney U test for independent samples was applied, there were no significant differences between gender on pre-test knowledge about reef ecology ($n = 320$, $p = .094$). Hence, even though a one-way ANOVA showed a significant difference between the male and female scores on the pre-test, the Mann-Whitney test showed gender did not have a significant effect on students' change in knowledge response over the course of the study ($n = 246$, $p = .969$).

6.2.5.2 Environmental attitudes.

In the environmental attitude section of the survey questionnaire, females recorded higher scores on three out of the five pre-test survey questions in component one as shown in Table 31 (EA14, EA16, EA42). For pre-test analysis, all groups were included, but Group 4 was removed from the change calculations, as this student group was not exposed to educational interventions. In environmental attitude questions, the females had higher positive responses than males. The females' mean environmental

Table 31. *Mean Ranking of Students' Pre-Test Environmental Attitude Responses and Gender. The M_W Category Displays the Mann-Whitney U Level of Significance for all Questions Regarding Pre-Test Environmental Attitude Responses with Respect to Gender*

	Females	Males	Mann-Whitney
EA14	163.90	158.32	.559
EA16	180.32	147.80	.002
EA21	150.13	166.86	.100
EA37	150.58	166.86	.117
EA42	183.38	144.94	.000

n = 320

attitude response on the pre-test was 20.93 (se 0.3604), with 20.13 (se 0.3014) for males. The Mann-Whitney U test was performed on environmental attitudes and established a mean rank for females and males as shown in Table 31. The only two survey questions that did show a significant difference in mean scores from the pre- to the post-test were environmental attitude questions EA16 and EA42.

Amounts of mean ranked change per question responses are shown in Table 32. Females had a higher mean change score from the pre- to post-test for all questions in component one except for question EA16. Total mean change in environmental attitude for females was 1.78 (se 0.3842) and 1.14 for males (se 0. 3094). The Mann-Whitney test showed questions Δ21 and Δ37 as the only two with significant differences in change from the pre- to the post-test responses.

Table 32. *Mean Ranked Change in Student Responses for Environmental Attitudes and Gender. The M_W Category Displays the Mann-Whitney U Level of Significance for all Questions Regarding Change in Environmental Attitude Responses with Respect to Gender*

	Females	Males	M_W
Δ14	160.83	160.29	.957
Δ16	157.69	162.30	.653
Δ21	172.01	153.12	.018
Δ37	174.96	151.23	.008
Δ42	161.08	160.13	.926

n = 246

In Figure 41, mean attitude change in student responses is on the vertical axis, and horizontal axis represents the three intervention groups, with females on the right side and males on the left side. The left bar is the pre-test attitude score and the right bar is the post-test score. The females had highest positive attitude responses in all three groups and also had the largest amount of change from the pre- to the post-test except in Group 3, where the males and females were approximately equal. For all pre-test responses on the questions addressed, females had higher scores except for question EA37. In mean change for student responses, females consistently had more positive changes in their scores than males. A Mann-Whitney U test showed gender not significantly related to overall pre-test environmental attitudes responses (n = 320,

p = 0.148), and not significantly related to change in overall attitudes (n = 246, p = 0.279) in component one.

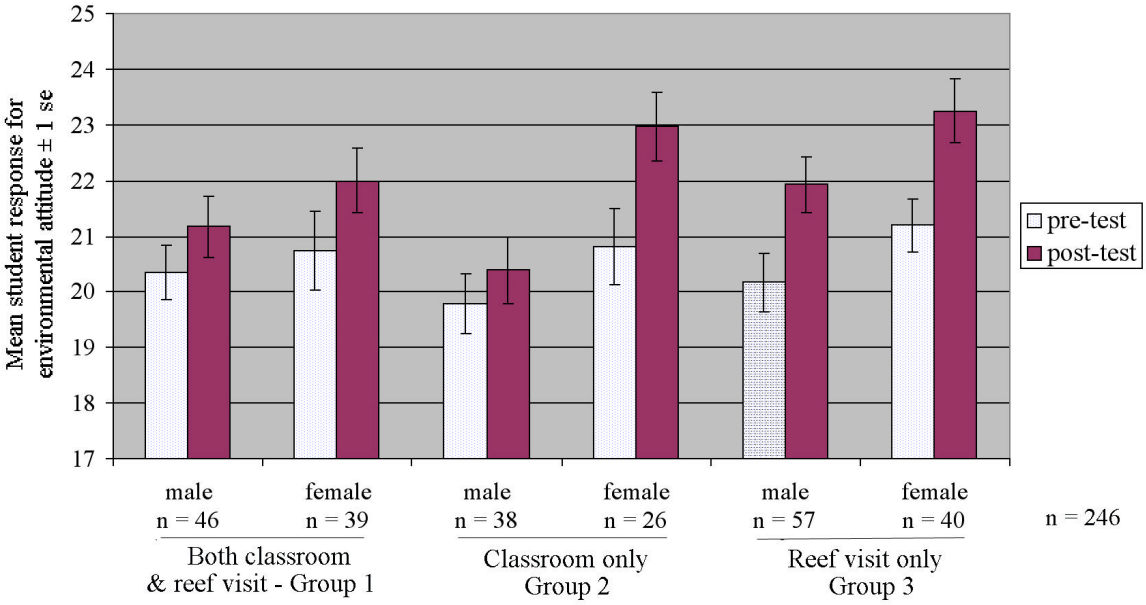

Figure 41. Change in student environmental attitude responses per gender and group.

6.2.5.3 Ecological intention to act.

In ecological intention to act section for component one, females recorded higher scores on all of pre-test survey questions in component one, except for one (Table 33). Not only did females have higher pre-test intention to act responses, but they also showed a higher propensity for change. Table 34 shows females with higher change ranking than males for ecological intention to act in all but question Ac27. The pattern

Table 33. *Mean Ranking of Pre-Test Ecological Intention to Act and Gender. The M_W Category Displays the Mann-Whitney U Level of Significance for all Questions Regarding Pre-Test Ecological Intention to Act Responses with Respect to Gender*

	Females	Males	M_W
Ac20	169.72	154.59	.145
Ac22	164.07	158.21	.568
Ac27	174.45	151.56	.026
Ac28	157.92	162.15	.682
Ac32	164.43	157.18	.483

n = 320

of females outperforming males, which was established with attitudes, remained consistent for change in ecological intention to act. The only question where the males had higher positive responses was on Ac28, and the only question that showed a significant difference between the male and female responses was Ac27.

Figure 42 shows change in ecological intention to act per student group. Females showed higher overall change than males, and responded more positively to intention to act questions than males in Groups 2 and 3, with males out-performing females in pre-test scores and Group 1 change. The vertical axis shows amount of change in positive student responses for intention to act survey questions and the horizontal axis shows student intervention groups and gender. There was no significant difference in the effect of gender on changes in intention to act questions about reef ecology (Table 34).

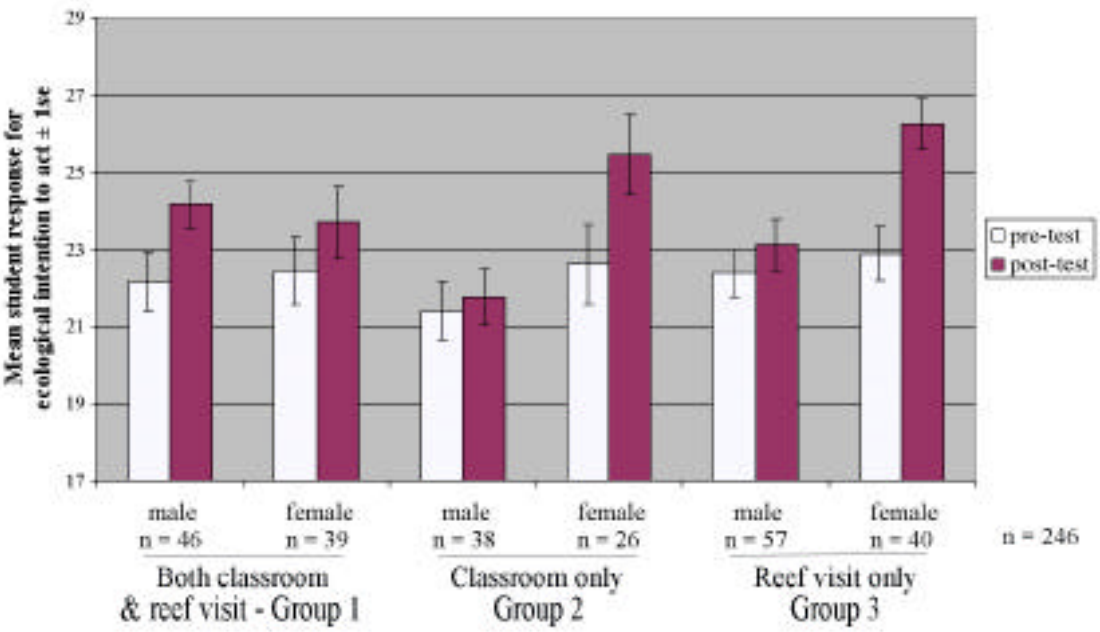

Figure 42. Change in ecological intention to act per gender and group.

Table 34. *Mean Ranking of Change in Ecological Intention to Act and Gender*

	Females	Males	M_W
Δ20ac	166.13	156.89	.289
Δ22ac	161.56	159.82	.828
Δ27ac	157.46	162.45	.518
Δ28ac	165.55	157.26	.325
Δ32ac	163.61	159.89	.555

n = 246

A Mann-Whitney U test showed gender was not significantly related to overall pre-test ecological intention to act responses (n = 320, p = 0.224), but **was** significantly related to change in ecological intention to act (n = 246, p =0.022) in component one. Females consistently outperformed males on positive responses to the survey questions, but the analysis of the Mann-Whitney U test showed the difference in the gender performance was not significant for environmental knowledge, attitudes or ecological intention to act, except for change in intention to act responses.

6.2.5.4 Gender and previous reef experience.

Pre-test responses to the survey question pertaining to gender and past reef experience were almost the same for female and male students as a whole. Mean scores on the pre-test previous reef experience responses for female participants were 3.00 (se 0.1244) and 3.20 (se 0.1045) for males out of a total of five possible. There were no significant effects of gender on the GBR experience responses (n = 320, p = 0.173).

6.2.5.5 Gender and previous snorkelling experience.

Mean scores on pre-test responses concerning gender and snorkelling experience for females were 2.2 (se < .001) and males were 2.54 (se < .001). There **was** significant effect of gender on answers concerning snorkelling experience (n = 320, p = .005).

6.2.5.6 Gender and previous camping experience.

Camping pre-test experience results showed females (3.10, se < 0.001) had less than males (3.22, se < 0.001). There were no significant effects of gender on camping responses (n = 320, p = 0.333).

6.2.5.7 Gender and previous experience watching nature channels on TV.

For watching nature documentaries on television scores, females (7.16, se 0.465) had lower mean scores than males (8.26, se 0.337). There **was** a significant effect of gender on answers concerning responses to watching nature documentaries on TV (n = 320, p = .014).

Knowledge findings (Figure 41, p. 141) showed females doing best in the experiential education group (Group 1), and males had their highest scores in Group 1, and had their highest amount of change in Group 1 and the classroom presentation (Group 2). However, there was no significant effect of gender with respect to pre-test

knowledge about reef ecology (n = 320, p = .094), and no significant effect of gender on change in knowledge about reef ecology (n = 246, p = .969). With respect to environmental attitudes, there was a significant effect of gender on pre-test response scores for EA16 (n = 320, p = .002) and EA42 (n = 320, p < .001). Concerning change in environmental attitudes, gender did have a significant effect on Δ21 (n = 246, p = .018) and Δ37 (n = 246, p = .008). Tests showed a significant effect of gender with pre-test ecological intention to act responses for Ac27 (n = 320, p = .026). This research showed there was no significant effect of gender on change in intention to act responses about reef ecology.

6.3 Discussion Quantitative Results

Objectives of this section are to briefly discuss quantitative results and put them into perspective concerning research about student learning and marine experiential education. The results are investigated with respect to different educational interventions and relationships in environmental knowledge, attitude and self-reported ecological intention to act skills. Variations were also observed in student demographics and gender.

This investigation found increased positive responses with educational interventions, and this was most evident in the environmental knowledge element. The marine education group with both classroom presentation and reef visit (Group 1) increased participants' environmental knowledge the most (Figure 29, p. 117). The attitude and intention to act results did not follow this profile across groups (Figures 30, 33). For both attitude and intention to act percentage change, Group 1 was higher than the contrast group (Group 4) in all cases, but the highest effect was not always in Group 1. The reef trip only group (Group 3) had the highest percentage change for environmental attitudes and ecological intention to act in component one. However, a weaker less significant relationship existed between groups for attitudes and intention to act than for knowledge, because there was a smaller percentage change and differences were not as pronounced. Environmental attitudes and ecological intention to act both increased from the pre- to the post-test with the educational interventions (Figures 30, 31, 32, 33) during the research. It was observed that the combination of a classroom presentation and reef visit had the highest positive effect on environmental knowledge and the reef visit only group had the highest change in positive survey responses for both environmental attitudes and ecological intention to act in component one.

Environmental knowledge responses increased significantly in all groups except the contrast group, and the largest change and highest post-test score were for Group 1. For environmental attitudes, all groups increased significantly from the pre- to the post-test except the contrast group, with Group 3 significantly showing the largest amount of change and the highest score on the post-test. The intention to act portion of the intervention analysis revealed that the largest amount of positive change and the highest mean score was for Group 3, the reef visit only group. This was shown to be a significant change between the pre- and post-test, and the groups were significantly different.

When comparing environmental attitude across the three components, component one (reef ecology) had the lowest positive responses on the pre-test, but then had the highest rate of change, with component three (alternative solutions) being the lowest after the post-test, as it remained mildly positive and was relatively unchanged. With respect to the three components and ecological intention to act, component one (reef ecology) had the highest positive responses for the pre-test, followed by component two (human impacts), and the lowest was component three (alternative solutions). The three components all showed a significant positive change from the pre-test to the post-test, with component one having the highest change, followed by component three which remained in the mildly negative category. Group 3 (reef trip only) students had the highest rate of environmental attitude and ecological intention to act change (Figures 30, 33) for component one, and the most positive responses on the post-test, so the reef trip had the most effect on environmental attitudes and ecological intention to act.

In component one, the inter-relationship between pre-test environmental knowledge, attitudes and ecological intention to act was stronger than anticipated. In Tables 17 to 19, responses for environmental attitude displayed significant relationships to at least one ecological intention to act response. The pre-test environmental attitudes and change responses were compared to changes in ecological intention to act and significant relationships were noted. Pre-test environmental knowledge was also included in this inter-relationship, and it showed correlations to both pre-test attitudes (Bradley, et al., 1999) and intention to act change (Tables 15, 16, 17, 18, 19), and this indicated some relationship between the variables.

Knowledge to attitude correspondence showed significant associations between pre-test environmental knowledge scores and two pre-test attitude questions (EA16,

EA42), but not to change in environmental attitude questions. The pre-test knowledge variable was significantly correlated to two pre-test intention to act questions (Ac20, Ac22), and two changes in intention to act questions (Δ20ac, Δ28ac). For the relationship between environmental attitudes and ecological intention to act questions, there were a number of significant correlations (17) between pre-test responses (Table 17), and a number (10) of significant correlations between changes in positive responses (Table 19). The number of correlated responses did drop from the pre-test scores to the change in scores, but significant correlations did continue. It is important to note that there were **no** significant correlations between change in environmental knowledge scores and change in environmental attitude or ecological intention to act scores in component one.

Such a high number of significant relationships between environmental attitude and ecological intention to act responses were not expected (Hungerford & Volk, 1990; Marcinkowski, 2001), but correlations were shown between pre-test environmental attitudes and ecological intention to act (Tables 17, 18, 19). This number of significant relationships exceeded expectations and indicated an inter-relationship on pre-test and change responses for environmental attitude and ecological intention to act for component one. Coral reef experiential education interventions increased self-reported environmental attitudes and ecological intention to act responses, as improvement was shown in arithmetic means over all three components (Figures 31, 32). Thus, an improvement in environmental attitude and ecological intention to act responses followed marine education interventions.

Relationships with student responses were also found with demographic elements. Previous experiences at the Great Barrier Reef, swimming, snorkelling, and camping had positive influences on student responses. Knowledge was not highly correlated to demographic variables overall, except for pre-test environmental knowledge (K_pre) and previous reef experience, swimming and snorkelling (Table 21). The only significant relationship for change in knowledge (ΔK) was a negative one to previous reef experience.

Previous reef experience influenced changes in environmental knowledge to a slight degree (Tables 21, 24; Figure 34). Previous reef experience directly influenced attitudes (Figure 35), with a number of correlations (Tables 22, 24). In addition, previous reef experience had an effect on ecological intention to act, and this was demonstrated by significant correlations in Tables 23, 25 and Figure 36. Significant

correlations were numerous between GBR experience and intention to act (Tables 23, 25).

Past experience of snorkelling influenced the reef ecology component of dependent variable questions (Tables 21, 22, 23, 27, 28, 29; Figures 37, 38). Significant correlations were shown between all pre-test intention to act responses (component one) in this study (Table 23), and toward no change in responses to intention to act. Apparent difference between snorkellers' and SCUBA divers' responses was an interesting development that was not anticipated, and the meaning cannot be determined in this study. Camping, on the other hand, had three significant correlations to change in attitude and four significant correlations to pre-test intention to act responses (Tables 22, 23). Watching nature channels on TV had few significant correlations with the dependent variables (Tables 22, 23). This category of demographic variable was stated by Fortner (1983) to be influential during the 1970s, but had little influence on this group of students' responses since only one response was significantly related to a pre-test attitude, EA37 (Tables 22, 23).

When demographic variables were considered, direct relationships existed with respect to knowledge, attitude, intention to act and positive questionnaire responses, except for watching nature channels on TV. Environmental knowledge, attitudes and intention to act were all positively affected by previous reef experience, and especially with respect to two visits or less. Previous reef experience, snorkelling and camping also showed positive relationships with the student learning outcomes. No significant changes between the pre- and post-test were observed with the demographic variables except with the effect of previous reef experience on environmental knowledge change. Watching nature channels on TV had the lowest amount of significant correlations to the three outcome variables investigated, but was significantly related to gender.

The next variable investigated was gender. Non-parametric techniques were used to explore these relationships since survey data were ordinal (ranked) and gender data nominal. Tables (Tables 31-34) and Figures (Figures 40-42) depicted gender relationship to knowledge, environmental attitudes and ecological intention to act. It was observed that on knowledge responses, females outperformed males in three out of four groups in the pre-test. On the other hand, males had the greatest rates of change in Groups 2 and 3 for knowledge (ΔK), but females responded best in Group 1 and generally outperformed males in positive survey responses (Figure 40). Females had more positive responses to all attitude questions, with questions EA21 and EA37 not

being gender neutral, and males having the highest change in component one (Tables 31, 32; Figure 41). Males had the highest rate of change in Group 3 for attitude questions. Intention to act responses showed females to have the most positive responses to all questions in all components (Tables 33, 34; Figure 42). Previous reef experience was gender neutral ($n = 320$, $p = .173$). Students with snorkel ($n = 320$, $p = .005$) and TV ($n = 320$, $p = .014$) experiences showed a significantly higher male response rate than female ($n = 320$, $p = .005$).

Findings demonstrated females had more positive responses than males on practically all aspects of the study relating to survey question responses. Females had the most knowledge change in Group 1 (Figure 40), with males showing the most positive change in responses for Groups 2 and 3. However, the Mann-Whitney U test showed there was no significant effect of gender on pre-test knowledge responses about reef ecology ($n = 320$, $p = .094$), and no significant effect of gender on change in environmental knowledge about reef ecology ($n = 246$, $p = .969$). With respect to environmental attitudes, there was a significant effect of gender on pre-test responses for EA16 ($n = 320$, $p = .002$) and EA42 ($n = 320$, $p < .001$) in component one. Concerning change in environmental attitudes, gender did have a significant effect on $\Delta 21$ ($n = 246$, $p = .018$) and $\Delta 37$ ($n = 246$, $p = .008$). The test showed a significant effect of gender on pre-test intention to act question Ac27 ($n = 320$, $p = .026$).

When investigating the relationship between environmental knowledge and gender females had a significantly higher score on the pre-test than males and had a higher overall rate of change on their test scores (Figure 40). The Mann-Whitney U test showed gender did not have a significant effect on students' change in knowledge response over the course of the study. For environmental attitudes the females had the highest mean scores overall, and the largest amount of change from the pre- to the post-test for every educational intervention group. Females consistently had more positive attitude scores than males, but a Mann-Whitney U test showed gender was not significantly related to pre-test or change in overall environmental attitudes responses in component one. For ecological intention to act, females had more positive pre-test intention to act scores, and also showed a higher tendency for change except in Group 1. As with environmental attitudes, females had more positive pre-test responses than males, with a Mann-Whitney U test showing gender not significantly related to overall pre-test responses, but gender was significantly related to change in overall ecological intention to act responses in component one. Females consistently outperformed males

on positive responses to the survey questions, with the Mann-Whitney U test showing the difference in the gender performance not being significant for environmental knowledge, attitudes or ecological intention to act, except for change in intention to act responses.

6.4 Chapter Summary

When demographic variables were considered, direct relationships existed with respect to knowledge, attitude and intention to act questionnaire responses. Direct experience with reefs had a positive impact, since the combination of a classroom presentation and reef visit had the highest positive effect on environmental knowledge and the reef visits had the most effect on environmental attitudes and ecological intention to act responses. Across the three components, component one (reef ecology) had the lowest positive responses on the pre-test for environmental attitudes, but then had the highest rate of change, with component three (alternative solutions) being the lowest. With respect to three components and ecological intention to act, component one (reef ecology) had the highest positive responses for the pre-test, followed by component two (human impacts), and the lowest was component three (alternative solutions). The three components all showed a significant positive change from the pre-test to the post-test, with component one having the highest change, followed by component three which remained in the mildly negative category.

When the three outcome variables were compared to each other before and after the educational interventions, there were significant correlations between pre-test knowledge, attitude and intention to act questions. For the relationship between change in environmental knowledge, attitudes and intention to act questions, there were significant correlations between attitude and intention to act, but none with change in environmental knowledge for component one.

Environmental knowledge, attitudes and intention to act were all positively affected by previous reef experience, and especially with respect to two visits or less. Previous reef experience, snorkelling and camping also showed positive correlations with student learning outcomes. No significant changes between the pre- and post-test were observed with demographic variables except with the effect of previous reef experience on environmental knowledge change. Watching nature channels on TV had the lowest amount of significant correlations to the three outcome variables investigated, but was seen to be significantly related to gender.

In the relationship between environmental knowledge, attitude and ecological intention to act, the females had significantly higher scores than the males. The males had a higher rate of change in Groups 1 and 2 for knowledge, Group 3 for attitudes and Group 1 for intention to act. The Mann-Whitney U test showed gender did not have a significant effect on students' pre-test or change in environmental knowledge, attitude or ecological intention to act responses over the course of the study except for overall ecological intention to act responses in component one.

This chapter empirically examined the learning and outcome relationships influenced by educational interventions implemented in this research, while also investigating a number of demographic factors. The next chapter will furnish qualitative findings from the student participants' perspectives. It analyses the data in a narrative manner to provide a human dimension, which expands information concerning the research objectives of the project.

Chapter 7

Qualitative Findings: Student Accounts

> *More knowledge about the reef, and how it works and how you can help it out, things like that. Make people more educated about the reef, because we all live here so we should know things about it.* (female 27)

7.1 Introduction

In this chapter I discuss my study and how it qualitatively illuminates high school student accounts of environmental learning at offshore coral reefs in Queensland, Australia. A structured interview approach is discussed with respect to a thematic analysis of student accounts of underwater experiences in reef environments. Rickinson (2001) notes greater attention needs to be paid to students' qualitative learning experiences, and Allison and Pomeroy (2000, p. 91) emphasise the importance of "the experiences of individuals and the meanings they make of their experiences." I could find no previous systematic learning value studies of snorkelling or reef monitoring in the experiential or environmental education literature. After I embarked on the difficult task of *in situ* data collection, I realised there was probably a practical reason these studies do not exist.

The concern is threefold: 1) to present the accounts of the student participants; 2) to add dimensionality to the quantitative data; and 3) to investigate effects of reef experiences in relation to the proposed model of ecological intention to act. Students' accounts are important as they enable recognition of learning. They provide oral records of their development as experiential learners and recognition of possibilities for future ecological actions. Their perspectives help us to understand whether or not direct reef experience makes a differences to them in realising one goal of the formal Marine Studies program and that is, developing an ecological vision for marine environments in Queensland (Queensland Studies Authority, 2005c).

7.2 Data Collection

Once the obstacle of ethics approval for conducting this high school student research was granted on 6 March 2003, the data collection commenced. This could not have occurred without the full cooperation of the Marine Teachers Association of Queensland, many willing high school teachers and the support of school principals.

After the necessary arrangements and approvals were in place, the researcher accompanied four different field excursions to the Great Barrier Reef Marine Park and collected interview data. As part of the fieldwork, the students were also taught techniques of coral reef monitoring. Most of the 15, 16 and 17 year olds were enthusiastic, but not very expansive, in their conversation with me, the middle-aged, male researcher.

The students were interviewed *in situ*, on boats and beaches after the coral monitoring exercise. In total 115 high school student interviews from four different schools were gathered on the return trips (Table 35), with 67 interviews conducted by the researcher and recorded using audio equipment. A further forty-eight peer interviews were videoed and conducted. I thought with students' interviews of each other, the adult researcher-adolescent participant effect could be minimised. The peer interviewers used a copy of the researcher's interview schedule so that similar questions were asked in researcher and peer interviews. Not all peer interviews followed the interview schedule precisely.

Table 35. *High Schools, Interview Types and Number of Students Interviewed from Each Participating School*

High School	SMCC*	WSHS*	GCC*	SCCC**	Total
Students on reef trip	52	26	27	55	160
Number of students interviewed by researcher	11	12	19	25	67
(Male/Female interviewed)	(4/7)	(8/4)	(11/8)	(15/10)	(38/29)
Percentage interviewed by Carl Stepath	21%	46%	70%	45%	42%
Percentage Male/Female interviewed by CS	36/64 %	66/34%	58/42%	60/40%	57/43%
Number of students recorded in peer interviews	12	6	9	11	48

Note:

* Indicates a day trip to coral reefs in the Great Barrier Reef Marine Park

** Indicates an extended field visit to North West Island

The weather was good for snorkelling on almost all research trips, but a few of the boat rides out to the reef were in rough seas during windy conditions. The boat ride to Hastings Reef and Breaking Patches on August 29, 2003 was particularly unpleasant for the Good Counsel College students as a number became seasick because of the high winds and rough seas. The early morning of August 10, 2003 was chilly and windy for the students from Southern Cross Catholic College when they snorkelled and monitored the reef at Northwest Island.

Three reef trips were day visits. One trip was of one-week duration. Students were interviewed immediately after their reef monitoring and free snorkelling experiences. In three cases, this meant the interviews were conducted on the boat journey back to port. With one exception, the weather was poor on the boat ride to the reef, with many students experiencing seasickness because of rough seas. In two cases, the boats were very crowded as the schools used commercial reef trip providers. Still, the warm conditions on the return trips proved productive for interviewing students. In the fourth case, I interviewed students on the beach at Northwest Island, and one such interview was after an early morning reef monitoring experience on a cold and blustery day when some became chilled. Unpleasant conditions in marine environments are a factor when doing this kind of research and some students were understandably unwilling to participate, as they were feeling cold, ill or tired. The entire transcript for one male student consists of the words, “I didn’t really like it. I was cold and sick.”

There are risks associated with marine environments when doing this kind of experiential education research. Rough sea conditions made the reef trip difficult for a few students not used to marine conditions, and consequently some of them were understandably unwilling to be interviewed. One of the ethical conditions of the project was that students did not have to participate and could withdraw at any time. No records were kept of students who did not participate in the interview process. Overall, more than 60% of students on reef trips did agree to interviews. In fine weather on the trip to port, with the boat running with the wind and warm conditions, the return trip was especially good for interviewing students. A small number of students were interviewed on the beach on the Northwest Island trip, with the majority being completed on the boat. Students were interviewed individually, and in small groups of two to four.

All interviews were audiotaped or videotaped and the tapes transcribed as accurately as possible given background conditions were generally noisy. Despite the many limitations to their collection, these data do represent a unique set of adolescent

opinions and statements on the value of reef experiential education collected *in situ*, on boats and on an island beach, in tropical marine environments. One surprising fact was the number of students who had never been to the reef before, even though almost all students interviewed for this research live in coastal Queensland towns. The four trips represent the first visit to the Great Barrier Reef for 21.6% of the high school students in the study.

7.3 Interviews

Transcripts of student responses were read and sorted. The first analysis was a subjective but consistent judgement of responses to the structured questions according to question topics. In the second analysis I sorted data looking for concepts of proximity in student accounts where students were able to locate their experiences in space and place. Proximity is defined as attachment, kinship and nearness in space or time. Proximity as a relationship between learners and marine environments is promoted in the Queensland Studies Authority *Marine Studies Senior Syllabus 2004*, and teachers are encouraged to treat marine environments as sites of learning and not just as objects of study.

Central to the second analysis is a question posed by Rose (1999, p. 252) who asks, “What kinds of space articulate what kinds of corporealised relation?” On the premise that environmental education research is an investigation of relations and relationships between differing bodies, both social and physical, the research questions concern the sites of learning. The first question addressed is, how do senior high school students relate their learning within classrooms to their experiences of learning within coral reefs in the context of marine studies pedagogy? The second question is, how do senior high school students come to understand the corpo/realities (relating to a person’s physical body) of coral reefs through their underwater immersion experiences? The third and final question is, how do senior high school students express a further ecological intention to act as a result of their immersion experiences on the Great Barrier Reef?

No data processing program was used to analyse the scripts. The researcher made subjective but consistent judgements of the students’ databased responses to structured questions. In each case, a number of student viewpoints were juxtaposed to show both a range and a consistency of responses.

7.4 Student Accounts in Relation to Research Questions

Question 1: How do senior high school students relate their learning within classrooms to their experiences of learning within coral reefs in the context of marine studies pedagogy?

The following transcripts clearly show students recognised the value of escaping the classroom and getting wet in order to learn more acutely about coral reefs. The experienced reef is “a completely different world” from the one that is read about in books or viewed on television or video screens or as represented in “other people’s stories”. Students voluntarily compare learning from texts, such as books and videos, with the reality of encountering reef environments they describe as “hands on” learning. The action component of listening to learn at the reef compares favourably with classroom situations. Every transcript is the account of a different student. Accounts from a total of 46 males and 27 females are presented in this chapter. Accounts are short but numerous.

It is just so awesome to get out here and really get hands on. Being in the classroom, you can only see pictures and hear other people’s stories [of the reef], but it is a completely different world when you experience it. The reef is something you have to see to believe, really. You definitely learn more out here. Like picking up little sea anemones - you can see it on video and watch people do it, but it is completely different when the anemone is in your hand and you are learning from your own experiences. (male 1)

The whole ecosystem out on the reef, it is great. Like, you hear about it and see it on TV, when you actually see it; it just means a whole lot more. It can’t get much better than this. Hands on is definitely the way to go. You learn a thousand more things looking at the reef [under water] rather than reading about it. (male 2)

Being out here understand a lot more. You actually experience things, whereas in the classroom you are being told about it. You probably learn lot more when you experience it. I learned how to drive the boat. (female 1)

I like it out here because you are actually doing it; you are not just sitting down and reading a book about it. I think you learn a lot more. (male 3)

This is so much better than the classroom, more hands on, more fun. I have been camping but I have never been to the Barrier Reef before. (female 2)

You learn things out here for sure. It makes it heaps easier to learn if you are actually doing things that you learn, not just sitting there listening to it. (male 4)

I like learning this way because it is actual hands on experience. When you are in the classroom there are too many distractions, your mind just slips. But when you are out here doing stuff you learn a lot better because you are interested. (male 5)

It gives you the opportunity to see things first hands on instead of reading out of a book. And people learn a lot more because they are interested. (female 3)

Actually, coming out here and experiencing the reef helps us learn better … like much better than reading books. It is right in your face so you can't really have any excuses. (male 6)

I wouldn't classify this as education because it is just too much fun, but if it has to be called education, then it is great. In a classroom, there a book is put in front of you and you are made to read it, but here you listen to everything because you want to, you want to know everything. (male 7)

It is so different to normal life, it is excellent. It is so much more interesting than the classroom. To be able to look at [the reef] was so good. (female 4)

I haven't learned so much in a week in my life to be honest. You still learn theory, but it is all based on practice, all the work is based on something that you have done on that day. You learn things out here for sure. It makes it heaps easier to learn if you are actually doing things that you learn, not just sitting there listening to it. (male 8)

It is better than in school … I look more in the field. Everyone knows that compared to a classroom, if you are in the field you can be in touch with what you are talking about. You can learn a lot more about it. We should do more field research. (male 9)

You learn so much out here. It is hands on. I think it is a great experience. I would come back if I had a chance. (male 10)

Thumbs up, top trip. I wish this was school everyday. (male 11)

Both male and female students state an appreciation for their involvement in offshore reef experiences. In these data, responses indicate processes of experiential learning such as recognition of awareness on the reef trip. Students can focus on their actual engagement with coral reef environments and value of outdoor immersed reef experiences. Highlighted in student responses here are the learning experiences of physical and immediate contact with coral reef environments. The value of this is often stated in terms of “I liked it out here”, “it is just so awesome” and “thumbs up”. Immersed in marine environments students are active in the learning experience rather than passive recipients.

The student responses indicate they think learning *in* the reef is more powerful than learning about the reef in the classroom. This visiting the reef and being immersed in the offshore ocean environment at the reef transmits a feeling of being part of nature, and this is sometimes lost in our modern world (Fine, 1992). It appears from the student accounts that this is a strong learning tool, and brings up recollections about what it feels like to be in nature. Some students responded by saying “you learn things out here for sure” and “the anemone is in your hand and you are learning from your own experiences.”

Question 2: How do senior high school students come to understand the corpo/realities of coral reefs through their underwater immersion experiences?

Data show that conceived relations between students and reef bodies do change as reefs become familiar places for students through field visits. The animal and plant bodies that create reefs become comprehensible and the realities of reef preservation become better understood. Students speak of not realising how many different species of

fish inhabit reefs, of encounters with corals, sea cucumbers, clams and how “lovely” it is to “get to see the reef”. Their accounts make apparent what they have learned about the effects humans have on coral reefs – a positive educational outcome aim of the Queensland Studies Authority *Marine Studies Senior Syllabus 2004* is to encourage students to reflect on their own values and attitudes towards marine environments. Overwhelmingly, the impression from student accounts is of the value of field trip experiences that provide contact with reef bodies. As well as having fun and rating snorkelling and reef monitoring as “pretty good”, students can immediately make the connections to a variety of reef conservation issues following their underwater encounters. The following represents the accounts of different students.

I never knew an island could be made from a coral reef. You realise we need coral reefs. We have to keep coral reefs safe and safe for our children. I am a lot more interested in actual reefs now and in reef animals. (male 12)

I know the difference between certain corals and fish, and what is poisonous and what is not harmful. (female 5)

You learn there is stuff out here that you never really knew what it was before. (male 13)

[I] liked the fact that we are able to come out here and have a swim and learn about the reef. It is lovely to get to see the reef, learn a bit. (male 14)

I have learned about the diversity of fish down there, there is so much to see and that was cool. (female 6)

I liked learning about the fish. I didn’t know what the fish were before. (female 7)

It makes us know what the reef is like and how we need to keep it in good condition so our kids can enjoy it like we do. (male 15)

I have never seen a coral reef before. I have never seen so much coral. We learned about all the different types of coral and fish. I quite liked looking at the butterfly fish and coral cod; it was quite interesting. (male 16)

People learn more when it is hands on instead of just reading about things that you forget easily. When you are in a classroom, you only see pictures, but we have actually seen the creatures, and been able to pick them up, and actually hold them, and we are not going to forget that. (female 8)

I loved the beach just lying out there and looking at the coral and fish. We saw some eagle rays and blue spotted rays and stingrays. You just see everything from a different angle. I learned how much we destroy everything and I learned how to help a coral reef rather than destroy it. Everyone is interested and they want to do it [participate] rather than in a classroom, which is just boring. It's up on the board and you're not doing anything and people just bludge. But here [on the reef], you want to do it because it is fun. (female 9)

I thought it was very educational and I learned stuff I didn't know before and that can help me and I can go and tell other people, just basic knowledge about the reef and different fish, different types of coral and everything like that. Whenever the conversation comes up, I will know a bit more than my share. (male 17)

The reef monitoring was pretty good except it was choppy the day we went out and a bit scary. I was worried about drifting away. I learned that sea cucumbers have this thing on the outside that maybe helps breast cancer, I learned about coral cays. I've learned heaps. (female 10)

I liked getting to have close up encounters with the native wildlife of the Great Barrier Reef. It was pretty interesting to do those surveys on the spot and see which creatures inhabit the reef. I learned the names of different fish that we saw and now when I go fishing, I will know what it is. (male 18)

It helps me respect what we have got out here. (female 11)

It makes you more conservative, and aware of what is going on in the world. And you tend to appreciate the reef more. It has changed a lot of stuff for me. (female 12)

People don't understand that coral is fragile and it can get screwed up pretty easily. They stand all over the coral, and they think 'that's a nice bit of coral' and pick it up, rip it out, which kills it, and they don't really take notice because they think it's unlimited. But it can die pretty easily and it takes a pretty long time for it to grow back. (male 19)

Bring more people out and let them have a look at the reef and see how wonderful it is. Let them see for themselves and they probably won't be so destructive to it. Like they throw stuff out of the boat and they don't think about the damage they are doing. (male 20)

It's great to see people coming out here enjoying the reef but thousands upon thousands of people are coming here and walking across the reef, would be ultimately bad for the reef. (male 21)

We all live here so we should know things about the reef. (female 13)

I liked going into the water because you could see all the stuff above the water and the coral underneath. I saw a bit of litter out there that I had to pick up, like beer bottles, quite a lot of them, [and] bits of plastic and plastic bags that I pulled off the coral as I was doing the monitoring. (male 22)

Yesterday I did coral reef monitoring with my friend Carl here, and what I really liked was when Carl took a photo of me under the water. And straight after that, I did a dive on the other side of the island, which not many people do, and it was beautiful. I learned not to put my fingers into clams and not to play with sea cucumbers for too long. (female 14)

I learned to treat the coral and the reef and ocean very carefully and the marine life out here is very fragile, just the smallest influence can be detrimental to it. (male 23)

I was a bit careless about the environment before I came out here. I was a bit of a litterer I guess. (female 15)

This experience makes me more conscious of how to treat the ocean and the reef, like stop polluting and stuff. (female 16)

I am definitely going to come back again, I love it. (male 24)

Marine studies is like a retreat, like getting to know yourself, how well you cope in certain situations and you learn about your friends and how well they cope with the same situations as well. I have also learned how to preserve the reef a bit more. (male 25)

The structured learning situation of coral reef monitoring was used as a pedagogical device to open up new ways of learning and creating value from this coral reef learning experience. The structured outdoor learning activity focuses attention on coral reef ecosystems by monitoring, rather than the unstructured activity of just swimming around and looking at the reef environment. Student responses included “I liked getting to have close up encounters with the native wildlife” and “I was a bit careless about the environment before I came out here”, indicating a change in understanding corpo/realities of coral reefs. Such structured learning activities as monitoring encourage acute observation, identification and recording. These are all active tasks forcing active involvement, and focusing attention on living reef creatures and ecosystems.

These data indicate likely change in awareness and attitudes, and substantiate earlier findings about a sense of place in the outdoors by Dettmann-Easler and Pease (1999), Powers (2004), as well as Yerkes and Haras (1997). Being outdoors helped change students’ views, as they become excited and learned during the experience (Quay, 2003). A continuing theme through the accounts was that student participation in the field trip formed the basis for recollection and “those actions were important in influencing knowledge and attitude” (Knapp & Poff, 2001, p. 59). An example comes from the adolescent female who said “This experience makes me more conscious of how to treat the ocean and the reef, like stop polluting and stuff.” Perceptual distances between coral reefs and the students appeared to be lessened. I get a strong sense from these data that reef experiences count as meaningful learning.

Question 3: How do senior high school students express a further ecological intention to act as a result of their immersion experiences on the Great Barrier Reef?

Now the investigation turns to whether actually going to the reef increased the students' desire or intention to consider personal actions in the future concerning conservation and the health of coral reefs.

And what can we do to help the coral reef – limit the activity around the reef and don't put your anchors on the reef, because that will wreck it, because they're alive, they're living animals. (female 17)

I learned all about coral, food chains, hermit crabs and crustaceans and stuff. I do a fair bit of snorkelling so I learned more about where to find different fish. (male 26)

The monitoring was fun because we got to see how many fish were in that little tiny area. It tells us how many fish are really out there – which is quite a lot. I liked monitoring…. Litter is the main things humans have to be a bit more careful about. (male 22)

I won't pollute as much. Like I won't throw things in the oceans and things like that. And I'll know the difference between certain corals and fish and what is poisonous and what is not harmful. (female 18)

Well I found that when I was walking over the coral I broke approximately 5 tons of coral in my week inhabitance on the island and the clams did try to eat my foot. But in the future, if I'm ever at a coral reef I will know from this experience not to walk on it as it is quite fragile. (male 27)

I learned to treat the coral and the reef and ocean very carefully and the marine life out here is very fragile, just the smallest influence can be detrimental to it. (male 28)

I didn't really enjoy the monitoring but I enjoyed learning stuff about the corals and the cone shells. I liked the cone shells. We learned how to tell which ones were poisonous.…

If I ever see a cone shell I can pick it up because I know which ones are poisonous. (male 29)

It helps me respect what we've got out here. (female 19)

I've learned how to preserve the reef a bit more. (male 30)

As individuals, I think there is a whole heap of problems that have affected the reef and have been going on and now we're starting to realise the after-effects of it, like general things like cane farmers probably never knew that the pesticides on their crops would affect the reefs way out here. I think a lot of people realise that now. What we could do – everything from no fertilisers on lawns, a lot of stuff like that. Make people aware. I see a lot of people, when they are snorkelling, they stand up anyway and then they wonder why is that reef wrecked. You know, that sort of thing, stuff like that. (male 31)

Basically be more careful and watch where you are stepping when you are in the water and don't go fishing where it's like, you've got to conserve the stuff, like fast boats and deep water boats, don't bring them too close to the corals and that. (female 20)

I don't think it will make a difference. I learned some stuff while we were here [that] will probably relate to school as we have to do assignments and essays and stuff. But not in my daily life, I don't think it will really affect me. (male 32)

I will always remember everything here [at the reef] because we won't get to do it again. I'll always remember the name of the sea cucumber. It will impact on me. I won't fish as much. (female 21)

When asked directly the question 'What can people do to help coral reefs?', students gave the following responses:

That's a big one, um, give people information straight off. (male 33)

Lots. Like don't send waste to the ocean. (female 22)

Try to reduce the pollution that's going on around here, dumping and pollution. And be careful what you're doing when you are out here. Don't break the coral. (male 34)

Protect them and try not to break the coral and stuff. (male 35)

Stop polluting and not caring about it. Most people just throw their anchor on the reef and crush it and stand on it. You have to treat it with more respect. (male 36)

Stop the pollution, stop dumping stuff in the ocean. (male 37)

Have awareness of things like pollution. That helps. And leave it alone. Like, come and enjoy it, but don't take it home and don't wreck it. Leave it as it is, the best way. (male 38)

Stop littering basically. I reckon stopping littering would be a good thing. Do your bit to keep the oceans clean. If you see a bit of rubbish, just pick it up. (male 39)

Reduce pollution, just be careful. (female 23)

I think they are doing a lot to help the reef already. Just try to keep reefs clean and don't do too much damage. I have been to a lot of the closer reefs, but this is the furthest I have been out and this [reef] is good, there are plenty of big fish and [it] is not very disturbed. (male 40)

Just be mindful that every little thing can trash it and like if you just throw something in the water, you think that's all right, but once everyone does it, then that's a lot of pollution. (female 24)

Lower pollution and human influence on the reef. It's great to see people coming out here enjoying the reef but thousands upon thousands of people are coming here and walking across the reef, which would be ultimately bad for the reef. At home, cut down water, use products that would not be bad for the reef. (male 41)

We can do anything really. But if you don't want to spend your whole life dedicated to it, you can teach people what you know about coral reefs and tell them what is important so they don't destroy reefs. (male 42)

Not putting insecticides into the water, and too much nutrients will kill the coral, and looking after it really. (male 43)

Not to pollute, stop pollution because it does affect the water and the animals. (female 25)

Student accounts showed an interest in "helping" the reef and undertaking actions meant to conserve the reef. The process of visiting the reef and having the experiential education intervention appeared to promote a sort of "orientation towards 'change-agency'" (Jakubowski, 2003, p. 24) or development of intention to act. This was indicated by student responses such as: "I learned to treat the coral and the reef and ocean very carefully and the marine life out here is very fragile" and "It will impact on me. I won't fish as much."

These data responses indicate a link between experiential learning, an increased awareness after the reef trip and an intention to act for the preservation of coral reefs. Students are focusing on their engagement with coral reef environments and, in their accounts, place value on the living aspects of the reef. Student accounts show physical and immediate contact with coral reef environments do link to an ecological intention to act. This was demonstrated by responses such as "I learned not to put my fingers into clams", "I saw a bit of litter out there I had to pick up", "Like I won't throw things in the oceans and things like that."

The student responses demonstrated a creation of new associations from a new underwater angle, and provide evidence to support the MEIA model concerning increases in intention to act. A number of students showed interest in activities related to reef preservation and health such as "be more careful and watch where you are stepping", "lower pollution and human influence on the reef", "don't put your anchors on reefs ... because they are alive", "looking after it really", "not to pollute, stop pollution because it does affect the water and the animals" and "I've learned how to preserve the reef a bit more." However, the limitations in this study mean that future action or intention to act cannot be measured. The value of this methodology of

collecting short and structured student responses is limited to the post *in situ* experience, and a more detailed and thorough long-term interview strategy is necessary. But, the student accounts support quantitative findings and the MEIA model, as well as provide a foundation for future comparative research.

Student accounts provide their perspectives on their experiences of underwater learning. This is unique in the current literature. Field trips do give students proximal experiences of reef environments as demonstrated by these accounts. When asked directly to describe their experiences, students talked about how they favour outdoor learning over a classroom approach, as well as the value of a "hands on", active approach to developing their understanding of coral reef diversity and their appreciation of the importance of coral reefs. Student accounts show they developed a concrete understanding of coral reefs in the Great Barrier Reef Marine Park as knowable places that are in need of conservation. As one male student told the researcher, "you need to get more students out here to learn how to protect the reef."

7.5 Marine Studies Curriculum and Student Accounts

In tropical Queensland, Marine Studies students have the opportunity to have underwater reef experiences such as snorkelling and sometimes structured reef monitoring activities. It would be difficult to find a marine educator who did not feel that taking their students into a variety of marine environments was 'a good thing'. The mandated fieldwork element of the Queensland Studies Authority *Marine Studies Senior Syllabus 2004* is based on this premise.

How we experience learning is affected by the places and spaces in which we learn. The *Marine Studies Senior Syllabus 2004* explicitly recognises the pedagogical value of learning outside the confines of the classroom. Students undertake field study in marine environments to acquire greater "knowledge and understanding of the sea, its inhabitants, the coastline and the sea floor" (Queensland Studies Authority, 2005a, p.1). To learn how these students are making sense of their outdoor experiences, the education researcher followed them through this field study and recorded their ideas of the experience. And this is one of the original features of this study.

The *Marine Studies Senior Syllabus 2004* encourages students to reflect on their own values and attitudes towards marine environments. From the student accounts collected *in situ*, research data emerged showing students did learn about human effects upon coral reefs. Overwhelmingly, the impression from student accounts is of the value

of field trip experiences that provide contact with offshore reef bodies. As well as having fun and rating snorkelling and reef monitoring as “pretty good”, students can immediately make the connections to a variety of reef conservation issues immediately following their underwater encounters.

According to the *Marine Studies Senior Syllabus 2004* (Queensland Studies Authority, 2005a), the development of student knowledge and skills in Marine Studies should be active, with learning experiences including practical student experience in the marine environment through planned research and investigative tasks. Key competencies for Marine Studies field trips are learning to: collect, analyse and organise information; communicate ideas and information; plan and organise activities; work with others in a team; solve problems; and use technology. Reef monitoring as a formal investigative task includes collecting and organising information (with analysis to take place later in the classroom).

So, key competencies were integrated in the structured learning interventions of this study. Many of the previously reported student accounts point to the partial fulfilment of the key competencies, and more accounts are added below. There is evidence from this limited data that student learning aligns to the key competencies in the syllabus.

The monitoring was interesting. I learnt a lot of new skills and saw how it was actually done, and just to get out there [in the water] was good. The monitoring was one of my favourite things to be honest. When we did that low water snorkel out on the edge of the reef, it was freezing, it was terrible conditions to be in out there, but I just loved seeing all the fish and seeing my favourite fish, the puffer, that was cool. And the coral was beautiful and the wildlife, the marine life out there was amazing. You see so much in one hour. (male 44)

It is so much more interesting than the classroom. To be able to look at [the reef] was so good. I learned how to socialise with other people a lot more. (female 26)

[I] liked the fact that we’re able to come out here and have a swim and learn about the reef. The scuba diving was pretty awesome. It’s lovely to get to see the reef, learn a bit of stuff. It’s pretty good. (male 45)

I didn't enjoy it [coral reef monitoring], but I can understand why it happens, why they do it and how it works. (male 46)

The interview data collection establishes fieldwork underwater at coral reefs as having learning value to the students themselves, as it aligns with the key competencies required by the Queensland Studies Authority. Often marine educators have had to make curriculum and pedagogical decisions based on intuition rather than empirical evidence for student learning. This study provides student accounts for documented evidence that substantiate how important outdoor reef excursions are for the participating students. The qualitative data show there are immediate benefits for student learning. There have been remarkably no findable studies confirming that visiting a reef and getting wet during a structured reef learning experience enhances student learning. This study addresses that gap in the marine education literature.

7.6 Chapter Summary

This chapter presents student interview data showing how they were able to give an account of coral reef experiential education. It addresses how senior high school students relate their learning experiences, how they come to understand the corpo/realities of reefs through their experience with underwater immersion, and how the student responses contributed to understanding the Model of Ecological Intention to Act. These students from five different schools on five different reef trips repeatedly reported how much they had learned, how "experiencing the reef helps us learn better … like much better than reading books." They draw comparisons between classroom learning and experiential learning consistently favouring the reef experience as being "better than school" because "you can be in touch with what you are learning about."

Reef trips give students proximal experiences of reef environments. When asked directly to describe their experiences, students talked about the value of a "hands on", active approach to developing their understanding of coral reef diversity. They also spoke about their appreciation of coral reefs. Student accounts show how their concept of coral reefs has been transformed from an abstracted offshore environment to concrete understanding of a real and knowledgeable place. Students said they had a "far greater understanding" and "connection" to the reef compared with knowledge gained from information texts.

There are indications in the student responses of changes in ecological intention to act as a result of their physical and immediate contact with coral reef environments." This limited student interview data does not prove the link between reef experiential education and long term future action or continued intention to act, other than the post-experience accounts. However, there is evidence that underwater experience does promote student learning. Data from this limited qualitative study indicate students are thinking about sustainability issues concerning coral reefs immediately following the learning experience.

Student accounts give a snapshot of the perceived value of reef trips, how experiential education can enhance ecological learning and the usefulness of coral reef monitoring as a pedagogical device. This chapter represents an original contribution to marine education research in presenting high-school accounts of their learning experiences in the Great Barrier Reef Marine Park. In the next chapter I discuss the combination of quantitative and qualitative results.

Figure 43. Woree State High School students on the boat ride to port, waiting to be interviewed, April 3, 2003. Photo by Carl Stepath.

Figure 44. Good Counsel College students underwater, experiencing snorkelling and monitoring Hastings Reef, August 29, 2003. Photo by Carl Stepath.

Figure 45. Marine education and learning with Woree State High School students and JCU assistant at Michaelmas Cay, April 3, 2003. Photo by Carl Stepath.

Figure 46. Cairns State High School students preparing to go snorkelling and collecting data at Green Island, October 30, 2003. Photo by Carl Stepath.

Figure 47. Southern Cross Catholic College student monitoring reef and using underwater slate on August 14, 2003. Photo by Carl Stepath.

Figure 48. Cairns State High School students experiencing the reef and monitoring at Green Island, October 30, 2003. Photo by Carl Stepath.

SECTION THREE: DISCUSSION AND CONCLUSIONS

Chapter 8

Discussion and Conclusions

He who bends to himself a joy
Doth the winged life destroy;
But he who kisses the joy as it flies
Lives in Eternity's sunrise.

Blake

8.1 Introduction

The educational problem addressed was analysing learning programs in marine education and reef related issues in the formal secondary school system. My work expands the studies of Fortner (1978, 1983) on experiences in oceanic knowledge and attitudes; Kaiser, et al. (1999) on attitude and behaviour; and Hines, et al. (1986/1987) on responsible environmental behaviour; and Hungerford and Volk (1990) on learning and changing learner behaviour. I utilised Rickinson's (2001) review of learning and environmental education, and built on existing studies in Australia (Blaikie, 1992, 1993; Blum, 1987; Clarke, 1996; Connell, et al., 1998; Fien, et al., 2002; Skamp, et al., 2003; Walker & Loughland, 2003) to include marine education. I argued that even though the aims of marine environmental education in Australia are documented, and there is agreement about improving coral reef and related environmental knowledge in schools (Kenman, 2005; Marine Education Society of Australasia, 2004; Moffat, 1997; Walker & Loughland, 2003), little is known about the environmental understanding held by Australian adolescents. This study concerns Queensland young people and coral reefs.

The research analysed experiential education interventions to provide information to help ensure the best educational outcomes possible for high school students. The aim of the study was to analyse improvement in the students' knowledge, attitudes and actions in a manner reflecting real world needs in a realistic context.

8.2 Review of Significant Findings in Light of Existing Research

Educational outcomes analysed in this research project were the three A's of coastal and marine education: awareness, attitude and action. Results showed marine

experiential education did have a positive effect on increasing environmental knowledge scores. My study demonstrated that if higher environmental attitudes and intention to act responses are desired, then an outdoor experiential learning situation such as coral reef monitoring produces greater improvements than classroom presentations. The reef experience alone caused the greatest change in environmental attitudes and ecological intention to act. This alludes to the fact that knowledge itself could be slowing down the improvement of attitudes and intention to act. New approaches to education need to be considered, where feelings are a focus rather than knowledge alone, if changes in attitude and personal action are desired. Feelings of being at and experiencing a coral reef appeared to affect the students, and this triggered large changes in their attitudes and intention to act responses. This was substantiated by the qualitative interview data where students gave accounts of their learning experiences, and a clear preference was shown for learning underwater at the reef, in preference to classroom environments.

Reef experiential education was shown to have a strong learning effect. Student survey responses significantly improved after a combination of a classroom presentation and coral reef visit. Environmental knowledge (awareness) showed the strongest influence from a combination of classroom presentation and the reef monitoring experience. Environmental attitudes and ecological intention to act responses showed the highest positive response change on overall scores with only the coral reef monitoring intervention. This was an unexpected finding. Results show that underwater proximal learning experiences with coral reefs have the most powerful effect on students' attitudes and expressed intention to act.

Previous experiences outdoors such as snorkelling and camping were both significantly correlated to pre-test intention to act responses, but neither was strongly correlated to changes in intention to act. A correlation between swimming and marine experience reported by Fortner (1983) was shown to exist, with my study showing an even stronger correlation between snorkelling and pre-test marine experience. Correlations between swimming, snorkelling and previous reef experience were strong, and this would be expected since both are used when immersed at a coral reef. With more camping and snorkelling experience, the students have higher pre-test ecological intention to act scores. The highest changes in intention to act scores were shown in the SCUBA diver category, and this probably needs further investigation.

Students' environmental knowledge was significantly and directly correlated to previous reef experience. Pre-test attitudes and ecological intention to act responses

were significantly and directly correlated to previous reef experience. According to Fortner (1983) and Stepath (1997), marine and aquatic experiences have a positive effect on knowledge (awareness) and attitudes. The students' previous experience of coral reefs, camping and snorkelling correlated strongly to knowledge (awareness), attitudes and intention to act responses. The most significant correlations were with previous reef experience. Snorkelling had the second highest correlation followed by camping. Direct relationships were shown between high environmental knowledge, attitudes and intention to act scores, and students' amount of previous reef experience.

These findings make sense when considering how students come to form their views, which were tested through the surveys. Students who had previous active, but informal, learning experiences of marine environments had more knowledge and more positive attitudes towards the conservation of coral reefs. These findings further substantiate the collected qualitative evidence that direct experience with swimming, snorkelling and being immersed in marine environments builds 'connections' with and to these environments. Students familiar with marine recreational activities reported higher levels of environmental awareness, attitudes and ecological intention to act.

It is well-known that students gain a great deal of their environmental knowledge and marine awareness through the entertainment media, such as TV nature documentaries (Blum, 1987; Fien, et al., 2002; Fortner, 1978, 1983; Walter & Lien, 1985). Most students reported learning about oceans from TV. Of all the demographic variables considered in this study, I found watching nature documentaries on television to have the weakest correlation to intention to act. My analysis implies this highly mediated learning is having little effect on students' attitudes and intention to act.

Gender has been shown to be important with respect to environmental education (Connell, et al., 1998; Fien, et al., 2002; Rickinson, 2001). In my study female high school students were shown to have had the highest knowledge (awareness) mean scores on the pre-test. There was a significant difference between the means of female and male scores ($F = 3.717$, $p = 0.055$). Earlier overseas (Blum, 1987; Fortner & Teates, 1980) and Australian (Eyers, 1975) studies found males to have a higher level of marine awareness, but my results agree with more recent Australian studies where females display higher scores (Clarke, 1996; Connell, et al., 1998). The female students had higher environmental knowledge scores, with both the male and female students having their highest change in knowledge scores with reef experiential education interventions. Female students scored highest in attitudes and intention to act responses, and had their

highest change scores in two groups; a classroom presentation only and a reef visit only. Males had their highest change in attitude with a reef visit only, and a combination of classroom presentation and a reef visit for intention to act. This study showed gender not to be significantly related to change in overall attitudes, however gender was significantly related to change in overall ecological intention to act. Female high school students had significantly more positive change on their intention to act responses as a result of the reef experiential intervention, and this is a new finding. Similar results are not found in the existing literature and afford interesting directions to further pursue in future research.

8.3 The Model of Ecological Intention to Act (MEIA)

The MEIA provided a theoretical context for examining student interviews and survey responses concerning coral reef learning experiences. Linear relationships between environmental knowledge (awareness), attitudes and ecological intention to act were statistically analysed. A change in knowledge (awareness) did not lead to changes in attitude or intention to act showing that learning relationships are not linear.

The MEIA was developed as part of the research process as a learning model for assessing marine education. The MEIA can be considered an analytical frame to test the educational importance of experiential learning interventions in this research project. The effect of reef experience and classroom presentations was tested against a control group. The premise was that actually experiencing the marine environment leads to increased learning and participation by high school students, and this may contribute to building future participation skills. Structured reef learning exercises were shown to engage students in hands on experiential learning. Reef monitoring as a learning technique could be added to any marine learning situation to improve educational outcomes, as this was statistically shown to be meaningful with respect to all three A’s, especially attitude and intention to act.

The strong pre-test relationship between environmental knowledge (awareness), attitudes and ecological intention to act disappeared once educational interventions were applied, though all three variables showed improvement. These results showed coral reef monitoring as a structured learning situation, it does improve student outcomes, and has the greatest impact on intention to act. My reading of these results is that a structured underwater pedagogy and experience was responsible for significantly enhancing learning outcomes. The addition of a purposeful underwater activity, as

analysed by the MEIA, did promote the desirable outcomes of traditional environmental education. My study showed that knowledge in and of itself is not enough to promote positive environmental attitudes and intention to act. Structured experiences in offshore marine environments do have a statistically significant impact.

The highest change in student responses occurred in the reef monitoring only group. Previous reef experience was positively correlated to both attitude and intention to act, again showing the value of underwater experiences in enhancing outcomes. My study produces new data about the relevance and value of coral reef education to Queensland high school students. The MEIA model provided a context to investigate the value of reef experience upon attitudes and intention to act, and demonstrated that direct reef experience added to an existing educational program improved students' environmental knowledge, attitude and action. While it was statistically shown that students involved in reef experiential learning had higher scores, it was also shown in qualitative student responses that 60% of students stated they learned more at the reef than in the classroom. A remarkable number of student interview responses from participating students were also unequivocal in their preferences for 'hands on' learning over classroom learning. The MEIA model predicted this.

8.4 Limitations of the Research

There were limitations associated with this research project. This research was conducted with adolescent student participants in formal school systems, Catholic and State, and many difficulties arose in dealings with school administrations, because of their fiduciary responsibilities. The researcher was an outsider and it was necessary for the schools and students to volunteer their class and excursion time for this university research project. The participating schools were extremely gracious, but differences existed from school-to-school, since the school programs were not identical; the class periods were not of the same length, and the time allotted for school reef excursions varied. Most of the schools' reef trips were of one-day duration, but one field trip lasted a week. Hart and Nolan (1999) argued that positive change in environmental attitudes came after exposure to some form of short or long environmental education experience, and my research confirmed this. I had originally intended to analyse the difference between a week and a day reef trip, but this did not work statistically because the number of students on the weeklong trip was too small to enable SPSS to provide empirically significant results. In retrospect, my study design could have considered the

effect of a longer exposure to reef experience, but this was not possible given the constraints of the number of participating students. Thus, no conclusion could be drawn about student learning and the value of longer time spent in the offshore environment.

The class and researcher interview time and how students were selected for the project were determined by the teachers and the administration based on learning requirements for each semester. It was not possible to train the teachers to administer the surveys, causing slight differences in the way the surveys were administered. A number of surveys were excluded (17.7%) because they 'lacked content', and a number of students in the contrast group, with no connection to the project, produced a higher discard rate (19.5%) since they could see no purpose in completing questionnaires. A 17% exclusion rate is not high for a written survey requiring the cooperation of 15-18 year old high school adolescents. The teachers did administer the surveys in a timely manner, the researcher did not meet the students prior to the pre-test survey taking, and considerable effort was expended to reduce researcher impact. There was a gender bias in the study, with males making up 60% of the participants, but this was reflective of the gender make-up of the Marine Studies program being studied.

A multi-methods research design was used to address unpredicted influences, and participants were allowed to withdraw at any time. They were drawn from a large sample of Queensland students collected from different schools to minimise extraneous effects. It was unfortunate that more class time was not possible with the students, but the empirical results did show significant changes. Even though the qualitative data collection was limited and the researcher underestimated its complexity, it did provide student accounts that add depth and increased understanding about student learning in the reef environment. My experiences revealed the importance of more training for quantitative researchers wanting to utilise qualitative practices and methods. It is necessary to be aware of these problems before interpreting results. Both a quantitative and a qualitative approach revealed facets of student learning. My research project demonstrates that bringing two methodologies together to experimentally examine reef experiential education in current marine education practices is possible. The study provides statistically and educationally significant findings about students' experiential learning, as a basis for future research into improved learning in marine environments.

8.5 Contributions of Qualitative Research

The qualitative interview technique provided students an opportunity to express

their own ideas and opinions on learning in the reef. The student participants, while subjects of study, are also agents of their own learning. The unique value of interviews is they reveal snapshots of personal and affective domains of learning, which are not easily captured in quantitative surveys. Along with expanding and adding dimension to the quantitative data, the qualitative findings provide space for student accounts of their 'own' learning experiences. Field trips were shown to give students proximal experiences of reef environments. Studies representing student accounts in environmental education are scarce (Rickinson, 2001), thus this work contains insights into adolescent reef learning experiences not found in other studies.

Reef trips give students proximal experiences of reef environments. The students described their experiences, talked about the value of a hands on, active approach to developing their understanding of coral reef diversity and their appreciation for the importance of coral reefs. Student accounts show they developed a concrete understanding of coral reefs in the Great Barrier Reef Marine Park as knowable places that are in need of conservation. As one male, student said, "you need to get more students out here to learn how to protect the reef."

Underwater experiences of coral reefs change what Probyn (2003) calls "relations of proximity" that "highlight the facts of connection and dis/connection" (p. 298). Reefs are physically located offshore and underwater. From land, reefs can be conceived as far away. Students' accounts are unequivocal - learning *about* reefs in the classroom from books, video and teacher talk is quite different to learning *within* reefs. Organised marine studies field trips that include reef walks, snorkelling and reef monitoring activities bring students into direct contact with the myriad of living bodies creating a reef. The result, which Rose (1999, p. 252) terms "the space of relation", is an imaginably conceived space between differing bodies. This space changed for many of the student learners. Students speak of "being more connected" to and becoming "more familiar" with coral reefs. As one student remarked, "I will always remember everything here."

The qualitative data show student accounts demonstrating the immediate power and influence of coral reef experiential learning. Consequently, if improved environmental attitudes and ecological intention to act are desired outcomes of marine education programs, then outdoor and offshore marine experiential education should be employed as pedagogy for effective results.

8.6 Implications for Educational Practice

Marine educators participating in this study held reef trips in high regard, but there is little previous research to support their positions. I attempted to evaluate the educational learning value of marine experiential education programs at coral reefs. This research experimentally investigated learning interventions as part of existing pedagogical practice in linking student reef trips to improved learning results across domains of knowledge, environmental attitudes and reported ecological intention to act. Field trips have been shown to have a large and significant impact on student learning outcomes. If marine education is to educate for a sustainable future, then it is critical to research and encourage students' field experiences 'of' and 'in' marine environments.

The stated aims of the Queensland Studies Authority Marine Studies curriculum are to provide opportunities to develop students' awareness of the value of the sea and acquire knowledge, understanding and skills applicable to marine environments. My research shows increases in these areas through the use of reef experiential education learning interventions. Consequently, the incorporation of both experiential education along with traditional classroom teaching practices enhance environmental knowledge (awareness) levels. My study also shows ecological intention to act outcomes are positively correlated to the students' reef experience, so if improved ecological intention to act is a desired educational outcome, then visits to coral reefs are shown to be educationally desirable.

The qualitative research data supports the empirical results and demonstrated that experiences of coral reefs heightened students' relations of proximity and connection to the reef. Reefs are located offshore underwater and out of sight, so can be thought of as far away, consequently, reefs monitored by the students then became known to them. The experience of observing and monitoring brought the learners into direct contact with living reef entities. They then reported change in their relations to imaginably conceived space around these other living beings. After monitoring, the students saw the coral reef as a place with which they had connection. They spoke of being more connected and familiar, and this all happened as the reef became a known place.

Experiential education enabled the students to have a connection and then establish reefs as being ecologically important. Therefore, both the quantitative research findings and the qualitative data support Queensland teachers' initiatives to get high school students on to boats and out to the reef as a worthy and valuable learning

activity. The research also supports educators wishing to make the case to introduce or expand the inclusion of reef trips into the formal school curriculum, at all levels, not just at senior secondary level. Reef experiential education does make a profound difference to student learning outcomes in marine education.

Ethical implications are a very important issue for consideration when conducting student field trips in threatened environments. The ethics application process thoroughly explored project ethical ramifications, except for the repercussions of visiting a threatened environment where we could contribute to further degradation. These were considered by the researcher, and many precautions were taken to minimise impact. Whenever a class of students visits a threatened environment, there is danger of having negative impacts on the creatures or situation being studied. In this study, the students were organised through professional tour companies, whose tours are designed for minimum impact on the reef, and the students were constantly supervised to insure there were no infringements of ecological guidelines for behaviour in the Great Barrier Reef Marine Park. The ecological footprint of our field trip was constantly being discussed and evaluated during the exercise, and the students were made aware of our impact on the creatures being studied. While these types of visits can contribute to environmental degradation, it was determined the educational benefits outweighed the ecological cost, especially since these students lived near the coast, and were learning about an important neighbouring natural resource. The harmonious cohabitation of these future adults and the reef is very important to their futures in Queensland.

Marine education embraces a plethora of complex real-life natural situations that combine a number of academic disciplines. Reef trips gave the students a proximal experience of reef environments, and a greater appreciation for coral reefs was noted with familiarity of real places and reef environmental conditions. This transformed an abstract offshore environment to a knowable place. According to student responses, learning in an experiential context gave them a greater understanding and connection to the reef environments. These notions of interrelations and accessibility are important in marine education, and student responses suggest reef environments can be experienced as more knowable connected entities.

Qualitative data confirm the pedagogical intent of the Queensland Studies Authority *Marine Studies Senior Syllabus 2004* mandating field experiences as a necessary part of curriculum. Research findings provide evidence that experiential learning in coral reefs is considered of value by the students themselves and senior

Marine Studies field work should continue to be supported by schools and education systems in Queensland.

8.7 Possibilities for Further Research

This large and unique study demonstrates that learning interventions associated with coral reef environments create positive student responses in terms of increased knowledge of coral reefs, enhanced environmental attitudes and reported ecological intention to act. This study is the first of its kind to investigate Australian adolescent experiences of reef education and examine educational outcomes for knowledge, attitudes and intention to act.

Findings demonstrate strong research support for incorporating marine experiential education into formal senior secondary school curriculum in tropical marine environments. Offshore experimental pedagogy significantly improved environmental knowledge and attitude scores. Since these are desired outcomes and objectives of the *Marine Studies Senior Syllabus 2004* curriculum, this pedagogic approach is valuable and important in Marine Studies programs. It is possible to extrapolate that experiential education in coral reef environments would also be of learning value to students in primary schools, and this would be a productive area of future research.

A Model of Ecological Intention to Act was shown to be effective for analysing learning. Results from this study indicate students are thinking about sustainability issues concerning coral reefs. The research aims were addressed using both a quantitative and qualitative methodology and both proved useful and meaningful for addressing pedagogical questions in marine education. From a quantitative perspective, there were gaps in the research findings, in which lie the foundation for future research, analysis of additional variables, refined methodologies and improved statistical procedures. More effort needs to be made to analyse effective action skills, and to investigate situational influences such as parental and peer pressure. Family, school, peer groups and other predisposing factors such as race, class and ethnic background may have a big impact on the formation of adolescent attitudes and intention to act towards coral reef environments. I did not explore these situational influences in this study, but they may be of research importance.

Other areas for further investigation are gender differences. Female students had significantly greater positive intention to act response changes after the reef experiential intervention, and the educational significance needs to be considered, since the

influence of experiential education in marine environments appeared to have more effect on females than on males. Priority could be given to comparing the results of this study with a smaller but more detailed qualitative investigation on student learning to evaluate pedagogical techniques for improving environmental attitudes and ecological intention to act. Researchers and teachers could consider spending more time discussing students' future intentions *in* and *for* the coral reef environment, and developing their critical thinking and action skills. Thus, the gendered dimensions of marine experiential education could be further studied.

8.8 Contribution to Marine Education

The unique contribution made in this doctoral research is that this is the only research to be conducted with Australian high school students in tropical marine environments in Queensland. According to the Queensland Studies Authority, the development of environmental knowledge and positive attitudes are priorities for Queensland Marine Studies programs. This study showed that reef experiential education enhanced students learning outcomes, and provided a research argument for why reef experiential learning should be included in formal curriculum and supported by educational institutions.

Marine outdoor education has evolved as a small subset of both environmental and experiential education, however, little research has been done concerning students' knowledge, attitudes and intention to act toward marine environments, especially in Australia. The issues facing marine education are unique since it is a diverse interdisciplinary field. Queensland has formalised senior secondary marine education with the *Marine Studies Senior Syllabus 2004* and over 60 high schools are running this program. This made Queensland the ideal state in which to conduct the research and Cairns the ideal city in which to investigate learning in the Great Barrier Reef Marine Park.

This research makes a contribution to marine education in examining student learning in relation to coral reef sites. The quantitative data, in particular, demonstrated significant contributions of experiential education in increasing student knowledge, environmental attitudes, and ecological intention to act. While such results are not surprising within the context of existing literature, this study demonstrates the value of experiential education in offshore marine environments. The qualitative research afforded a rare opportunity to record student accounts of their reef immersion learning

experience. The study used an inter-disciplinary theoretical framework and methodology, which addressed multi-method approaches and experimentally tested educational intervention procedures in order to analyse the effect of direct experience on student learning. This experimental approach has not been greatly explored in marine education research.

8.9 Conclusion

Past research reveals more about environmental knowledge and attitudes than about students' educational experience and preferences, and more about learning outcomes than learning processes. This research and evidence base was not static, and provided an opportunity for additional foci to emerge concerning student learners and their experiences of marine learning. Understanding of learning in marine experiential education was advanced by addressing the idea of moving "away from a linear model of the role of nature experience in environmental education" (Russell, 1999, p. 127). Changes in learning and introductions of learning interventions brought with them new and different conceptual approaches, and an evaluation methodology evolved to record them. The study identified issues and challenges, and supplied a focus on student learning, learners, and their experiences. "More work is needed to expand existing models of learning" (Quay, 2003, p. 111), and this research provides a multi-method groundwork from which to build upon or move forward from in understanding adolescent learning in coral reef marine experiential education.

This work took an elemental first step in addressing the question of proximal relations between humans and coral reefs along the Queensland coast of Australia. The analysis brought together the literature and techniques from a number of varying disciplines to generate statistical findings for those interested in the learning value of field trips to coral reefs. The qualitative findings record student commentary that affirmed the learning value of structured activities underwater as part of reef trips. It is time for us to begin thinking of the natural environment as a "co-instructor" (Russell, 2005) in our field learning experiences, and to begin the long journey of bringing natural environments closer in/to curricular practice as we rethink issues of sustainability and education in the 21st century.

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Appendix A

Extended list of acknowedgements

This is a list of more people that helped in the completion of this PhD project. A sincere thanks to all, because I could not have done it without your input and support. Mahalo.

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Marie Short

Peter Valentine

Education Queensland

James Cook University Dive Committee

James Cook University Ethics Committee

James Cook University – Cairns Library Staff

Marine Education Association of Australasia

Appendix B
Copy of initial survey questionnaire: Pre-test

Marine Education Study: Pre-Test 2003
Carl M. Stepath, James Cook University, Contact: (07) 4042 1546
Thank you for filling out this survey…

Questions about you and your experience (fill in and tick the best answer):

A. Name: _____

B. School: _____

C. Year in school: _____
D. Date: _____
E. My course of study is: _____
F. After high school I plan to - tick one
___ Get a job and start work
___ Attend TAFE or university
___ Other – Please name:_____
G. Gender :

___Female

___Male

H. Age: _____

I. My home postcode _____.

J. I have lived in the Cairns area for _____ years _____ months.

K. I have lived in a reef neighboring community like Cairns (a town within the tropics, 23.5 degrees N or S)

___ Less than one year

___ 1- 2 years

___ 2 - 3 years

___ 3 - 4 years

___4 – 5 years

___ More than 5 years

My parents occupation: _____

L. I was born in Australia - tick one:

___ Yes

___No - Where were you born? _____

M. I go fishing - tick one:

___ Yes

___No

N. Last month I spent the most outings doing - tick one:

___Marine outdoor things

___Terrestrial (land based) outdoor things

O. My cultural heritage - tick one or two:

___Aboriginal

___African

___Asian

___European descent

___Pacific Islander

___South American

___Torres Strait Islander

___Other – please name: _____

P. My parents education level -tick one:

___Some high school

___High school graduate

___Some University or TAFE

___University or TAFE degree

___Completed post-graduate degree

Q. Watersports (paddling, surfing, sailing, windsurfing, etc.) are my favorite pastimes – tick one

___ Yes

___No

S. Experience with coral reefs -tick one:

___ Never visited,

___ Visited once or twice

___ Seen quite a few times

___ Seen many times

T. Snorkeling experience – tick one:

___Never;

___Seldom [1-5 times per year];

___Often [5-9 times per year];

___Very often [more than 10 times per year];

___Certified SCUBA diver

U. Swimming experience (in pools, etc.) -tick one:

___Can't swim;

___Can swim a little, but never do

___Seldom [1-5 times per year];

___Sometimes [between 5-11 times per year];

___Often [at least once a month]

W. I spend a lot of time at the beach or in the marine environment such as boating, diving or fishing -tick one.

___ Yes

___ No

X. At the beach or in the marine environment each month, I spend (tick best):

___ less than one hour

___ 1 – 2 hours

___ 2 –3 hours

___ 3- 4 hours

___ 4 - 5 hours

___ more than 5 hours

Y. Outside hiking, bird watching, camping, mountain biking, etc. I spend _?_ hours per month (tick best):

___ less than one hour

___ 1 – 2 hours

___ 2 –3 hours

___ 3- 4 hours

___ 4 - 5 hours

___ more than 5 hours

Z. I have done coral reef monitoring – tick one:

___Yes

___No

AA. The most important activity to me is (answer all if possible, rank activities in order of your personal opinion, 7 highest to 1 lowest):

___Beach or marine activity (beach, swimming, snorkeling, fishing, boating, etc.)

___Rainforest or terrestrial activity (camping, hiking, bird-watching, biking, etc.)

___Computer related activity

___Television or entertainment related activity (TV, music, etc.)

___Social activities (parties, outings, etc.)

___Sports (outdoors)

___Sports (indoors)

BB. I play video games – tick one:

___ Yes

___ No

DD I bird watch – tick one.

___ Yes

___ No

EE I go hiking - tick one.

___ Yes

___ No

FF. I go mountain biking - tick one.

___ Yes

___ No

GG. I have been to the Great Barrier Reef - tick one:

___Never;

___Once;

___Two times;

___A number of times [between 3 – 11 times];

___Often [12+ times]

HH. I last went to the Great Barrier Reef - tick one:

___ Never

___ More than 5 years ago

___ More than 2 years ago

___ Last year

___ This year

___ This month

II. I like to watch nature documentaries on TV - tick one:

___Yes,

___No

JJ. Please rank items listed below. Rank in the order "you" do these things (answer all if possible, "10 most" and "1 least," 0 if you don't do at all):

___Surf the Internet

___Use Email

___Play sport

___Play LAN games with friends

___Use chat groups

___Watch Discovery Channel

___Watch other Nature documentaries

___Watch other Pay TV

___Use a mobile phone

___Other – Please name: _____

LL. I am/was a member of an environmental group - tick one:

___Yes,

___No

MM. My parents are/were members of an environmental group – tick one:

___Yes

___No

NN. My family uses a compost bin at home - tick one:

___Yes,

___No

OO. My family is energy conscious and saves energy - tick one:

___Yes

___No

PP. My family recycles materials whenever possible - tick one.

___Yes

___No

QQ. Outdoor camping experience-tick one - tick one:

___Never

___Little (once every few years)

___Sometimes (once a year)

___Often (2-10 times per year)

___Very much (once a month or more)

Please put a tick next to <u>your</u> answer.

1. The great Barrier Reef World Heritage Area is approximately how long?
___ 500 kilometres
___ 1500 kilometres
___ 2300 kilometres
___ 1000 kilometres

2. The box jellyfish is:
___ Not a coastal species, and is found around islands off the mainland.
___ They are usually found out on the offshore reef.
___ A coastal species, and is usually found around islands close to the mainland.
___ They are not usually found out on the offshore reef.

3. Corals are:
___ A thin layer of living animals, which secrete a limestone skeleton as they grow. Coral colonies grow, divide and multiply in a process known as budding.
___ A thin layer of plants and do secrete a chalky, limestone skeleton as they grow. Coral colonies grow, divide and multiply in a process known as budding.

4. Corals have colour due to:
___ The algae that lives on the outside of their polyps, like clothing.
___ The presence of a brown algae (zooxanthellae) that live within their tissues.
___ The various organisms that live around the reef.
___ The presence of a unique animal that live within their tissues.

5. The coral reef grows off the coast of Queensland because:
___ Corals need very dirty water which is high in nutrients
___ Corals need clear water which is low in nutrients
___ Corals need clear water which is high in nutrients.
___ Corals do not need clear water which is low in nutrients

6. The clarity of the water on the reef is:
___ Determined by the amount of microscopic plants in the water, not by the amount of sediment in the water.
___ Determined by the amount of sediment and microscopic plants in the water.
___ The angle with which the sunlight hits the water

7. Lobsters are crustaceans. Crustaceans are characterized by hard shells and jointed appendages. Which one of these is not a crustacean? – tick one
___Shrimp
___Rock crab
___Barnacle
___Octopus

8. The Pacific Ocean includes about 25,000 islands. Fitzroy Island is an example of which type of island?
___Continental Islands
___High Islands
___Coral Reefs
___Uplifted coral platforms.

9. The colourful mantle of clams may be due to the light hitting the microscopic plants (zooxanthellae) found lined up in rows just below the surface of the mantle. When clams lose their zooxanthellae they turn white.
___ True
___False

The following questions are about your opinions. Please rate the extent to which <u>you</u> agree or disagree with each statement by circling one number.
1 = Strongly Disagree2 = Somewhat Disagree 3 = Mildly Disagree
4 = Mildly Agree 5 = Somewhat Agree 6 = Strongly Agree

14. Coral reefs are not important to other life on the planet Earth.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

15. Coral reefs provide jobs for the community
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

16. The Great Barrier Reef is in healthy condition.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

17. New technology creates jobs for me.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

18. People make too much fuss over protecting the coral reef.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

19. The coral reefs don't need my help.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

20. My daily actions can cause damage to the reef
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

21. Living near the Great Barrier Reef makes me realise the importance of coral.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

22. The coral polyps that live on the reef need my help.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

23. My family supports environmental groups.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

24. My friends think we should help the coral reef:
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

25. My family thinks the Great Barrier Reef is fine.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

26. I do the things my friends want me to.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

27. I can do things to help coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

28. My personal health has an impact upon the future of the Great Barrier Reef.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

29. Fertilizing lawns impacts coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

30. A high growth economy has no effect on coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

31. I can change what I do if it is damaging to reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

32. My own actions affect coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

33. I would pay environmental taxes (e.g. raising fuel prices), to help coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

34. I will plant trees to help coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

35. Pollution should be controlled.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

36. The government should give generous financial support to solar energy.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

37. The idea of One Earth (‘Spaceship Earth’) is important to me.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

38. Humans can change their behavior to help coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

39. A high growth economy has no effect on coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

40. Humans need coral reefs for survival.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

41. Humans have a right to modify the environment to suit their needs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

42. The concern about environmental problems has been exaggerated.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

43. I talk to my friends about problems related to the environment.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

44. Purchasing environmentally friendly products makes no difference to the reef.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

45. I would decrease my car’s fuel consumption to help coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

46. I would boycott companies for ecological reasons.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

47. Humans have a right to modify the natural environment to suit their needs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

48. Governments should ensure raw materials last as long as possible.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

49. People in developed countries need to consume less in order to help the marine environments.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

50. Because of pollution problems, we need to decrease the use of the automobile as a major means of transportation.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

Thank you for filling out this questionnaire. Your time is appreciated. Carl ☺

Appendix C Final survey questionnaire:

Post-test questions

Marine Education Study: Post-test 2003

Carl M. Stepath, James Cook University, Contact: (07) 4042 1546

Thank you for filling out this survey…

A.Name: _____

B. School: _____

C.Year in School: _____

D. Date: _____

E. My course of study is: _____

The following 9 questions are about the marine environment. Please put a tick next to your answer.

1. The great Barrier Reef World Heritage Area is approximately how long?
___ 500 kilometres
___ 1500 kilometres
___ 2300 kilometres
___ 1000 kilometres

2. The box jellyfish is:
___ A coastal species, and is usually found around islands close to the mainland. They are not usually found out on the offshore reef.
___ Not a coastal species, and is found around islands close to the mainland. They can also be found out on the offshore reef.

3. Corals are:
___ A thin layer of living animals, which secrete a limestone skeleton as they grow. Coral colonies grow, divide and multiply in a process known as budding.
___ A thin layer of plants and do secrete a chalky, limestone skeleton as they grow. Coral colonies grow, divide and multiply in a process known as budding.

4. Corals have colour due to:
___ The algae that lives on the outside of their polyps, like clothing.
___ The presence of a brown algae (zooxanthellae) that live within their tissues.
___ The various organisms that live around the reef.
___ The presence of a unique animal that live within their tissues.

5. The coral reef grows off our coast because:
___ Corals need very turbid water, which is high in nutrients
___ Corals need clear water, which is low in nutrients
___ Corals need clear water, which is high in nutrients.
___ Corals need turbid water, which is low in nutrients

6. The clarity of water is:
___ Determined by the amount of microscopic plants in the water, not by the amount of sediment in the water.
___ Determined by the amount of sediment and microscopic plants in the water.
___ The angle with which the sunlight hits the water

7. Lobsters are crustaceans. Crustaceans are characterized by hard shells and jointed appendages. Which one of these is not a crustacean? – tick one
___Shrimp
___Rock crab
___Barnacle
___Octopus

8. The Pacific Ocean includes about 25,000 islands. Fitzroy Island is an example of which type of island?
___Continental Islands
___High Islands
___Coral Reefs
___Uplifted coral platforms.

9. The colourful mantle of clams may be due to the light hitting the microscopic plants (zooxanthellae) found in rows just below the surface of the mantle. Clams which have lost their zooxanthellae are white.
___ True
___False

The following questions are about your opinions. Please rate the extent to which <u>you</u> agree or disagree with each statement by circling one number.
1 = Strongly Disagree2 = Somewhat Disagree 3 = Mildly Disagree
4 = Mildly Agree 5 = Somewhat Agree 6 = Strongly Agree

14. Coral reefs are not important to other life on the planet Earth.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

15.Coral reefs provide jobs for the community
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

16.The Great Barrier Reef is in healthy condition.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

17. New technology creates jobs for me.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

18. People make too much fuss over protecting the coral reef.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

19. The coral reefs don’t need my help.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

20. My daily actions can cause damage to the reef

Strongly Disagree 1 2 3 4 5 6 Strongly Agree

21. Living near the Great Barrier Reef makes me realise the importance of coral.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

22. The coral polyps that live on the reef need my help.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

23. My family supports environmental groups.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

24. My friends think we should help the coral reef:
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

25. My family thinks the Great Barrier Reef is fine.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

26. I do the things my friends want me to.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

27. I can do things to help coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

28. My personal health has an impact upon the health of the Great Barrier Reef.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

29. Fertilizing lawns impacts coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

30. A high growth economy has no effect on coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

31. I can change what I do if it is damaging to reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

32. My own actions affect coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

33. I would pay environmental taxes (e.g. raising fuel or resource prices), to help coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

34. I will plant trees to help coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

35. Pollution should be controlled.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

36. The government should give financial support to solar energy.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

37. ‘One Earth’ ("spaceship earth") is important to me.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

38. Humans can change their behavior to help coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

39. A high growth economy has no effect on coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

40. Humans need coral reefs for survival.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

41. Humans have a right to modify the environment to suit their needs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

42. The concern about environmental problems has been exaggerated.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

43. I talk to my friends about problems related to the environment.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

44. Purchasing environmentally friendly products makes no difference to the reef.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

45. I would decrease my car’s fuel consumption to help coral reefs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

46. I would boycott companies for ecological reasons.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

47. It is OK for humans to modify the natural environment to suit their needs.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

48. Governments should ensure raw materials last as long as possible.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

49. People in developed countries need to consume less in order to help the marine environments.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

50. Because of pollution problems, we need to decrease the use of the automobile as a major means of transportation.
Strongly Disagree 1 2 3 4 5 6 Strongly Agree

Appendix D

JCU Ethics approval

JAMES COOK UNIVERSITY
Townsville QLD 4811 AUSTRALIA

Tina Langford, Ethics Administrator, Research Office. Ph: (07) 4781 4342, Fax: (07) 4781 5521

ETHICS REVIEW COMMITTEE
(Human Ethics Sub-Committee)
APPROVAL FOR RESEARCH OR TEACHING INVOLVING HUMAN SUBJECTS

PRINCIPAL INVESTIGATOR	*Carl Stepath*
SCHOOL	*TESAG/School of Education*
PROJECT TITLE	***Coral reefs as experiential environmental education: Learning and Australian Students***
DATE	*20 August 2002 – 31 December 2003*
CATEGORY	*1*

This project has been allocated Ethics Approval Number with the **following provisos and reservations**:

H1362

1. All subsequent records and correspondence relating to this project must refer to this number.
2. That there is NO departure from the approved protocols unless prior approval has been sought from the Human Ethics Sub-Committee.
3. The Principal Investigator must advise the responsible Monitor appointed by the Ethics Review Committee:
   - periodically of the progress of the project;
   - when the project is completed or if suspended or prematurely terminated for any reason;
   - if serious or adverse effects on participants occur; and if any
   - unforeseen events occur that might affect continued ethical acceptability of the project.
4. In compliance with the National Health and Medical Research Council (NHMRC) ***"National Statement on Ethical Conduct in Research Involving Humans"*** you must provide an annual report detailing security of records and compliance with conditions of approval. The report should very briefly summarise progress or in a final report detail the outcomes of your research.

NAME OF RESPONSIBLE MONITOR	*A/Professor Peter Leggat*
SCHOOL	*Public Health and Tropical Medicine*
APPROVED AT MEETING **APPROVED** (Conditions Approved by Monitor) **All approvals have now been received: schools involved in the study – St Mary's Catholic College, Worse State High, Southern Cross Catholic School, Cairns State High, Good Counsel College; email approvals from Lecturer-in-charge ED0092/3192, GE2455; Qld Ed approval received; PADI Insurance/Current PADI Dive Certificate; Suitability Card; JCU Diving Officer.**	***Date: 31 July 2002*** ***Date: 6 March 2003***
[forwarded by email without signature] Tina Langford Ethics Administrator **Research Office** Tina.Langford@jcu.edu.au	Date: 13 March 2003

C:\Documents and Settings\tlangf\My Documents\NDP. ETHICS\APPROVALS\Human Approvals\Human H_2002\06_02\H1342 Stepath Final Approval.tif

Appendix E

Commission for Children and Young Children approval letter

Commission for Children and Young People
14th Floor, T&G Building, 141 Queen Street, Brisbane, Qld, 4000
PO Box 12671, Brisbane, George Street, Qld, 4003
Ph: 07 3247 5525 Fax: 07 3247 5507
www.childcomm.qld.gov.au

16 October 2002

Employee Ref: **46267/46459**

Mr Carl M Stepath
PO Box 414
SMITHFIELD QLD 4878

Dear Mr Stepath

SUITABILITY NOTICE – REGISTRATION NUMBER 46267/1

Your application for a Suitability Notice/further Suitability Notice for child-related employment has been considered and approved.

Your suitability notice in the form of a plastic card is enclosed. This notice is valid for 2 years from the date of issue, unless it is cancelled earlier. A renewal notice will be sent to your residential address two weeks prior to the expiry date. You should therefore notify the Commission of any change of address during the currency of this notice.

If you are employed or are engaged in child-related employment, the *Commission for Children and Young People Act 2000*, requires that, if there is a change in your criminal history* during the period of your employment, you must immediately disclose this change to your employer. Your employer must then apply to the Commission for a new suitability notice. Please note the Act does not require you to give your employer any information about the change other than it has occurred. A failure to disclose a change in your criminal history is an offence under the Act and you may be subject to severe penalty. However, the Act does not require an employer to stop employing you when you inform any change in your criminal history. A copy of this letter has been sent to your employer.

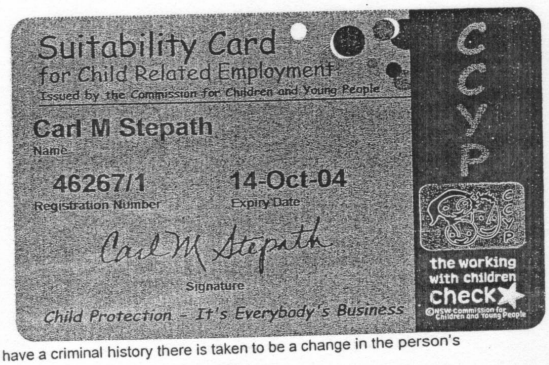
If you are a person carrying on a child-related business, section 113 of the Act requires that if there is a change in your criminal history*, you must immediately apply to the Commission for a further suitability notice. Failure to do so is an offence under the Act and you may be subject to severe penalty.

Should this card be lost or stolen please notify the Commission immediately on 3247 5145 or 1800 113 611.

Yours sincerely

R. A. Sullivan

Robin Sullivan
Commissioner for Children and Young People



*Section 110 of the Act states that for a person who does not have a criminal history there is taken to be a change in the person's criminal history if the person acquires a criminal history.

the working with children check

Commission for Children & Young People
Queensland Government

Appendix F
Education Queensland approval letter

Queensland Government

Strategic Directions, Policy and Research
Education Queensland

19 November 2001

Mr Carl Stepath
PhD Candidate
James Cook University
PO Box 414
SMITHFIELD Q 4878

Dear Mr Stepath

Thank you for your application to undertake research titled *"Coral Reefs as Experiential Environmental Education: Learning with Australia School Students – A Case Study "* in Queensland Schools and Other Units. I wish to advise that your application to approach Queensland State Schools for the conduct of your research has been approved.

In approving your application the Department makes you responsible for ensuring that principals, parents and students are aware that participation in this project will encompass boating and snorkelling activities. Students who do not wish to participate in the water activities or those who are considered weak swimmers are not to be disadvantaged in their scholastic endeavours.

Although the department has granted approval for the research, you are reminded that it is a condition of approval that Principals must be contacted in the first instance, and their approval granted before any teacher or student is approached to participate.

Education Queensland is interested in this research and at the completion of your project; it would be appreciated if you would provide this office with a copy of your findings. You are asked to notify the Department should the findings of the research be published following completion of your study.

Should you have any questions about the research approval process please do not hesitate to contact Ms Rebecca Nguyen on (07) 3237 1120. Please quote your file number 500/27/228 in future correspondence.

Yours sincerely

Elizabeth West

Elizabeth West
Principal Adviser
Strategic Directions Policy and Research Branch
Office of Strategic and Executive Services

Office of Strategic Planning and

Appendix G

BIG CAT
Green Island
Reef Cruises

Big Cat Green Island Reef Cruises
Tour Vessel Terminal
The Pier Marketplace
CAIRNS, QLD 4870, Australia
Phone: 07 40510444 Fax: 07 40518896
Email: info@bigcat-cruises.com.au ACN: 010 731 567
Web Site: www.bigcat-cruises.com.au

University Ethics Committee
C/O Carl Stepath
155PhD Candidates
Schools of Tropical Environment Studies & Geograpy & Education
James Cook University
PO Box 414
Smithfield
QLD 4878

4th June 2002

To the University Ethics Committee

This letter is to confirm that our company supports the high school marine education and coral reef monitoring project of Carl Stepath at JCU, Cairns. We look forward to working with Mr Stepath regarding marine education and students of Far North Queensland.

This is a great opportunity for the students to learn about marine ecology and apply it directly to the reefs they visit. This is a program that demonstrates we are working with the community, while helping high school and university students. We support this type of program and will help this high school marine ecology and coral reef monitoring project with special rates for trips to the reef and facilities and equipment for the training program.

If you require any further information please don't hesitate to contact me.

With Kind Regards

JENNY SMITH
Reservations Manager

Appendix H
Sample school approval letter

St Mary's Catholic College
Providing excellence in education since 1986

53 Anderson Road
WOREE Q. 4868

PO Box 259E Earlville
CAIRNS Q. 4870

Telephone: (07) 4054 6144 Facsimile: (07) 4054 6617
Email: addmin@smcc.qld.edu.au
A.B.N. 42 408 340 094 002

7th June, 2002

To The JCU Ethics Review Committee,
JCU
Cairns

Dear Sir / Ms,

I have spoken to Carl Stepath, from JCU, Cairns about his propose project for Marine Education and monitoring of that environment, - Coral Reefs as experiential environmental education: Learning with Australian high school students - a case study, and consider it a worth while cause.
As I am the Senior Science Co-ordinator at St Mary's Catholic College, Woree, I believe that students in our region would benefit greatly from becoming involved in this style of project and I would like to see the project given the green light to proceed.
Carl anticipates that many students will be involved in this marine education and research project, and it appears to be beneficial educationally and will challenge students to think wisely and long-term, as the students will learn about reef ecology and apply it to our reefs during visits to them. Carl's work will measure educational effects on awareness, environmental attitudes and participatory action skills.
We anticipate the program will start in the second semester of 2002 and run for two more semesters, and we have approximately 20 to 60 students available to take part at any one time. Our Marine Studies teacher will accompany the students on the reef visit(s) and supervise the students while the study is being conducted.

Yours sincerely,

Megg Kennedy
(Senior Science Co-ordinator)

Kim Gubiani
(Deputy Principal)

Owen Hitchings
(Acting Principal)

Appendix I
Sample student parent approval letter

Carl M. Stepath, PhD Candidate

James Cook University

Schools of Tropical Environment Studies & Geography, and Education
P.O. Box 414, Smithfield, Qld. Australia
Ph: (07) 4042 1546 Fax: (07) 4042 1284

Date: July, 2003

Hello,

My name is Carl Stepath and I am a researcher from JCU in Cairns. My research concerns coral reef education and will collect data about how high school students feel about reefs. I am requesting your permission for your son/daughter to participate this semester. In mid-semester we will go to the Great Barrier Reef, and learn about marine ecology and reef monitoring; with alternative programs available to those students who do not swim well. In this project, students will be required to listen to presentations about coral reef ecology, go snorkeling and learn monitoring skills on a free trip to the reef, where we will note fish, invertebrates and coral cover. At several stages during the semester, the students will be interviewed or surveyed by questionnaire, with some audio and videotaping of the process. I am very interested in student opinions and ideas about the reef, and hope your son/daughter can be involved in this fun project. The student's involvement is voluntary and they can withdraw at any time.

All this will be happening during this semester. We will learn about what a marine biologist does, and gain knowledge of coral reefs and future job possibilities. The students and their classmates will be exposed to the ocean environment through boat rides and snorkeling around the reef with safety conscious, trained and knowledgeable personnel. These trainers are qualified in first aid, and have a high level of diver certification. The reef visits will be with reputable and experienced tour boat operators to assure a fun experience offshore. Be sure to have them bring lunch (snacks), sun block, a hat, swimmers and a towel.

Although you have already completed consent forms for your high school, James Cook University requires this consent form to be completed. We also request permission for photographs to be taken of your son/daughter during the project for use in the thesis. To participate students need to return the attached consent form, signed by their parent/guardian to their class teacher in a few days. They can not participate unless this letter is signed.

Thank you.

Sincerely,

Carl M. Stepath
Telephone - Office: (07) 4042 1546; mobile: 0401 236 155

Appendix J

Sample student parent approval and waiver form

JAMES COOK UNIVERSITY

TOWNSVILLE Queensland 4811 Australia Telephone: (07) 4781 4111

INFORMED CONSENT FORM

SCHOOL: Cairns H.S.

PROJECT: Learning with Australian High School Students – coral reefs, a case study

CHIEF INVESTIGATOR: Carl Stepath

CONTACT DETAILS: ***JCU Contact Details: office – 4042 1386, mobile 0401 236 155***

DETAILS OF CONSENT:

Your consent is requested for your son/daughter to take part in learning research by a PhD student from JCU. This research is in conjunction with Cairns S.H.S.'s science department's coral reef trips. Your son/daughter will be taking part in learning research, will learn information about fish, invertebrates and corals, and go to monitor a reef. They will answer survey questions and be interviewed concerning their opinions about coral reefs. We request your permission to videotape and audio- tape any interviews and teaching sessions. We also request permission for photographs to be taken of your son/daughter during the project for use in the thesis. The time commitment required will be approximately six hours per semester for interviews, the reef trip will take one full day, and instruction concerning the coral reef monitoring techniques will also take class time. The research outcomes of this study will be published in a PhD thesis, related journal articles and conference presentations. Student involvement is voluntary and they can withdraw at any time. You are welcome to accompany your son/daughter on the trip at your own expense, if space is available. Thank you for your time concerning this project.

CONSENT: The aims of this study have been clearly explained to me and I understand what is wanted of me. I know that taking part in this study is voluntary and I am aware that I can stop taking part in it at any time and may refuse to answer any questions. I understand that any information I give will be kept strictly confidential and that no names will be used to identify me with this study without my approval.

Student Name: *(printed)* Parent Name: *(printed)* Address:	
Phone number (not required): **Parent Signature:**	**Date:**

Campuses at TOWNSVILLE (07) 4781 4111 CAIRNS (07) 4042 1111 MACKAY (07) 4957 6048

Appendix K Snorkel & Dive Risk Management Plan

Coral reefs as experiential environmental education: Learning with Australian high school students – a case study.

Risk Management Plan: Boat trip and Snorkelling at the Great Barrier Reef

Risk Assessment

Description of hazard	Occupation & tasks at risk	No. of persons @ risk
Swimming, snorkelling and boating at the Great Barrier Reef	Water inhalation, choking Broken bones, scrapes Jellyfish, irikanji Dehydration, sunburn Stonefish, cone shells etc	20-30

Risk Controls

Control Categories	Short-term Controls	Long Term Controls
Design Elimination Redesign Separation Administration Personal protective equipment	First aid kit on site Ice water for soaking and vinegar for treatment Helicopter evacuation to hospital with 30 min. Sunscreen and shade in picnic area of Green Is. Species ID and notice of dangerous marine animals not to be touched	Training of students about marine problems and hazards on the fieldtrip. Boat personnel and equipment, as well as facilities at Green Is. Life jackets and emergency life saving equipment accessible

Appendix L
Medical emergency contact list of health care practitioners

MEDICAL PRACTITIONERS WITH TRAINING IN DIVING MEDICINE

A complete list of medical practitioners with training in diving medicine is maintained by the South Pacific Underw
Medicine Society, and is published periodically in their journal. For a copy of this list contact the University Diving Co
or:

The Secretary
SPUMS
C/o Australian and New Zealand College of Anaesthetists
630 St Kilda Road
Melbourne. Victoria. 3004.

Some Centres with diving medical doctors in North Queensland are;

Townsville

Mundingburra Medical Centre 128 Ross River Rd Dr Con Savis Dr Loretto Maxwell	(07) 4779 0622
Townsville Diving Medicine Centre 2-10 Walker St Dr Michael Rooney	(07) 4771 2899
Northside Family Physicians 89 Bundock St Dr Will Cairns	(07) 4721 2455

Ingham

Ingham Medical Centre Crn Halifax Rd and Heard St Dr Dennis Pashen	(07) 4776 2100

Cairns

McLeod Street Medical Centre 67 Mcleod St Dr Cathy Meehan	(07) 4052 1583
Cairns Central Medical Centre 112A Mcleod St Dr B G Cameron Dr Nicola Davis Dr M Mitchelson Dr Paul Phibbs Dr Dragi Simjanoski	(07) 4031 3717

Specialist advice can be obtained from:

The Hyperbaric Unit Townsville General Hospital	(07) 4781 9455
Diving Emergency Service C/o Hyperbaric Medical Unit Royal Adelaide Hospital	1800 088 200 24 hours toll free within Australia 61 8 373 5312 user pays outside Australia

Appendix M
Researcher structured interview questions

Structured questions asked by the researcher with a tape recorder, asking each student their own ideas in limited responses.

Interviews for the boat ride back from reef trip (DATE):

1. What is your name and what school do you attend?

2. Tell me what you liked the best about today's trip?

3. What was interesting and meaningful to you?

4. What was the most fun thing about today's trip for you?

5. Tell me what you learned today?

6. Does this new information make any difference in your life?

7. Do you think actually coming out here and experiencing the reef makes it better for learning?

8. What are we are doing that is damaging to coral reefs?

9. What can our community do to help coral reefs?

10. What would those things be in our own lives?

11. What would you change to make this coral reef monitoring trip better?

Appendix N

List of peer interview structured questions

SAMPLE QUESTION SHEET: Peer interviews that were asked from one student to another and videoed by an assistant researcher.

Video interview questions at ??? Island reef trip (DATE):

1. What is your name and what school do you attend?
2. Tell me what you liked the best about today's trip?
3. What was the most fun thing about the coral reef monitoring for you?
4. Tell me what you learned today?
5. Does this new information make any difference in your life?
6. Do you think actually coming out here and experiencing the reef makes it better for learning?
7. Do humans need coral reefs for survival?
8. What are we are doing that is damaging to coral reefs?
9. What can we do to help coral reefs?
10. What would those things be in our own lives?
11. What are the most interesting things for you about coral reefs?
12. What are the most interesting things to you about today's trip?
13. How can this coral reef monitoring trip be made better?

Appendix O

Coral reef monitoring underwater data collection sheet

REEF CHECK 2001- Please fill in all Black outlined boxes							
te Name:							
Depth:			Team Leader:				
Date:			Time:				
Indo-Pacific Belt Transect : Fish							
Data recorded by:							
	0-20m	25-45m	50-70m	75-100m	Total	Mean	SD
Butterfly fish					0	#DIV/0!	#DIV/0!
Sweetlips (Haemulidae)					0	#DIV/0!	#DIV/0!
Snapper (Lutjanidae)					0	#DIV/0!	#DIV/0!
Barramundi Cod (*Cromileptes*)					0	#DIV/0!	#DIV/0!
Grouper >30cm (Give sizes in comments)					0	#DIV/0!	#DIV/0!
Humphead wrasse					0	#DIV/0!	#DIV/0!
Bumphead parrot					0	#DIV/0!	#DIV/0!
Other Parrotfish (>20cm)					0	#DIV/0!	#DIV/0!
Moray eel					0	#DIV/0!	#DIV/0!
Indo-Pacific Belt Transect : Invertebrates							
Data recorded by:							
	0-20m	25-45m	50-70m	75-100m	Total	Mean	SD
Banded coral shrimp (*Stenopus hispidus*)					0	#DIV/0!	#DIV/0!
Diadema urchins					0	#DIV/0!	#DIV/0!
Pencil urchin (*Heterocentrotus mammilatus*)					0	#DIV/0!	#DIV/0!
Sea cucumber (edible only)					0	#DIV/0!	#DIV/0!
Crown-of-thorns star (*Acanthaster*)					0	#DIV/0!	#DIV/0!
Giant clam (*Tridacna*)					0	#DIV/0!	#DIV/0!
Triton shell (*Charonia tritonis*)					0	#DIV/0!	#DIV/0!
Lobster					0	#DIV/0!	#DIV/0!
or each segment, rate the following as: None=0, Low=1, Medium=2, High=3							
Coral damage : Anchor					0	#DIV/0!	#DIV/0!
Coral damage:Dynamite					0	#DIV/0!	#DIV/0!
Coral damage : Other					0	#DIV/0!	#DIV/0!
Trash : Fish nets					0	#DIV/0!	#DIV/0!
Trash : Other					0	#DIV/0!	#DIV/0!
Comments:							
Grouper sizes (cm)							
Bleaching (% of coral population)							
Bleach (% of colony)							
Suspected disease (type/%):							
Rare animals sighted (type/#):							
Other:							

INDO-PACIFIC BELT TRANSECT

Appendix P

Coral reef monitoring methodology

The coral reef monitoring was done using the Reef Check International methodology taken from Hodgson and Stepath (1998). The *site selection* was at the convenience of the boat operator on a given day, and the sites visited were Green Island, Fitzroy Island, Northwest Island, Breaking Patches Reef, Hastings Reef and Michaelmas Cay. In the *Basic design,* the goal was to survey one-depth contours of approximately 1.5 m below chart datum (lowest low water). However, since the snorkel, trips were not always at the same tide height, and the highest coral cover will not always be found at this exact depth. Thus, the depth contour with the highest coral cover within the 1 – 2.5 m depths were chosen. The sites were chosen in a convenient manner on the day of the monitoring, and the data collected was used for training purposes only. Along the reef contour, two 50 m long line transects lines were deployed and surveyed by the students. The transects followed the designated depth contour either one after the other or side-by-side in a parallel fashion. The transect lines and their start and end points were separated by at 10 m on the reef flat. The distance between the start of the first transect and end of the last transect will be 20 + 5 + 20 = 45 m on each 50m tape. The depth contours were chosen for practical reasons of time and safety. A single 50 m fibreglass measuring tape was used.

There were three types of data that was recorded by the students. The two transect surveys were made along the same transect lines. The first information collected was the Site Description (Appendix K). On this data sheet anecdotal, observational, historical, locational data was recorded on the day. The second type of information collected was the Fish Belt Transect (Appendix G). In this data collection technique, two 5 m wide (centred on the transect line) by 20 m long transects was sampled for fish typically targeted by spearfishermen, aquarium collectors, dynamite and cyanide fishermen. The fish transect should be carried out first, before any other monitoring. The last type of data collected was on the Invertebrate Belt Transect (Appendix G). This procedure utilised the same two 5 m wide (centred on the transect line) by 20 m long transects as above were sampled for invertebrate species typically targeted as food species or collected as curios.

The Great Barrier Reef, Reef Check fish indicators are: Butterfly fish, Sweetlips (Haemulidae), Snapper (Lutjanidae), Barramundi cod (Cromileptes) Grouper (Coral Trout) larger than 30cm, Humphead wrasse, Bumphead parrotfish, other parrotfish

larger than 20cm and Moray eels. The invertebrates to be counted were: Banded coral shrimp (*Stenopus hispidus*), Black or diadema urchin (*Echinothrix diadema*), Pencil urchin (*Heterocentrotus mammilatus*), Sea cucumber (edible only), Crown-of-thorns sea star (*Acanthaster*), Giant clam (*tridactna*), Triton shell (*Charonia tritonis*), Collector sea urchin and Lobster. All these fish and invertebrates to be counted were listed on the data sheet and the students swam the transect line and marked the ones they say along the prescribed transect.

Pre-dive Preparation

The training needed for each team was basic snorkelling knowledge, with a minimum experience and knowledge level prescribed by the individual schools. A one-hour training was provided in the classroom one week before the snorkel day at the reef. The JCU snorkel protocol (Appendix J) was explained to the students in the classroom briefing and followed at the snorkel site to insure student safety. A snorkel briefing was also given at the snorkel site on the day of the monitoring so that the training could be absorbed and to provide sufficient time for questions and discussion. The Team Leader/Team Scientist/Marine Ecology Instructor made a pre-snorkel presentation that includes:

1) A snorkel safety plan and explanation of the goals of Reef Check;
2) A review of the sampling design and rationale of the indicator organisms;
3) Field identification training for all organisms and Reef Check definitions for substrata;
4) An introduction to the data recording format, and preparation of slates;
5) An explanation of how to avoid smashing reef corals by proper use of fins;
6) Explanation about creatures on the reef that could cause harm to the students;
7) Explanation of the post-dive data entry, checking and submission procedures.

There were two field data sheets (pro-forma) supplied to the students, and they were the Site Description and Belt Transect sheets. The Belt Transect sheets are divided into a section for invertebrates and a section for fish.

Teams used a plastic writing slate made for the purpose of monitoring. Photos of the indicators were printed in colour-laminated sheets and sometimes carried underwater for reference. One buddy pair should laid out a 50 m transect line along the specified contour (1-2.5m) with the help of adult supervisors. The time to deploy the transect was approximately 30 minutes. After deployment, the entire length of the transect was examined to ensure it was not snagged or floating too high off the bottom. Small marker

floats were attached to the starting point of the line.

A GPS (Global Positioning System) reading was obtained from the boat we were transported on, and the compass bearing to the end marker buoy was recorded on the site description sheet.

Fish Belt Transect Instructions

The fish belt transect was the first work done after the transect line was deployed. Work started after the transect line was laid and the estimated time to completion was 30 minutes per site. Data was recorded on a slate following the Belt Transect Sheet format. The snorkelers assigned to count fish swam slowly along the transect and then stopped to count target fish every 5 m, and then wait 3 minutes for target fish to come out of hiding, before proceeding to the next stop point. This is a combination timed and area restriction survey, two sections x 20 m long x 5 m wide = 200 m2. At the prescribed depth contour, there were eight "stop-and-count" points, and the goal was to complete the entire 200 m2 belt transect in 30 minutes.

The target fish have been selected as some of the top fish typically removed from reefs by spear or line fishing or other methods. Given the magnifying effect of water, snorkelers practiced estimating sizes using the sides of the slates, which were marked in 20 or 30 cm increments. Notes were made of any rare animal sightings such as large manta rays, sharks and turtles, and if these are off-transect records, they were written at the bottom of the slate under “Comments.” During the fish transect work, the other team members gathered descriptive site data and swam around the snorkel site. Only one site description form was filled out per site.

Invertebrate Belt Transect Instructions

When the fish belt transect was complete, snorkelers in the invertebrate group carry out monitoring along the belt transect for invertebrates. The same transect line is used and, like the fish belt, the invertebrate belt transect is 5m wide with 2.5 m on either side of the transect line. It is best to split the work, with each diver recording data along one 2.5 m wide strip. Estimated time to complete this work is 30 minutes. Total survey area will be 20 m x 5 m =100 m2 for each transect, for a total of 200 m2. In addition to recording indicator organisms, each group noted the presence of coral bleaching or unusual conditions (eg. that might be diseases) along the transects. Team members were encouraged to look in holes and under overhangs to detect species, such as lobster, that may be hiding

Post Dive Tasks

The team scientist was responsible for gathering the slates and data together after the survey were completed, and reviewed them immediately after the monitoring with the team members. The purpose was to make a quick assessment of the data to determine if some error has been made that can be corrected while the team is still on site, and the transect is in place. Typical errors that could be corrected would be "double-counting" of fish, misidentification of organisms or mis-labelling the slate. When an error is suspected, a resurvey should be made to check or to correct it. Before departing from the site, the team scientist ensured that all required data had been collected, and that the slates had been filled out properly, in particular with each individual's work identified.

Appendix Q

The Southern Cross Catholic College Field-trip to Northwest Island

The Southern Cross Catholic College (SCCC) component was different, since it took place over a seven-day period at Northwest Island (NW) off the coast of Gladstone, Queensland. I left Cairns on Aug 5 and returned on Aug 17, with the trip to NW taking place from August 9-16, 2003. The trip had been discussed for months with the marine studies coordinator at SCCC. Arrangements were made for my classroom presentation and final filling out of the remaining student survey forms was taken care of upon my arrival at the school. Certain classes were not ready, since they needed to fill out their questionnaires, and this was done just before the marine ecology presentation. This made the presentation a little shorter than I had planned. This information was given to the students on the island, because the small groups allowed extra time to be spent with the students at the reef site. The contrast group also had to be pre-tested, with Mr. Lloyd Jones making sure this was taken care of, and then having the post-tests later mailed to me in Cairns.

I arrived a day prior to the classroom presentation, and was able to meet the staff and make preparations for the presentation. The marine teachers were extremely busy and preoccupied, since there were an infinite number of things to do in preparations for the trip to NW; as we were taking all the equipment for ourselves and the students, including food, water, dive gear, boats, compressors and camping gear. A great deal of preparation went into the trip, especially since we had to bring everything to the island, including our own drinking water, food, boats, fuel and SCUBA air compressors. The island has no facilities except for composting toilets, and everything else for the 50 students and 9 staff had to be loaded into buses, trucks and boats and hauled up to Gladstone for barge transport to the coral cay. Obviously, it was extremely difficult to focus on a research project when the entire marine program and associated teachers were focused on this trip to NW, and their desire to make it successful and safe.

The students were very busy during the week island stay. The following is a brief synopsis and schedule of the SCCC trip, NORTH WEST ISLAND 2003, YEAR 11, MARINE STUDIES FIELD STUDY. The coach carrying 44 students, coaster with 5 students towing a power boat, and truck loaded with 5 tonnes of marine studies and camping gear departed Scarborough at 11 pm on August 18, 2003. There were stops at Gympie, Gin Gin and finally a 7am breakfast at McDonalds in Gladstone. Then onto the

marina to board and load the barge "Curtis Endeavour" for the 6-hour trip to North West Island. We arrived at NW at 4pm, August 9, after a calm crossing - while students hurriedly pitched tents, the staff put on a BBQ sausage sizzle to feed the hungry hordes. Next morning was spent establishing camp before moving into the regular sequence of activities. The five groups of 10 students rotated through two activities per day, a high and low tide activity as follows:

LOW WATER ACTIVITIES

1. Island Profile - identifying flora, fauna, geography, botany and human impacts on the island. Construction of an island profile;
2. Transect of Reef Flat - identifying, counting and graphing sea cucumbers and clams;
3. Organisms - identifying and classifying marine creatures of the reef flat;
4. Snorkel - demonstration and assessment of skin diving skills;
5. SCUBA - testing and assessing of scuba skills over the edge of the reef.

HIGH WATER ACTIVITIES

1. First Aid - treatment of marine accidents with first aid;
2. Boating - demonstration and assessment of boating skills for powerboat license;
3. SCUBA - testing and assessment for PADI Open Water Certification;
4. Transect of the reef crest;
5. Manta Tow - towing students with powerboat in 2-3 metres of water.

NIGHT ACTIVITIES

Day 1 (8pm-midnight) - walk across island, then back to camp for a night reef walk with water proof torches at low tide to identify creatures of the night;

Day 2 (7.30-9.30pm) - Boating theory for powerboat license (in tents 10pm, lights out 10.30pm);

Day 3 (7.30-9.30pm) - Boating theory for powerboat license.

Day 4 (7.30-9.30pm) - Boating theory for powerboat license (night scuba dive, 5.30-7.30pm);

Day 5 (7.30-9.30pm) - Walk across island, astronomy (Southern Cross, South celestial pole, Scorpio and Planet Mars);

Day 6 -(8pm-10pm) Talent quest;

Day 7 - Departure from NW for Gladstone at high tide, 9pm.

Other mid-tide activities were plankton identification using microscopes and radio procedure using three hand held 27meg radios.

Obviously, we were all very busy keeping up with this schedule making for a very fun trip for all of us, especially the students. This was all organised by Mr. Lloyd Jones, Marine Studies Teacher at Southern Cross College, with the help of his friendly and extremely competent staff.

3.6 SCCC Observations

The total emersion into an environmental situation, especially an island off Australia in the GBR was very special for everyone involved. It appeared to be far better then the day trips out of Cairns. According to my personal observation, this longer stay is better because the students:

- actually get to see the creatures on a day in day out situation and establish a relationship with them;
- learn about the ecology of a place without the normal developments that we have in our normal daily life (highways, cars, TV, homes, etc);
- they receive a tremendous amount of training such as boating, first-aid, marine organisms, transect reading, snorkelling at high and low water, learning establishments of cays and their botany, sustainable living practices, fishing and fish habitats, manta tows and seeing large marine creatures that do not hurt them, astronomy, reef at dark;
- seeing sunrises and sunsets on undeveloped island with no TV, radio, newspapers, electronic gadgets, etc (other types of distractions);
- learning about the reef in a day to day situation with the observation of low and high tide situation and how different they are, as well as night and day on the reef;
- learn how to get along with adults (besides their parents) and their classmates on a real intimate way on a day to day basis;
- being on their own away from their parents and leaning how to get along with their friends without normal support groups and being able to go home and chill out.

The excursion to NW went as planned, and the kids and I really got along well. In fact it is a somewhat emotional when we parted, since one of them (Charlie) even gave me a necklace as a memento. They were all very nice to me; with the boys teasing me all the time about my American accent and the way I say my name. I don’t think I have ever

heard my name said so many times in my life. The girls were very interested in the video presentation, and hearing about my daughters and their life in Hawaii. Upon my return to JCU, I have even received a number of emails and mobile phone text messages when I returned to Cairns, one of them said: Carl. I hope you didn't take the way I didn't pay attention in your class's personal. If I'd had known your were so well educated I would have paid more attention, KM. The students really appeared to have a wonderful time on the island while learning about the marine environment.

Appendix R
JCU Snorkel Protocol

Coral reefs as experiential environmental education: Learning with Australian students – a case study.

Participation in snorkel activity is at the discretion of the staff member or snorkel safety officer. Non-compliance with any rule will automatically lead to the person(s) being excluded from further snorkelling activities.

1. Snorkelling is permitted under the following conditions:
    - Snorkel in teams of at least two people (buddy pairs)
    - All snorkellers remain in the designated snorkel area
    - All snorkellers sign in and out in the snorkel log
    - Teams inform the safety officer prior to entering the water
    - Snorkellers must be out of the water one hour before sunset.
    - All snorkellers will use sunscreen and pay attention to instructions about being in the water!
    - Be careful of dangerous creatures such as stinging jellyfish, cone shells, stonefish, fire coral, stingrays and lionfish.
2. The participants will be supervised at all times and will follow JCU university prescribed safety regulations while snorkelling.
3. Students will only snorkel in the assigned hours and area.
4. Each team will remain in visual contact with all other members at all times. If visual contact is lost, teams must reform.
5. Adverse weather or water conditions will be avoided and may result in the cancellation or termination of a snorkel.
6. No snorkel team will leave the assigned area or location during the course of the snorkel. Entering caves, tunnels or crevasses is not permitted.
7. It is the responsibility of each person to ensure that his or her “Time In” and “Time Out” is recorded.
8. Each snorkeller is required to sign the Record of Snorkel Form immediately after leaving the water. The safety officer insures this.
9. Participation is not obligatory. Anyone may withdraw from any snorkelling activity at any time for any reason. If a snorkeller needs to terminate a snorkel early, the buddy pair must return to the boat together.
10. All snorkellers are required to wear a wetsuit or other body covering so that arms, legs and body are protected. In addition, all poor swimming snorkellers are required to wear a personal floatation device.
11. A thorough explanation of the dangers associated with this type of field trip will take place before the snorkelling. The participants will be explained the problems with stingrays, stonefish, fire coral, stinging jellyfish, and other harmful marine organisms.