

**From knowledge to behaviour: can environmental
education realise its potential?**



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*“In the end we will conserve only what we love
We will love only what we understand
We will understand only what we are taught”*

Baba Dioum, Senegalese Ecologist

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1. Abbreviations

CBD: Convention on Biological Diversity

EE: Environmental Education

EMP: Environmental Management Plan

GDP: Gross Domestic Product

GLM: General Linear Models

IUCN: International Union for Conservation of Nature

LUNGOS: Liaison Unit of Non-Governmental Organisations Seychelles

MAM: Minimal Adequate Model

MEA: Millennium Ecosystem Assessment

NGO: Non-Governmental Organisation

PBC: Perceived Behavioural Control

PC: Principal Components

PCA: Principal Component Analysis

SIDS: Small Island Developing State

SR: Seychelles Rupees

TPB: Theory of Planned Behaviour

TSR: Theory of Self-Regulation

TRA: Theory of Reasoned Action

UNDP: United Nations Development Program

UNEP: United Nations Environment Program

UNESCO: United Nations Educational, Scientific and Cultural Organization

WCS: Wildlife Club Seychelles

WSSD: World Summit on Sustainable Development

2. Abstract

Environmental education is employed in broad range of conservation interventions in order to increase the knowledge of recipients. Favourable attitudinal and behavioural changes are widely anticipated outcomes of a successful environmental education program. It has been suggested that through the transfer of information from recipients to individuals in the wider community environmental education can have a broad influence. A limited published literature exists to substantiate these predicted conservation merits of environmental education. Substantially more evidence illustrating the capacity and limitations of environmental education is needed in order to facilitate its appropriate use and maximise its conservation outputs.

This study contributes to the existing literature by assessing the influence of informal environmental education on the child recipients and their parents. Both student and parents were observed to have improved knowledge of wetland ecosystems when the child had undertaken education on wetland habitats. Child attendance of environmental education is subsequently shown to have a significant influence on household water management behaviour. The use of quantitative measures of knowledge, attitude and behaviour provides strong support for the demonstrated capacity of environmental education to achieve intergenerational influence.

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4. Introduction

Environmental education (EE) and awareness raising is one of four broad categories of conservation intervention described by Salafsky *et al.*, (2002) which can be employed to resist the trend of increasing biodiversity loss. EE throughout its continually evolving definitions and mandate has always retained the goal of reducing the impact of people on the environment, proactively or reactively (UNESCO, 1977). It is broadly anticipated by those delivering EE that through knowledge acquisition people's attitudes and behaviours are also influenced and as a result EE has the potential to assist in the reduction of anthropogenic impacts on the environment to sustainable levels (UNESCO, 2002a). The psychological complexities of how acquired knowledge can potentially influence attitudes and behaviour are complex and still debated. In conjunction with a lack of quantitative studies assessing the impacts of acquired knowledge on attitudes and behaviour this uncertainty makes assessing the conservation value of EE difficult (Bride 2006).

Globally, funding for conservation is scarce when viewed in light of the goals it is charged with achieving (Ferraro & Pattanayak, 2006). Where available funding should be spent is a topic of much debate across the field of conservation and has been one of the driving influences behind the development of conservation prioritisation (Possingham *et al.*, 2001; Pimm *et al.*, 2001; Dalton, 2000). Within EE a theoretical dichotomy between age groups exists. Should funding target children who will inherit a planet with compromised ecological systems and on whose shoulders responsibility for the actions of proceeding generations will fall? Or should funding be spent on informing adults who have the capacity to make immediate changes to the way that human beings interact with the planet at the personal and political level? Evidence from socialisation theory that knowledge and values are transferred between generations (Ambert, 1992; Kuczynski, *et al.*, 1997 and 2007; Knafo & Galansky, 2008) indicates that a choice to educate adults or children does not necessarily exclude the other group from being influenced by an EE program. Investigations into the transfer of acquired environmental knowledge between generations are limited (but see

Vaughan *et al.*, 2003) and to my knowledge no studies have analysed the impact of transferred knowledge on the attitudes and behaviour of individuals who have not directly received EE.

The Seychelles has a comparatively longstanding history of youth orientated environmental education through a network of school affiliated wildlife clubs under the umbrella of the Non Governmental Organisation (NGO) Wildlife Clubs Seychelles (WCS). Differences in the taught subject matter between Wildlife Clubs allows for an experimental design which compares the knowledge of a group of students who have received education on a designated topic with their counterfactuals, students who have not received education on the designated topic. Sampling a study and control group of students who both attend WCS controls, to the largest extent possible, the effects of other potentially confounding variables. Analysis of the knowledge, attitudes and behaviour of the students' parents can provide evidence for the occurrence or absence of intergenerational knowledge transfer and the conservation significance of EE for individuals who have not been directly involved with an EE programme.

4.1 Aims and objective

The overall project aim is to provide much needed quantitative data on the potential of environmental education to be a valuable conservation intervention in efforts to reverse the accelerating trend of environmental degradation.

The specific objectives of the project are to:

- 1) Investigate the ability of informal EE to increase environmental knowledge
- 2) Investigate the occurrence of intergenerational transfer of environmental knowledge between students who attend WCS and their parents
- 3) Investigate the influence of transferred knowledge on parental attitudes and household behaviours.

5. Background

5.1 Environmental education

Environmental education is a broad and inclusive term, the focus of which has fluctuated with developments and trends in conservation science since it was first defined by the International Union for the Conservation of Nature (IUCN) in 1970. Holistically, environmental education can be described as intending to provide students with opportunities to gain awareness and sensitivity to the environment, knowledge and experience of environmental problems, a positive attitude and valuation of the natural world, necessary skills for the identification, mitigation and removal of environmental threats and the motivation and ability to participate (Jacobson *et al.*, 2006). EE directly addresses the frequently critical role of human beings in environmental degradation (MEA, 2005) by influencing public visions of nature, described as the democratic basis for environmental conservation (Van der Born *et al.*, 2002). As a result of the multiple subject areas and teaching methodologies available to educators, EE has the potential to influence components of biodiversity conservation as varied as the national adoption of environmental legislation and individual life choices (Hart & Nolan, 1999). Accordingly EE is seen as a critical component of re-aligning human pressures on the planet's environmental systems to sustainable levels (Jacobson *et al.*, 2006). The strength of conviction with which some individuals believe in the necessity of EE as part of global conservation efforts is highlighted by Bride (2006).

“Unless a process of education can facilitate development of the desired changes in public understanding and support in relation to biodiversity, conservation biology will, despite holding a few outposts, continue fighting a losing battle, with many of its exponents simply recording the demise of much of the world's biodiversity.”

A key and debatable assumption in the above quotation is that EE has the capacity to change 'public understanding and support'. The notion that education has the power to achieve positive changes in the way that humans interact with the environment is a commonly recurring theme and is frequently quoted in the aims and mission

statements of international declarations on the purpose of EE. The United Nations Educational, Scientific and Cultural Organisation (UNESCO) Johannesburg Summit asserted that education is an important instrument to change the knowledge, values, behaviours and lifestyles appropriate to achieve sustainability and stability (UNESCO, 2002). This reflects the third goal of EE as laid down at the seminal Tbilisi conference which stated that EE should create new patterns of behaviour in individuals, groups and society as a whole (UNESCO, 1977). The faith placed in education to achieve these monumental shifts in human societies is derived from a belief that knowledge and awareness are important components of the psychological interactions which define how we, as individuals and communities, behave (Ajzen, 1985).

5.2 From knowledge to behaviour

If the goal of environmental education is to use acquired knowledge as a tool to modify or prevent environmentally damaging behaviours then a causal link between receiving education and behavioural change must be demonstrated. The interactions between knowledge, attitudes and behaviour are complex and the psychological framework within which they interact is still debated.

Knowledge is defined by the Oxford English Dictionary as

“ Expertise, and skills acquired by a person through experience or education; the theoretical or practical understanding of a subject, what is known in a particular field or in total; facts and information or awareness or familiarity gained by experience of a fact or situation.” (OED, 1990)

EE therefore is assumed to have the capacity to influence knowledge. This capacity is demonstrated by Vaughan *et al.* (2003) who used a pre-test, post-test methodology to demonstrate that Costa Rican school children taught a one month long course on the natural history and conservation of scarlet macaws (*Ara macao*) improved on 71% of test questions related to the taught subject matter. Informal methods of education such as posters, videos and workshops were used on the Union of the Comoros to

demonstrate the benefit to humans, of ecosystem services provided by critically endangered fruit bats. Subsequent analysis of the influence of the educational techniques used showed an increase in knowledge concerning the bats and their roles in seed dispersal (Trehwella *et al.*, 2005).

Psychological frameworks defining the inputs which influence the expression of behaviour recognise the importance of attitudes as an interim stage between knowledge and behaviour. Attitudes can be considered psychological tendencies expressed by appraising a particular entity with a degree of approval or disapproval (Asunta, 2003). Influenced by knowledge and in turn influencing behaviour, attitudes represent individuals “feelings, values or beliefs” (Henerson *et al.*, 1987). Beliefs relate directly to the information (the knowledge) a person has about an issue in question (Asunta, 2003).

Environmental attitudes are described as the feelings a person has about how to be in a proper relationship with one's environment (Puohiniemi, 2002). The environmental knowledge and environmental attitudes of American high school students have been shown to be correlated (Bradley, Waliczek & Zajihecek, 1999). Further evidence of an association is offered by Aipanjiguly *et al.*, (2002) who demonstrates that greater knowledge about manatees in waters off the Florida peninsula is positively correlated with attitudes supportive of manatee conservation. The education program designed to increase knowledge of endemic fruit bats in the Union of the Comoros reported by Trehwella *et al.* (2005) provides directional evidence for increased knowledge resulting in improved attitudes. Evidence that demonstrates the contributory nature of knowledge on environmental attitudes is rare within the literature but represents an important step towards demonstrating a causal link between knowledge and behaviour. Making the next logical step of isolating attitude change as the sole causative agent of a behavioural change is extremely difficult. This is due to the number of inter related inputs hypothesised to influence the expression of behaviour.

Definitions of behaviour are multiple and varied. Broadly behaviour can be described as the decisions, practices and actions of individuals and groups (Byers, 1996).

EE seeks to encourage behaviour that minimises the environmental cost of undertaking an action (Kollmuss & Agyeman, 2002). Cook and Selltiz (1964) claimed attitudes influence behaviour in interaction with other influences. Three commonly quoted models which attempt to define the interacting influences are briefly described here.

The theory of reasoned action (TRA) hypothesises that behaviour is determined by an individual's intention to perform the behaviour (Figure 1). Intention is described as having two influential components; attitude, the individual's evaluation of how to behave and subjective norm; the individual's assessment of social opinion concerning suitable behaviour. Attitudes and subjective norms are based on cognitive knowledge (Ajzen, 1985).

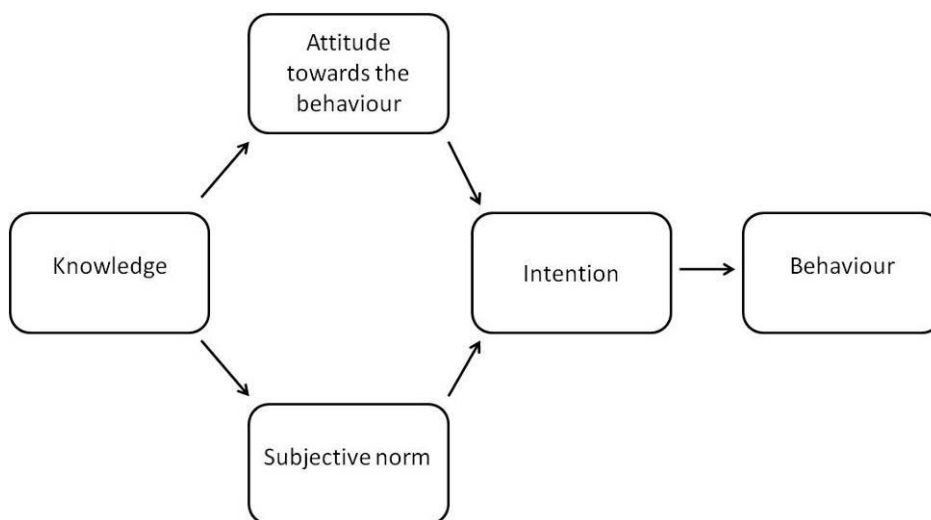


Figure 1: A graphical representation of the theory of reasoned action adapted from Ajzen (1985)

According to TRA by increasing knowledge of the environment, its threats and ecologically sound practices EE is capable of influencing attitudes towards behaviour, behavioural intention and the undertaking of behaviour. Wide scale EE aimed at a large subsection of a society is theoretically capable of influencing subjective norms. There are, to my knowledge, no published studies which quantitatively assess the influence of EE on environmental attitudes at a societal level, however EE on this scale does occur. Rare Pride specialise in using social marketing techniques to

promote an ‘ambassador species’ through community wide ‘pride campaigns’ designed to inspire society wide positive attitudes towards a flagship species (Butler, 2000). The results of ongoing analysis between communities which receive pride campaigns and control communities are eagerly awaited.

TRA was updated to the theory of planned behaviour (TPB) (Figure 2) with the addition of an extra variable, ‘perceived behavioural control’ (PBC) (Ajzen, 1985 & 1991). PBC defines the perceived ease of performing the behaviour for an individual; actual behavioural control represents the skills, time, money or co-operation a person has from others to facilitate the behaviour. People with high PBC have a greater likelihood of positive behavioural intention, resulting in an improved chance of a behaviour being enacted (Ajzen & Madden, 1986). The three belief measures which influence attitude, subjective norm and PBC are influenced by knowledge (Ajzen, 1991)

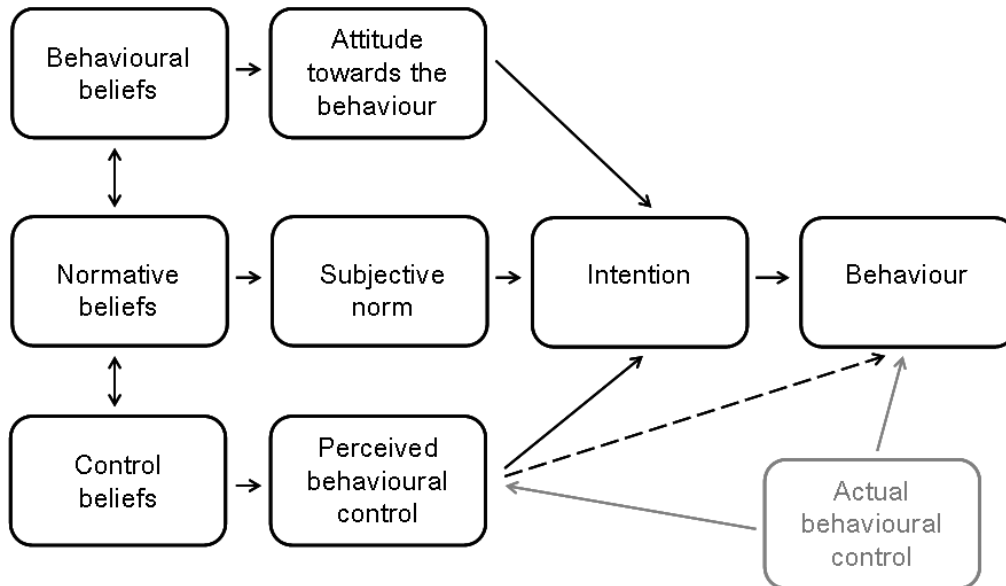


Figure 2: A graphical representation of the theory of planned behaviour (Ajzen, 2002)

Critiquing TRA and TPB Bagozzi (1992) notes the absence of desire, which is included in his theory of self-regulation (TSR). Desire is described as a “motivational

commitment to act” which affects the influence of attitudes. Attitudes are described as forming an intention to act rather than this motivational commitment.

A complete review of the proposed influences of knowledge and attitude on behaviour is well beyond the scope of this thesis. Further analysis of the differences between the three behavioural theories briefly discussed is offered by Leone, Perugini and Ercolani (1999). More recent theories such as the Extended Model of Goal-Directed Behaviour, (Perugini & Bagozzi, 2001) which increase the list of behavioural inputs yet further may be of interest to some readers. Whilst differences of opinion remain about the precise nature of behavioural predisposition TRA, TPB and TSR and more recent additions all recognise the importance of knowledge dependent attitudes. EE is capable of modifying both knowledge and attitude, it is therefore suggested that influencing of behaviour is an attainable goal for environmental education.

Uncertainties about the exact psychological determinants of behaviour impact efforts to quantify the success of EE. The role of psychological, cultural and socioeconomic inputs in behavioural expression make isolating EE as the causative driver of behavioural modification difficult to prove or disprove (Bride, 2006). A bias of research towards qualitative analysis of ‘perceptions’ and ‘opinions’ rather than ‘understanding’ further limits the ability to draw conclusions regarding the influence of knowledge acquisition on exhibited behaviour (but see Kaiser *et al.*, 1999 and Kaiser & Fuhrer, 2003).

5.3 The development of environmental education

The initial definition for EE placed its emphasis on creating a holistic knowledge base amongst recipients (IUCN, 1970). An increasing awareness of the negative impact of humans on the environment and the need for environmental conservation prompted a more proactive definition with a conservation emphasis to be devised at the United Nations Educational, Scientific, and Cultural Organization (UNESCO) international environmental education workshop in Belgrade (UNESCO, 1975)

The work of the 1975 Belgrade conference was expanded upon in the UNESCO and United Nations Environment Program (UNEP) 1977 Tbilisi conference, where environmental education was given a set of defined goals:

- To foster clear awareness of, and concern about, economic, social, political and ecological inter-dependence in urban and rural areas.
- To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment
- To create new patterns of behaviour of individuals, groups and society as a whole toward the environment.

(UNESCO, 1977)

Additionally an Action Plan for International Environmental Education, featuring twelve core principals was developed (Appendix 1).

The implementation of these principals was given a new emphasis in 1987 when the UNESCO-UNEP Moscow Conference and the report *Our Common Future* produced by the World Commission on Environment and Development (WCED, 1987) stressed the need for environmental education to provide the facilities necessary to achieve sustainable development. Sustainable development became, and remains, a major focus of environmental education. A decade of Education for Sustainable Development 2005 - 2014 has been proclaimed by the United Nations General Assembly (UNESCO, 2005).

The Convention on Biological Diversity (CBD) describes public understanding and support as a “Prerequisite for biodiversity conservation and sustainable use” (CBD, 1992a). However a lack of understanding and support for conservation efforts is not included among the major threats to biological diversity in CBD’s theme IV (CBD, 1992b), nor is environmental education recognised as a ‘cross cutting issue’ which Bride (2006) suggest may be due to a lingering lack of perceived status.

5.4 The implementation and monitoring of environmental education

Whilst the direction, emphasis and importance of environmental education have been debated and defined at international level, the implementation of environmental education in the field has addressed what Salafsky *et al.*, (2002) describe as one of the major indirect threats of biodiversity loss; a lack of awareness. The conceptual framework for improving the practice of conservation produced by Salafsky *et al.*, (2002) describes education as one of the four broad groups of action which can be used by individuals or organisations conducting conservation work to achieve their goals. A taxonomy highlighting the diversity of strategies for awareness raising is shown in Table 1.

Table 1: A basic taxonomy of education and awareness raising strategies and approaches for conservation, adapted from Salafsky *et al.*, (2002)

Approaches	Example strategies
Formal education	Developing school curricula (World Wildlife Fund Windows on the Wild)
	Teaching graduate students (Jacobson, 1990)
Nonformal education	Media training for scientists (Jacobson, 1999)
	Public outreach via museums (Domroese & Sterling, 1999)
Informal education	Media campaigns (Greenpeace)
	Community awareness raising (Public Interest Research Groups)
Moral confrontation	Civil disobedience (Greenpeace)
	Monkeywrenching / ecoterrorism (EarthFirst!)
Communication	Environmental publishing (Island Press)
	Web-based networking (forests.org)

There is a noted lack of empirical measures of success in the field of conservation which inhibits the maximisation of positive outputs per monetary input (Ferraro & Pattanayak, 2006). The MEA makes note of this deficiency stating that “Few well-

designed empirical analyses assess even the most common biodiversity conservation measures” (MEA, 2005). Following this trend analysis of the effectiveness of EE programs at imparting knowledge; changing attitudes and modifying behaviour are limited (Howe, 2009). Ferraro & Pattanayak (2006) recommend comparing the outcomes of an intervention with a counterfactual, an analogous situation where the intervention has not been employed, whilst controlling for confounding factors. Such analysis provides strong evidence for the effectiveness or inadequacy of the employed intervention.

5.4.1 The focus of environmental education on children

Children are a frequent target audience for formal and informal environmental education, there are some persuasive reasons why. Bryant and Hungerford (1977) showed attitudes toward the environment start developing at an early age. Studies on adolescents demonstrate that they have already acquired sufficient knowledge of environmental issues, economics and sustainable development to express well developed views on the subjects (Iozz, 1989). Attitudes acquired at an early age do not change easily and have a strong influence on later thinking (Asunta, 2003) making it important that sufficient facilities are made available for environmental education to have an influential presence during this important phase in attitude acquisition. Globally, children are frequently obliged to attend educational institutions; this aggregation of children within an environment specifically designed for learning reduces many logistical difficulties associated with running environmental education programs for adults (Shin, 2008). As a result many studies into the development of attitudes have taken place within the school environment (Goodwin *et al.*, 1981; Morrell & Lederman 1998).

Leeming and Porter (1997) provide three further pertinent reasons for focusing environmental education towards youth. They describe young children as

- less likely to have well-established environmentally harmful behaviours to "unlearn"

- having a longer period to influence environmental quality
- possible effective agents promoting environmentally responsible behaviour in others.

The third point is of particular interest to this study

5.4.2 The choice between educating children and adults

There is a potential conflict concerning where funding for environmental education should be spent. A lot of good reasons for designating funding towards children have been discussed and to this list must be added the fact that the world's children will inherit a planet with severely compromised ecological systems (MEA, 2005). Historically, studies showed that young generations were the most concerned about the environment (Arcury, 1990; Van Liere & Dunlap, 1981) worryingly some newer studies demonstrate a reduction in child environmental concern when compared to older generations (Dietz *et al.*, 1998). The importance of an environmentally aware and concerned generation taking on responsibility for the actions of past generations is clear.

Whilst there are robust reasons for targeting children with environmental education many serious environmental issues such as the deforestation of tropical forests, unsustainable over extraction of marine fish stocks and the looming issue of global climate change require swift, decisive action (MEA, 2005). In order to inspire such action it is logical to argue EE should be targeting those who have the capacity to implement rapid changes in the way societies operate through modification of their own behaviours and by demanding legislative changes via their capacity to influence events at a political level. Children rarely meet these criteria. It should also be noted that adults who have experienced human induced alterations to the environment may be more susceptible to awareness raising whilst children, due to shifting baseline syndrome will be less conscious of the extent to which restoration needs to take place. For a review of the evidence for shifting baseline syndrome and a discussion of its possible impacts see Papworth *et al.* (2008). The third reason Leeming and Porter

(1997) give for focusing EE on children “[they] may serve as effective agents to promote environmentally responsible behaviour in others” hints at the possibility of a mutually inclusive solution to the apparent tradeoffs associated with focusing EE on a single generation.

5.5 Intergenerational influence and its relevance to environmental education

The commonly held view is that parents teach their children, inculcating their knowledge, values and beliefs. Historically, socialization theories reflected this view and considered children to be ‘blank slates’ receiving and adopting aspects of cognitive development from parental influence (e.g. see review by Kuczynski, *et al.*, 1997). This notion of unidirectional parental influence on child development has been debunked (e.g. Harris, 1995; Maccoby, 2000). There is a growing body of literature which provides evidence for bi-directional influence between parents and children (Ambert, 1992; Kuczynski, *et al.*, 1997; Knafo & Galansky, 2008). Parents influence their children’s environmental knowledge and attitudes during their development via information sharing and the activities they jointly undertake (Musser & Diamond, 1999). Once children attain a degree of independence from their parents, such as attending school, their knowledge sources are no longer tightly shared. Heterogeneity of family members’ daily interactions generates the capacity for differing knowledge and perceptions which are the foundation for the transfer of knowledge, attitude and other cognitive components. (Knafo & Galansky, 2008). There are documented reports of parents recognising that their values and attitudes are influenced by their children (e.g. Hagestad, 1984; Peters, 1985). A quantitative study on the intergenerational transfer of knowledge from children to parents is given by Vaughan *et al.* (2003). Investigations into child acquisition of knowledge about scarlet macaws showed that post child attendance at a month long educational course, their parents averaged improved post-test scores on 38% of questions. A group of control parents whose children had not been enrolled on the course showed no improvement. A second post test conducted eight months later showed a 52% improvement of parent

scores. A brief discussion of three methods through which intergenerational influence is hypothesised to occur is offered here (adapted from Knafo & Galansky, 2008).

5.5.1 Methods by which children can influence their parents

Passive child influence:

An alteration of parental values associated with childbirth or the child entering new developmental stages. In an environmental context the effect of having a child on an adult could alter their future outlook, instigating a more considerate attitude to the environment and openness to ways of protecting the planet for their offspring.

Active child influence:

Children can have an effect on parental values through direct endeavour or by supplying parents with pertinent information, indirectly influencing parental opinions. Vaughn *et al.*, (2003) illustrate active child influence.

Reciprocal influences:

The complex integrated nature of intergenerational influence, with bidirectional transfer of knowledge and opinions, leads to the positive reinforcement of subjects and mutual learning which come under the umbrella of reciprocal learning (Kuczynski, Harach & Bernardini, 1999). For discussion on the reciprocal nature of intergenerational influence and the occurrence and impact of parent - child feedback loops see Whitchurch & Constantine, (1993).

It should be noted that there is a lack of analysis on the methods through which parents can influence children especially concerning environmental topics. A key challenge for studies aiming to investigate the occurrence of intergenerational knowledge transfer is determining the true direction of parent - child influence and isolating potentially confounding factors such as shared demographic characteristics associated with living semi-paired lives (Knafo & Galansky, 2008).

5.7 The Seychelles

5.7.1 Study location

The Republic of Seychelles is a Small Island Developing State (SIDS) of 115 islands comprising 43 steep sided, mountainous granite islands and 72 coralline islands located in the South Western Indian Ocean between latitudes 3' and 7' south and longitudes 45' and 56' east (WSSD, 2002) (Figure 3). The main island of Mahé comprises 148 square kilometres of the Seychelles' total land area of 455.3 square kilometres (WSSD, 2002) and is the location of the national capital, Victoria. Mahé is home to circa 90 percent of the nation's 82,800 inhabitants (UNDP, 2006)

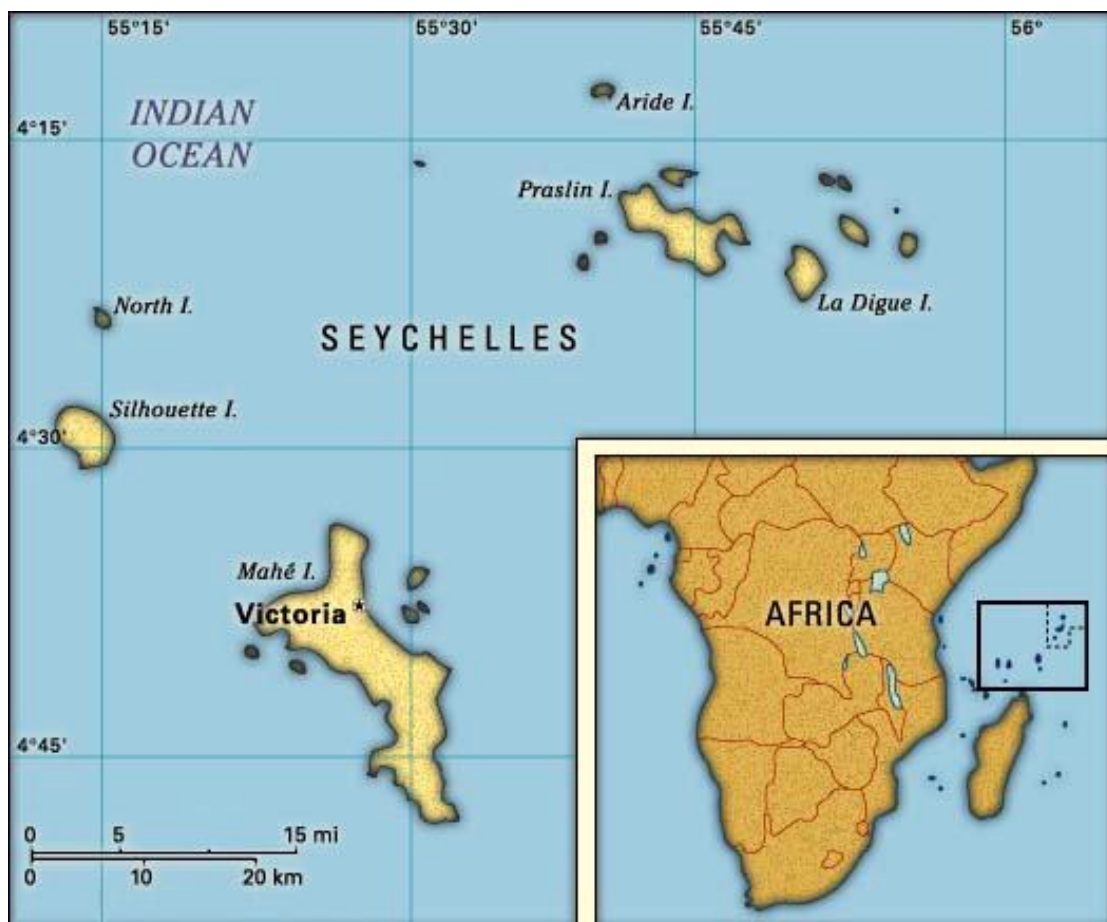


Figure 3: Global location of the inner Seychelles islands (Encyclopaedia Britannica, 1999)

Uninhabited until 1770, the islands of the Seychelles were a French then British colony until independence in 1976 (WSSD, 2002). The people of the Seychelles (Seychellois) originate from French settlers, freed African slaves, British sailors, and

traders from China, India and the Middle East (National Assessment +10 Review, 2004). There has been an additional recent influx of expatriate labour from Sri Lanka and South East Asia (UNDP, 2006). The Seychelles government is run as a multiparty democracy.

The Republic of Seychelles is a middle-income SIDS with an economy principally centred on the country's tourism industry and fisheries (UNDP, 2006). The importance of these two industries is reported in the National Assessment of the Barbados Programme of Action +10 Review and summarised here (Assessment +10 Review, 2004). An Exclusive Economic Zone of over 1.3 million kilometres allows the Seychelles to benefit from the exploitation and transshipment of a large fishery. Tuna is the principal catch with the Seychelles selling licences to fish its waters to an increasing Indian Ocean tuna fleet from Europe and the Far East. Tourism in the Seychelles accounts for approximately 20% of Gross Domestic Product (GDP) and 17% of employment. Limiting the number of tourist arrivals and aiming to maximise per capita visitor yield has made the Seychelles an exclusive, high end, destination. Like many SIDS the Seychelles faces economic constraints including a high susceptibility to external economic fluctuations, remoteness from major markets and the risks associated with environmental degradation (UNDP, 2006).

5.7.2 The Seychelles environment; its importance, threats and conservation

The Seychelles are remote from major land masses and have a small total land area (less than 1% of the Galapagos Islands). In accordance with biogeographical predictions the Seychelles have a low richness of terrestrial species but a high proportion of endemics (MacArthur & Wilson, 1967). Examples of island gigantism include the alibaba tortoise (*Geochelone gigantea*) that grows up to 400kg and the coco de mare palm (*Lodoicea maldivica*) with seeds up to 20kg which are found alongside the worlds' smallest frog *sooglossus gardineri* at just 1.2cm. More than 46 % of the Seychelles terrestrial habitat are protected as national parks and reserves (Assessment +10 Review, 2004), an additional 20-25% of land is listed as sensitive and may become protected in the near future (WSSD, 2002). 228 square kilometres of

ocean are legally protected in the form of six marine protected areas (Bijoux & Cedras, 2003). The Vallée de Mai Nature Reserve and Aldabra atoll were both named as UNESCO world heritage sites in the early 1980s (UNESCO 2002b).

Through the provision of a supporting resource base, biodiversity is an integral component to the tourism and fisheries industries which are of critical importance to the Seychellois economy. An economic assessment of Seychelles biodiversity use value (Murray and Henri, 2005) showed that a post independence development strategy led by the state has resulted in the Seychelles having the highest human development index of any African nation (50th in the world) (UNDP, 2005) and a reported inflation rate of 3.9%, GDP per capita of US\$8063 and a registered unemployment level equivalent to only 3.8% of the population (Murray and Henri, 2005). These impressive, although potentially inflated, figures are attributable to and dependent upon the nation's biodiversity (Murray and Henri, 2005).

Table 2: The monetary contributions of biodiversity to the Seychelles economy in 2003, adapted from Murray and Henri (2005)

Industry	Value (Million Rupees)	Percentage of total biodiversity value
Industrial and semi-industrial fishing	1118.6	46.8
Tourism	779.6	32.6
Other revenue from industrial tuna fishing	350.9	14.7
Agriculture and forestry	74.3	3.1
Artisanal fishing	59.8	2.5
Other plant and animal products	5.0	0.2
Total biodiversity value	2388.2	100

The economic evaluation undertaken by Murray and Henri (2005) (Table 2) only measures direct use values and as such must be seen as a serious underestimation of the true value of biodiversity to the Seychelles. Recent reductions in the number of

tourist arrivals of up to 15% (UNWTO, 2009) due to the recent global economic slowdown and a reduction in tuna landings due to the increasing range of Somali pirates (FFA, 2008) has had a strong detrimental effect the Seychelles economy. The cost of some basic commodities and consumer products has increased by 300-400% (Davies Roberts, pers. comm.). The current economic difficulties provide a small scale warning of the likely economic impact of environmental degradation.

The Seychelles' unique and economically valuable biodiversity is threatened by multiple drivers of biodiversity loss. Invasive species, especially rats (*rattus sp.*) and domestic cats are currently the single largest threat to most terrestrial species on the Seychelles (Merton *et al.*, 2002). Invasive trees and creepers also have a noted detrimental effect on forest habitats (Flieschman, 1997). Land is a valuable commodity on the Seychelles and development pressure has resulted in habitat clearance and a major land reclamation project on the east coast of Mahé adjacent to the Bai St. Anne marine national park (Finn, 1983). Global climate change is an overarching threat to Seychelles biodiversity; a review of the potential impacts of climate change to small island states is given by (IPCC, 2001). Coral reefs have been highlighted as particularly vulnerable to the effects of climate change (Hughes *et al.*, 2003), the vulnerability of the Seychelles coral habitats demonstrated by a serious mass bleaching even in 1998 (Spencer *et al.*, 2000). Illegal extractive use of biodiversity represents a threat to noted Seychelles species, especially in marine environments where it is seen as a sufficiently large threat as to be harmful to some artisanal fishing industries (Assessment +10 Review, 2004).

Freshwater habitats on the island have been identified as worthy of special conservation concern. Historically freshwater from streams and rivers was a vital commodity, the integrity of which was maintained by strict community control. Rules concerning the use of river water were enforced by nearby community members and the island's police force (Terrence Vel, pers. comm.). The creation of the Public Utilities Company and reservoirs on Mahé has made piped water readily available and reduced public dependence on streams and rivers. Community management of freshwater resources has collapsed as a result and litter, industrial pollution,

household waste water and the reclamation of wetlands have all become issues of concern. The loss of community management of freshwater resources may hint at a greater underlying threat to Seychelles biodiversity. Murray and Henri (2005) describe a society-wide underestimation of the value of Seychelles biodiversity. They note national pride in species but a cultural lack of awareness that the behaviour of individuals is as critical to environmental protection as the policies of government. This laissez-faire attitude towards personal responsibility is referred to as 'habitattitude' by Murray and Henri (2005) who note its relevance to the ways in which Seychellois interact with freshwater habitats.

The Seychelles is considered to have a strong tradition of environmental conservation, restoration and education. The constitution of the Republic of Seychelles, under article 38, provides the right to every person to live in and enjoy a clean, healthy and ecologically balanced environment in Seychelles. Working to achieve this constitutional right the Ministry of Environment is supported by the Liaison Unit of Non-Governmental Organisations Seychelles (LUNGOS). The Seychelles has achieved notable conservation successes particularly in the field of island restoration (Komdeur & Pels, 2005) and has pledged that by 2010 the Seychelles will be "firmly established globally as a committed leader in sustainable development" (MET, 2001). Environmental organisations working within the Seychelles have identified environmental education as a key component of their work towards achieving the ambitious aims laid out in the 2000-2010 Environmental Management Plan (EMP).

5.7.3 Environmental education on the Seychelles

Post-independence the Seychelles invested heavily in public services and education with the creation of free primary and secondary schooling. The Seychelles is continuing this trend of investing in education and now supports 34 primary and secondary schools, a polytechnic college and is a joint member of the University of the Indian Ocean. In 1990, after the publication of the Seychelles first EMP (MET, 1990), environmental education was integrated across the formal education

curriculum. This inclusion of EE beyond the traditional subjects of biology and geography allows the teaching and expression of EE to expand beyond written, formal learning and into music, songs, dance and practical activities which compliment the Creole culture (M. Martin, pers. comm.). Each school has an environmental educational resource person and actively takes part in national environmental events including the EcoSchool competition which assesses the commitment towards environmental protection of the entire school community, from cleaners to students to the head teacher.

An important component of EE in the school community is provided by WCS. WCS is a LUNGOS affiliated NGO that oversees the operation of an extracurricular wildlife club in every primary, secondary and post secondary institution. Wildlife clubs are utilised internationally as a method of providing children with environmental education which is not feasible in the school environment due to time or logistical constraints (Thomas & Thompson, 2004). The content of clubs activities is developed by club leaders and WCS to meet the individual circumstances and requirements of each wildlife club. An educational resource library covering topics highlighted as particularly suitable, such as school heritage gardens, or of particular environmental concern, such as wetland conservation is made available to all clubs. In addition to providing resources for children WCS supports club leaders through training designed to facilitate the running of club activities.

6. Method

6.1 Experimental design

Ferraro & Pattanayak, (2006) describe a counterfactual group, who represent the likely situation had a conservation intervention not taken place, as a requirement for analysis of the effect of a conservation intervention. Equally important is confirmation of the cause and effect relationship between the intervention and observed differences from the counterfactual scenario. The project's experimental design therefore addressed two key issues, selecting a suitable counterfactual population and the causality of knowledge acquisition in children and parents.

Data was collected from four population sub samples; a study group of children, a suitable counterfactual group and the parents of the two child sub-groupings. It was not appropriate to select as a counterfactual a group that had not attended WCS at all. Defining study and control groups in this manner would have introduced confounding factors related to the decision to attend WCS or not. For example parents with high environmental knowledge may encourage their children to attend WCS. Variation in subjects covered between wildlife clubs allowed for the selection of a study group who had undertaken work on a designated topic and a control group who had worked on alternative topics. Freshwater and mangrove systems, which are often jointly taught, were chosen as the unit of teaching to be investigated and are subsequently referred to as 'wetland systems' for the sake of clarity.

Determining the direction of influence is a key goal of any study on intergenerational knowledge transfer (Knafo & Galansky, 2008). For this study to achieve its objectives it was necessary to determine whether:

- High child knowledge of wetland systems was due to teaching at WCS
- High parent knowledge of wetland systems was due to knowledge transfer from children to parents or to confounding variables such as demographic or socio-economic factors.

Wetland systems were chosen as the knowledge unit because their threatened status has resulted in the subject being covered at several wildlife clubs. Wetland habitats are also a subject upon which Seychellois parents were considered likely to have relatively low baseline awareness due to a historically strong bias towards species conservation on the islands, especially endemic bird populations (Norris & McCulloch, 2003; Komdeur, 1994). The null hypothesis is therefore that the wetland knowledge of parents and students is relatively constant between wildlife clubs. Data on a large number of possible confounding factors which might influence parental and child wetland knowledge and behaviour (such as education level) were collected to ensure that these variables were accounted for when assessing the impact of EE on student and parent response variables.

6.2 Data collection

Fieldwork for data collection was carried out on the island of Mahé, Republic of Seychelles between the 2nd of May and 2nd of July 2009. fifteen wildlife clubs agreed to take part in the study, ten clubs associated with primary schools and five associated with secondary schools (Appendix 2). An initial meeting with each club was undertaken to introduce the concept of the study. Subsequently attempts were made to visit each club weekly to observe club activities first hand, build a rapport with students and gauge an acceptable level of complexity for aspects of the planned questionnaire survey instrument.

6.2.1. Semi-structured interviews

Semi-structured interviews were undertaken with all wildlife club leaders. This type of interview allows the subject to follow trains of thought novel and unexpected to the interviewer, while a predefined list of topics to be covered prevents omissions of important information (Millwood & Heath, 2000; Bernard, 2006). Multiple interviews with all club leaders were not possible. The assured coverage of key topics afforded by semi-structured interviews allowed critical knowledge gaps regarding clubs past,

current and future work to be documented prior to the finalisation of the experimental design. A holistic view of the differences between clubs in terms of the way they operated, their emphasis on structured education or informal activities and the extent to which the club was a stand alone entity or integrated into the wider school and village communities was achieved as respondents elaborated on the club they ran. An overview of wildlife club operations and the place of environmental education within the formal and informal education system were provided by regular informal discussions with Terrence Vel, WCS Co-ordinator and Jeanette Larue, Environmental Education Coordinator at the Ministry for Education

6.2.2 Survey instrument

Self administered questionnaires were used to collect data from the students and their parents. These enabled the collection of a larger dataset than could be achieved by a single researcher conducting face to face interviews in the studies time period (Bernard, 2006). Additional benefits of this survey technique include removing issues arising from variation in stimulus between respondents (Bernard, 2006). Reduced financial and time costs are notable in comparison to telephone and face to face interviews (Bourque & Fielder, 1995). Self-administered questionnaires are also more suited to the inclusion of questions with multiple response categories (Bernard, 2006). The need to collect paired data from parents and children, potential language barriers and the need to acquire a sufficiently large data set under tight time and cost restrictions made the use of a self-administered parent and student questionnaires a logical survey technique. In addition to discussed benefits self-administered questionnaires have a set of disadvantages which must be circumvented or accounted for. The issue of literacy was not deemed significant as the Seychelles has a high literacy rate off 91.8% (Appleton & Teal, 1998). Low response rates are a recognised problem with self administered questionnaires (Squire 1988; Heberlein & Baumgartner, 1978). Response rates were maximised by following the “total design method” (Dillman 1978, 1983; Salant and Dilliman 1994) Notable steps included....

1. Professional appearance: Questionnaires were word processed, printed, photocopied and individually signed. Delivery of the questionnaires was made in envelopes bearing the Imperial College London Logo, (Fox *et al.*,1988) note university sponsorship is a highly influential mechanism of increasing response rate.
2. Question order followed recommendations that, opening question should be non-threatening, easy and related to the subject of the study. Potentially threatening socio-demographic questions (sudman & bradburn, 1982) were placed at the end of the parent questionnaire.
3. A prize draw was organised for students who returned completed questionnaires. A prize of 500 Seychelles Rupees (SR) was made available for the winning child and a further 500 SR for their wildlife club. The prize structure provided a stimulus for both children and club leaders to ensure the return of completed questionnaires.

Two questionnaires were designed to measure multiple aspects of wetland knowledge, attitudes, behaviour and demographic characteristics; one questionnaire was designed for wildlife club students and a second for their parents. An English language version of the questionnaire was used for the adult sample and a Creole translation of the student questionnaire was produced for primary school students in addition to the English language version distributed to secondary school participants, reproductions of the parent and student English language questionnaires are in Appendix 3. Translations were conducted by Mrs Bibi at Plaisance Secondary School and back translations, to confirm translation accuracy were conducted by at the ministry of Education. For an overview of back translation methodology see Brislin (1970) or Werner & Campbell (1970).

6.2.3 Question wording and format

Questionnaire wording followed fifteen recommended rules from Bernard (2006) and was independently checked for violations which could impede the ability of the survey instrument to collect viable data. Using closed-ended questions within a questionnaire efficiently provides desired factual information whilst open-ended questions allow respondents to expand on their answers, potentially highlighting information that the questionnaire designer would not have thought to include in a list of fixed options. Both closed and open-ended questions in the survey instrument were included for reasons analogous to those for undertaking semi-structured interviews; ensuring the required data is present and acquiring a broader overview of subject areas.

6.3 Pilot study

Self-administered questionnaires rely on the respondent being able to grasp the meaning and desired response method of every questionnaire in the study (Baker, 1994). A pilot study was conducted at Dolphin (Secondary) and Palourd (Primary) Wildlife Clubs. A total of 24 students were sampled to allow an assessment of the suitability and answerability of all three questionnaires. No issues with the survey instrument were reported to myself or club leaders and analysis of the pilot study data did not reveal any potential problems. An unchanged questionnaire was administered to the remaining 13 wildlife clubs between the 12th and 26th June.

6.4 Sampling methodology

161 questionnaires were handed out to students in classes P5 and P6 in primary schools and S1-S3 in secondary schools, representing an age range of 8 to 15. Children in classes S4 and S5 were excluded from the survey because of limited wildlife club attendance arising from academic commitments. Students below eight years of age were considered to require an alternative, less complex survey instrument. The age range selected therefore maximise the number of respondents whilst minimising

variation in the sample population. All of the students at a club which met the age criteria were sampled; the number of students sampled per club is shown in Appendix 2. Non-probability sampling of a clubs entire intake was necessary to ensure sufficient samples giving an acceptable level of precision (Bernard, 2006). In addition to their own questionnaire students were given an adult questionnaire to take home for a parent to fill out. Written instructions, in an appropriate language, detailing the purpose and procedure for filling out the questionnaire were included and wildlife club leaders orally delivered the same instructions prior to handing out the questionnaires.

6.5 Statistical analysis

The main processes involved in the analysis of collected data are outlined in Figure 4.

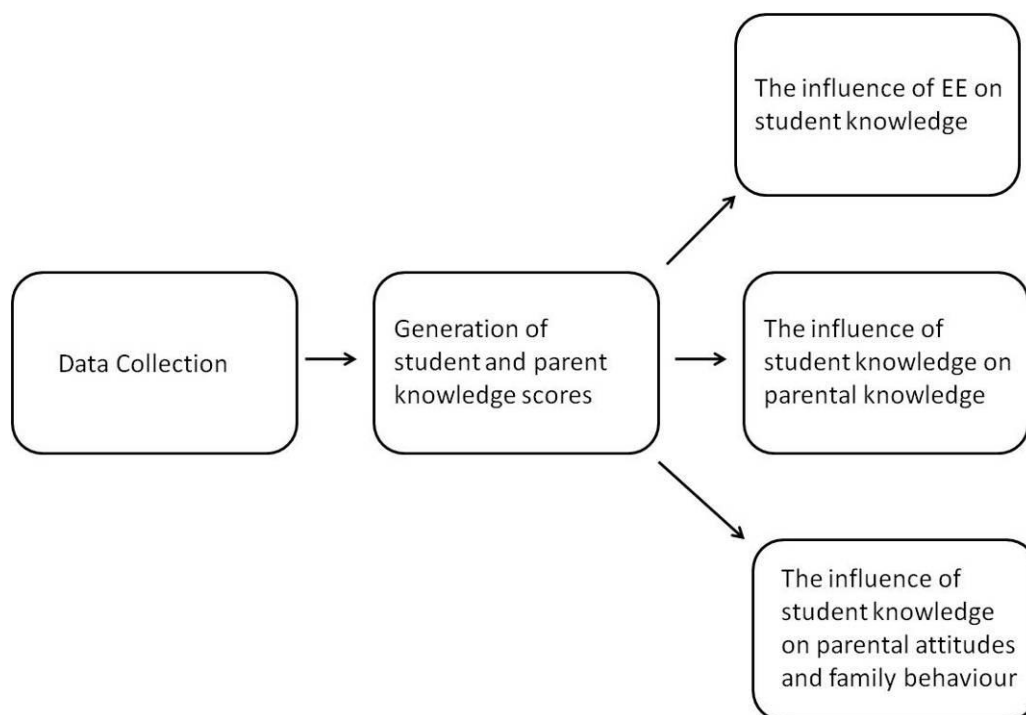


Figure 4: Flow diagram outlining the main sections of the data analysis.

6.5.1 Principal Component Analysis

Principal component analysis (PCA) is used to reduce the dimensionality of a group of subject measures by producing a series of principal components (PC), linear combination of optimally-weighted observed variables (Stevens, 1986). PCs are generated by partitioning the sum of the variances of the original variables. The first PC generated (PC 1) has the largest possible Eigen value (explains the largest possible amount of variance in the initial data set) (Morison 1967). The second PC generated (PC 2) explains the largest amount of the remaining variance whilst being orthogonal to PC 1 (Fowler & Cohen, 1995) a process also known as mathematical maximation procedure (Stevens, 1986). The process continues until as many PCs have been created as there were original variables. The aim of PCA is to produce a few PCs which explain sufficient variance for the dimensionality of the original data set to be effectively reduced whilst maximising retention of the existing variance (Jolliffe, 1986). Searching for variable redundancy in this way means that, if successful, generated PCs that pass suitability criteria (outlined below) can be used as criterion values in subsequent statistical tests (Morrison, Marcot & Mannan, 1992).

Five questions were used to assess the wetland knowledge of questionnaire respondents (Table 3). For simplicity and clarity questions will be referred to by a designated short name. For both parent and student PCA all five knowledge measures were equally weighted.

Table 3: survey questions used to measure the wetland knowledge of student and parent respondents.

Question short name	Question description and scoring
Species naming	<p>The ability to name wetland species; responses ranked as none, poor, average, good and very good. Scores were devised according to the number of different organisms named. Responses to the species level scored twice that of more general answers.</p> <p>Scores of 0 = None, 1–3= Poor, 4-6= Average, 7-9= Good, 10+ = Very good</p>
Institutions named	<p>The ability to name local organisations and institutions who conduct work on freshwater and brackish environments. Scores equalled the number of institutions correctly named.</p>
Aware of local river	<p>The ability to describe the location of the nearest river or stream to the respondent’s home. Subjects were asked to name the approximate distance to their nearest river. Those offering a response were deemed to be aware of a local river whilst those indicating their uncertainty by marking the box ‘I’m not sure’ were recorded as unaware</p>
Wetland naming	<p>The ability to name a river or stream, a wetland and a mangrove system on the island of Mahé. Respondents were scored from 0 (unable to name a single wetland system) to 3 (able to name one of each wetland type).</p>
Functions named	<p>The ability to name ecosystem functions provided by wetland and mangrove ecosystems. Respondents were asked to name up to three functions of wetland ecosystems and were scored according to the number correctly named.</p>

The suitability of generated PCs was assessed according to three commonly employed criteria (Stevens, 1986).

- 1 An Eigen value of one or more is observed; the component therefore accounts for more than the average proportion of information (the amount of variation contributed by a single variable) (Kaiser, 1960)
- 2 The PC has a Cronbach's alpha, a measure of an instrument's inter-item reliability, of sufficient magnitude for exploratory study. 0.6 is chosen as a suitable cut-off, following Nunnally (1967)
- 3 The PC has at least three variables with significant loadings

Generated principal components were used as criterion variables measuring wetland knowledge in subsequent analysis.

6.5.2 Univariate Analysis

Parametric and non-parametric univariate statistical tests were conducted as appropriate to investigate differences in the distributions of parent and student PCA generated knowledge measures between population sub-samples. Analysis was also conducted to investigate the influence of reported intergenerational discussions of environmental topics on adult knowledge scores.

Kruskal-Wallis rank sum test assessed variation in measured explanatory variables between sampled wildlife clubs. This enabled the need for the inclusion of the wildlife club attended as a random variable in subsequent models to be determined.

6.5.3 Tree models

Trees categorise a single response variable into mutually exclusive homogeneous groups using binary recursive partitioning defined by explanatory variables (Crawley, 2002). Homogeneous groups of individuals' response variable measures are characterised by the distribution (categorical response) or mean value (numeric response) of explanatory variables (De'ath & Fabricius, 2000). A frequent use of tree

models is for data exploration. Explanatory variables that do not appear in the model can be considered less predictive of a response variables variation. The exclusion of these variables from further statistical analysis is an efficient way of avoiding over-parameterisation of subsequent exploratory or predictive models (Venables & Ripley, 1999). Questionnaires distributed to students and parents collected data for twenty two unique explanatory variables; twenty one were analysed in tree models investigating determinants of PCA-generated parent knowledge measures and nine in tree models determining potential predictors of student knowledge measures. Variables highlighted as having a strong influence on the observed variation in parent and student knowledge measures were subsequently utilised in general linear models (GLMs) and when necessary mixed effects models.

6.5.4 General linear and mixed effects models

The dataset included variables showing non-normally distributed errors and irregular variance necessitating the use of GLMs rather than linear models. GLMs enabled the analysis of an explanatory variables effect on the response variable whilst considering other variables contained within the model. GLMs were used to highlight the explanatory variables that best defined PCA generated measures of wetland knowledge. Explanatory variables highlighted as influential by tree models and their second order interactions were included in a saturated model with an appropriate error structure (Crawley, 2007). Saturated models were fitted and their residuals examined for evidence of lack of fit. The models were then simplified to a minimal adequate model (MAM) by the stepwise deletion of least significant variables (Crawley, 2002). ANOVA tests between updated and preceding models were used to check that variable removal had a non-significant effect on the fit of the model (Crawley, 2007). GLMs for students' knowledge score were principally developed to analyse the influence of variables related to the undertaking of environmental education, specifically work associated with wetlands. Models for adult knowledge scores were principally concerned with investigating the influence of student knowledge and variables associated with the undertaking of wetland orientated environmental work by related children. Pseudoreplication resulting from the

sampling of multiple individuals from a single wildlife club was controlled for, according to need (6.5.2) by developing a linear mixed effects model fitted by restricted maximum likelihood estimation with 'wildlife club attended' as the random variable.

The following diagnostic plots were used to assess model fit:

- 1 Residual Vs. Fitted values plot: Produced to check for trending or heteroskedasticity in residuals, indicative of issues such as missing variables
- 2 Normal Q-Q plot: Used to evaluate normality of residual distribution
- 3 Scale location plot: to investigate the occurrence of patterns in the variance of residual values
- 4 Residual Vs. leverage plot: used to ensure that no values have an excessive leverage

6.5.5 Partial correlation Coefficients

Partial correlation coefficients show the strength of a relationship between two variables whilst controlling for the presence of additional explanatory variables (Crawley, 2002) making them highly suitable for investigating the strength of correlation between a response variable and an individual explanatory variable of interest shown to be significant by a MAM.

Partial correlations were calculated as follows.

- 1 A MAM for the response variable of interest was fitted (Model X)
- 2 The residual deviance was calculated by fitting the intercept on its own (Model Y)
- 3 A third model (Model Z) was generated by removing the variable of interest from Model Y
- 4 An ANOVA between model X, model Y and Model Z was used to obtain the necessary partial deviance.
- 5 $\sqrt{(\text{partial deviance} \div \text{residual deviance})}$ gives the appropriate partial correlation coefficient.

6.5.6 Measures of environmental attitudes and behaviour

Attitude towards wetlands were measured on a counts scale of 0-4 according to the number of threats to wetlands systems respondents highlighted as being environmental threats the Seychelles government should prioritise (question 6 in the students questionnaire, Appendix 3; question 7 in the adult questionnaire, Appendix 4). GLMs for parent and student were fitted with a Poisson error structure due to the count nature of the response variable.

The measure of behaviour chosen addresses the pertinent issues of water shortages on the Seychelles (Payet & Agricole, 2006). The measure analysed families' choice between undertaking comparable behaviours with a high and low water cost, for example taking a bath or having a shower. The measure was adapted from a commonly used water budgeting project for school children which features as an exercise in the materials made available, by WCS, for club leaders working on wetland subjects. Behaviours were scored +1: water conscious and -1: high water cost. Total family scores were calculated after parents selected from 16 possible behaviours. The local suitability of the measure is tempered by its reliance on reported behaviour. There are commonly recognised issues with using reported behaviour (Bernard, 2006), applicable to this behavioural measure is the tendency for people to underreport socially undesirable behaviours, for a detailed review of the reliability of reported behaviour see DeMaio, (1984). Behaviour scores exhibited a normal distribution (Figure 5) and were fitted to a GLM with Gaussian errors.

Distribution of family water use scores

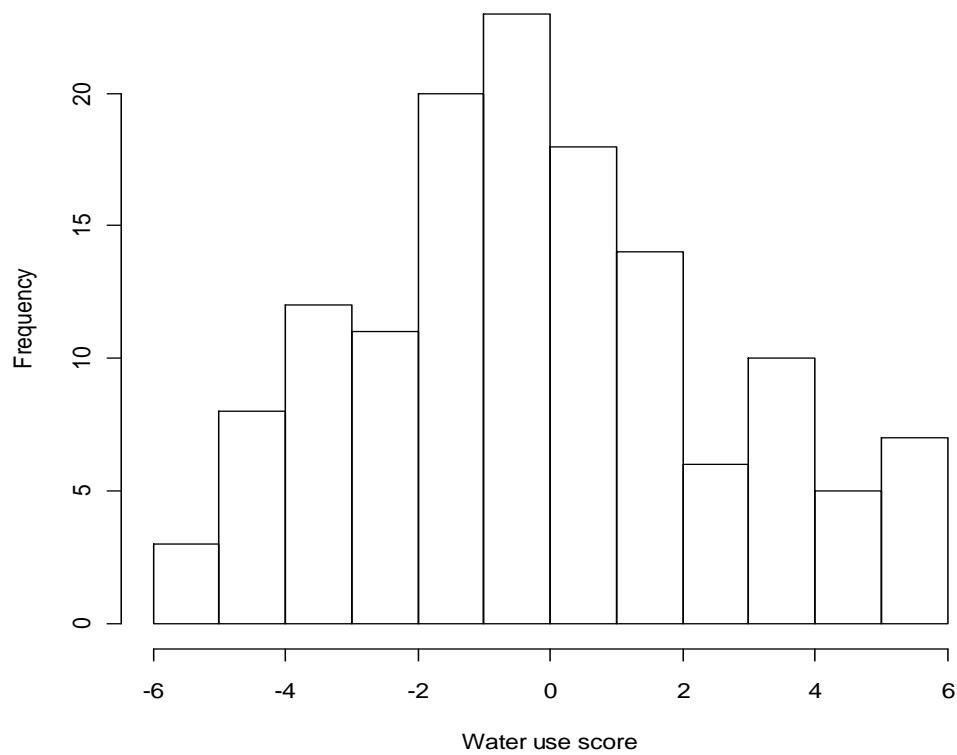


Figure 5: The distribution of family water uses behavioural scores across the sampled population.

Data analysis was conducted with Microsoft Excel, SPSS Ver. 17.0.2 (PASW) and R ver. 2.8.1 (R Development Core Team, 2009)

7. Results

7.1 Observations on club structure

Semi-structured interviews with wildlife club staff and observations of clubs activities revealed considerable variation in the way wildlife clubs operated. Club leaders typically took up the running of clubs with limited ecological experience and had been in charge of their respective clubs for time periods ranging from six months to upwards of seven years. All clubs combined academic, formal learning, with hands on practical activities, however there was variation in the emphasis clubs placed on different learning styles. Some clubs were run with a strong focus on ecological facts such as species identification and environmental threats whilst others were observed to have a less academic style and emphasised the teaching of concepts through games and practical activities, such as recycling through the use of recycled materials to create arts and crafts. Variation in student attendance was also seen with some clubs observed to have highly fluctuating numbers of participants whilst others operated a strict absence policy. All wildlife clubs had a strong presence in their associated schools; more established clubs were seen to have an influence that extended further into the wider community. A conscious attempt was made to address measurable inter-club variation highlighted by the semi-structured interviews in the questionnaire survey instrument.

Semi-structured interviews and past club action plans revealed seven wildlife clubs that had undertaken work on freshwater or mangrove ecosystems in the past 12 months; five primary and two secondary, these clubs formed one population sub-sample with those clubs which had not undertaken wetland work making up the second sub-sample. 85% of the distributed questionnaires were returned with sufficient information for the generation of directly comparable knowledge scores for both parents and student.

7.2 Generating knowledge scores for student and their parents

7.2.1 Student's Knowledge scores

A correlation matrix (Table 4) was produced to illustrate associations between variables measuring student knowledge and ensure the absence of strong multicollinearity. Correlations were not sufficiently high to justify the exclusion of a knowledge measure from the PCA. Weak yet consistent correlations between four of the initial knowledge measures indicate potential variable redundancy.

Table 4: Linear correlations between the five student's wetland knowledge measures.

	Species naming	Institutions named	Aware of local river?	Wetland naming	Functions named
Species naming	1.000				
Institutions named	0.338	1.000			
Aware of local river?	0.074	0.167	1.000		
Wetland naming	0.345	0.320	0.069	1.000	
Functions named	0.232	0.387	0.190	0.334	1.000

An initial PCA investigated all five principal components. PC 1 and 2 were the only components that explained substantial quantities of variance within the initial dataset. A second PCA requesting these two principal components was used to make decisions about the viability of PC 1 and PC 2 as measures of student knowledge. Table 5 illustrates the explanatory power, reliability and loadings of each component.

Table 5: Descriptive measures and component loadings of student PC 1 and PC 2

Principal Component	Cronbach's Alpha	Variance Accounted For		Component loadings				
		Total Eigen value	Percentage of Variance	Species naming	Institutions named	Aware of local river?	Wetland naming	Functions named
1	0.641	2.053	41.05	0.659	0.730	0.327	0.697	0.703
2	-0.004	0.997	19.93	-0.347	0.045	0.873	-0.292	0.163
Total	0.840 ^a	3.049	60.98					

a. Total Cronbach's Alpha is based on the total Eigen value.

PC 1 passes the three suitability criteria. PC 2 explains sufficient variance for its suitability to be investigated further; however the loadings show that PC 2 is principally a measure of a single explanatory variable 'Awareness of local river'. PC2 is also observed to have an unacceptably low Cronbach's alpha.

The biplot of individual students PC 1 and PC2 scores clearly illustrates that PC 2 is principally a measure of an individual component (Figure 6). Children with average scores for the 4 initial knowledge measures described by PC1 have scores of around zero whilst those with above or below average knowledge have correspondingly large positive or negative PC 1 scores.

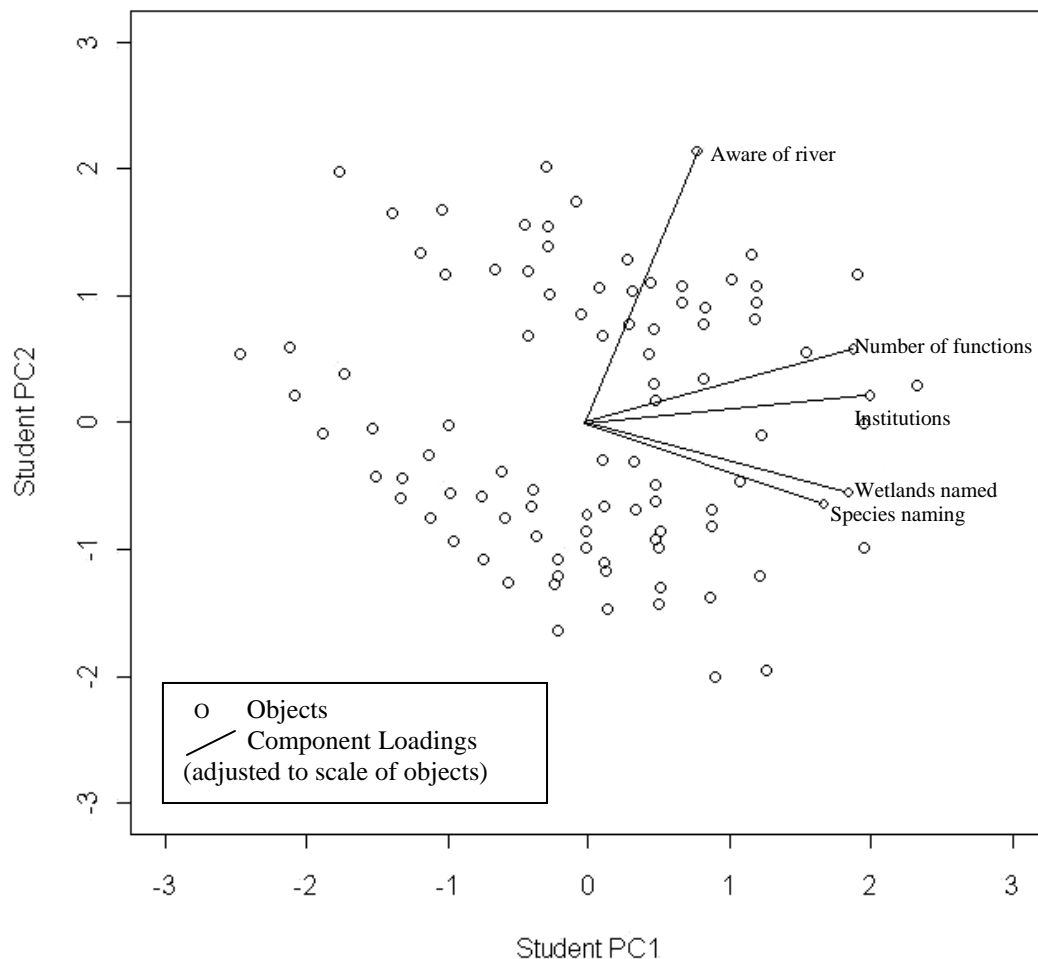


Figure 6: Bi-plot illustrating the distribution of individual students PC 1 and PC 2 scores and the influence of component loadings.

The single variable nature of PC 2 and the satisfactory explanation of remaining, marginally influential components by PC 1 make it possible to discard the less informative PC 2 as a knowledge measure. In further analysis, individual students' PC 2 values are replaced with the initial knowledge measure; ability to describe the location of the nearest river or stream to the respondent's home. Awareness of river shows some correlated to PC 1, with a component loading of 0.37 (Table 4).

7.2.2 Parents' knowledge scores

The same PCA process was repeated for parents' responses to the same five wetland knowledge measures. A high similarity was observed throughout the PCA analysis. Correlations between initial knowledge measures were stronger than for children but still insufficient to justify exclusion on the grounds of multicollinearity (Table 6). Awareness of a local river was again correlated less with the other knowledge measures.

Table 6: Linear correlations between the five adult wetland knowledge measures

	Species naming	Institutions named	Aware of local river	Wetland naming	Functions named
Species naming	1.000				
Institutions named	0.498	1.000			
Aware of local river	0.185	0.263	1.000		
Wetland naming	0.459	0.435	0.214	1.000	
Functions named	0.429	0.456	0.230	0.376	1.000

An initial inspection of all five adult PC values showed only Parent PC 1 and PC 2 explaining sufficient variance in the initial dataset to warrant further analysis.

The properties of parent PC 1 and PC 2 are akin to that of those seen for student PC 1 and PC 2; parent PC 1 has a strong Cronbach's Alpha, high Eigen value and explains a high portion of the variance (Table 7). Whilst parent PC 1 explains a higher percentage of variance than was seen in the children's PCA, parent PC 2 is slightly weaker in all

descriptive properties when compared to the children’s analysis; its Cronbach's Alpha score is again unacceptably weak.

Table 7: Descriptive measures and component loadings of adult PC 1 and PC 2

Principal Component	Cronbach's Alpha	Variance Accounted For		Component loadings				
		Total Eigen value	Percentage of Variance	Species naming	Institutions named	Aware of local river?	Wetland naming	Functions named
1	0.751	2.505	50.11	0.788	0.724	0.468	0.738	0.771
2	-0.203	0.860	17.20	-0.195	-0.091	0.878	-0.196	-0.061
Total	0.879 ^a	3.365	67.31					

a. Total Cronbach's Alpha is based on the total Eigen value.

The component loadings of parent PC 1 and PC 2 (Table 7) are analogous to those produced by the students PCA. The replacement of parent PC 2 with the original knowledge measure; ‘aware of river’ is again sanctioned by the variable’s disproportionately large influence on parent PC 2 scores (Figure 7). The apparent pattern of two parallel lines in the distribution of parent PC scores in figure 7 is a by-product of the binomial nature of the knowledge measure ‘awareness of local river’ which influences PC2 scores so strongly.

Crucially for investigations into the intergenerational transfer of knowledge, student and parent PC 1 scores measures the same construct comprising of four initial measures of factual wetland knowledge and PC 1 is subsequently referred to as ‘knowledge score’. Aside from the simplicity of conceptualisation and naming, the fact that parent and student knowledge score are comprised of fundamentally similar loadings allows for direct comparison between individual parent and student knowledge measures, ‘awareness of local river’ is also comparable between generations.

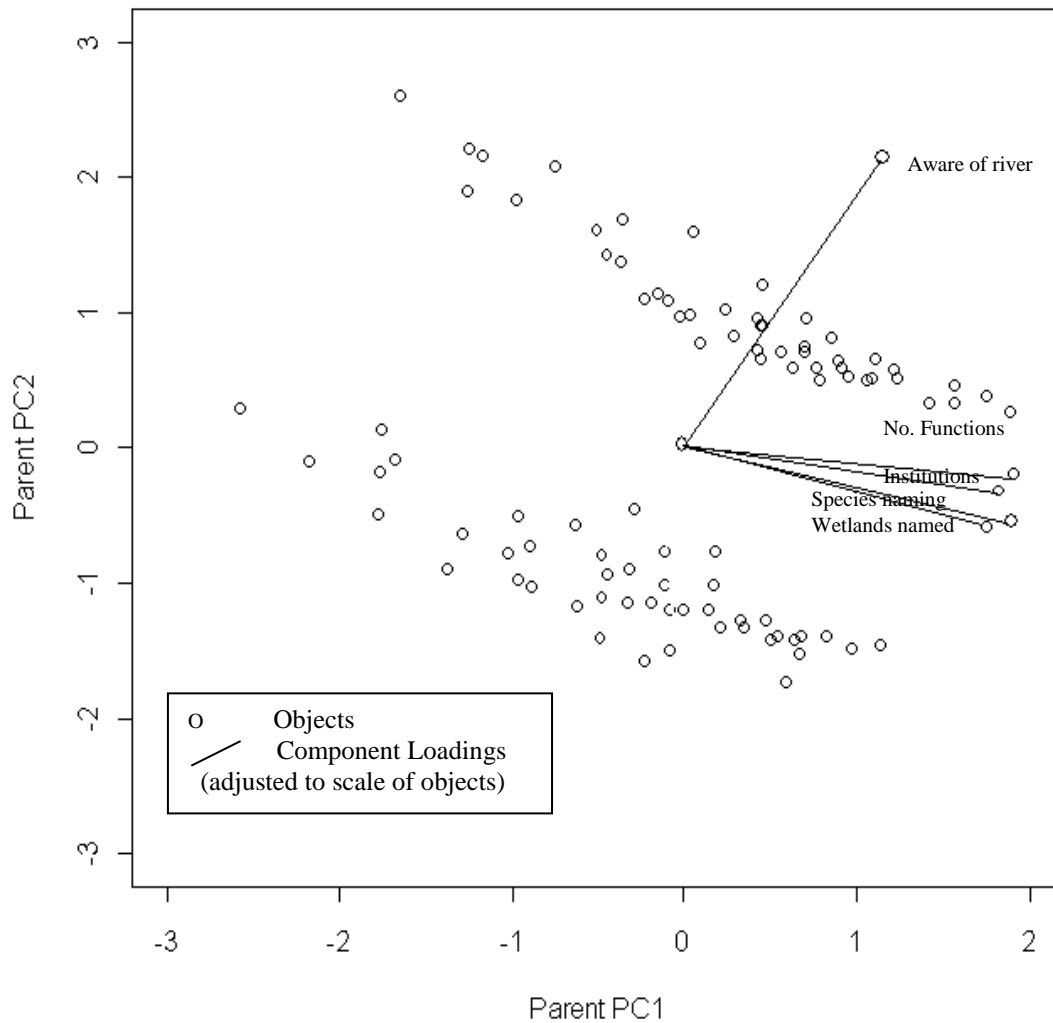


Figure 7: Bi-plot illustrating the distribution of individual parents PC 1 and PC 2 scores and the influence of component loadings.

7.3 Univariate statistics

7.3.1 Knowledge score distributions

For the entire student sample, knowledge scores show a normal distribution around zero, a majority of the 137 students are not aware of the location of their local river. Student knowledge scores show differences in their magnitude and variance between sub-samples (Figure 8). A one tailed, two sample Students T-test confirms that individuals who have carried out wetland work have significantly higher knowledge scores than those who have not ($t = 4.144$, $df = 134.7$, $p = 2.99e-05$). Pearson's Chi-squared test with Yates' continuity correction shows no significant difference

between the proportions of the two sub-samples who were aware of their local ($\chi^2 = 0.595$, $df = 1$, $p = 0.440$).

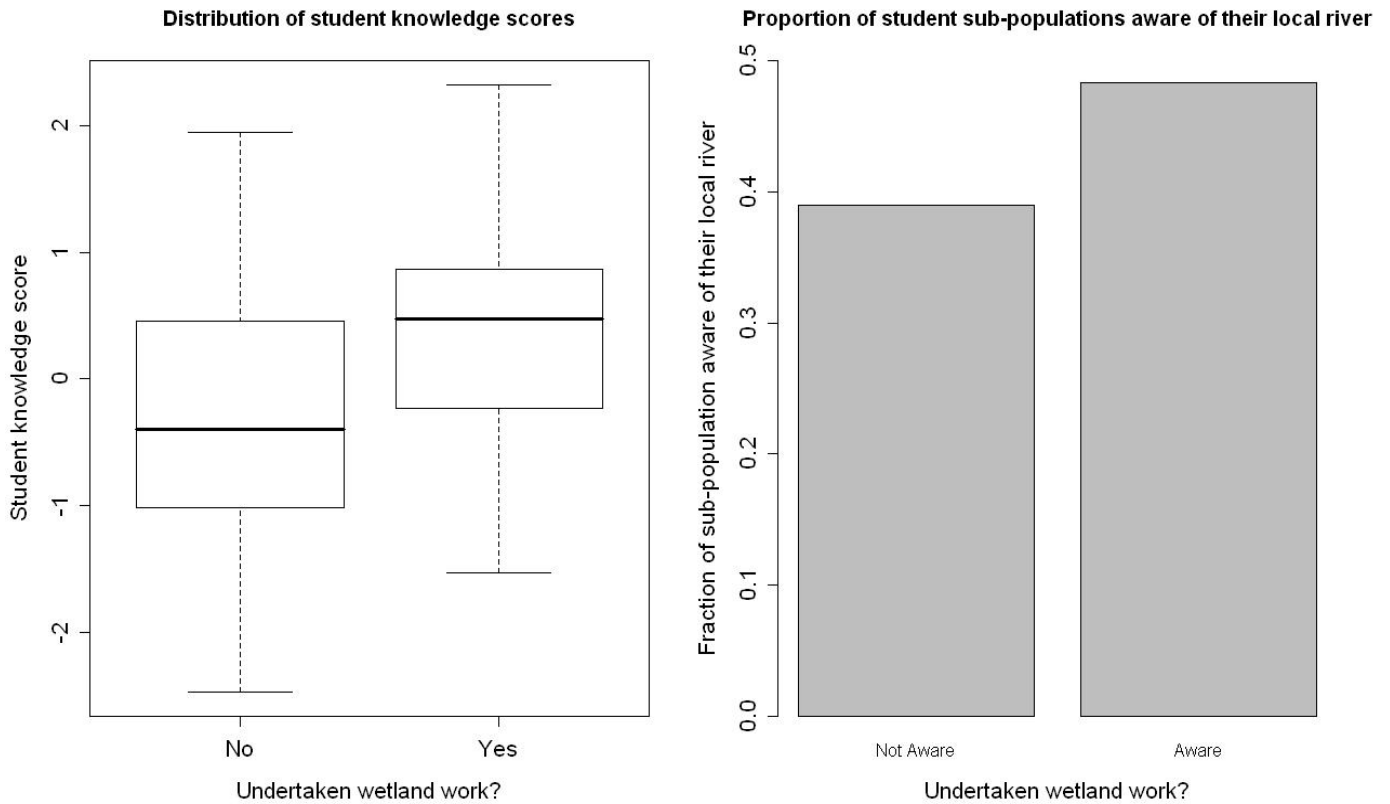


Figure 8: The distribution of student knowledge scores and the proportions of individuals aware of their local rivers location per sample sub-set.

For the adult sample, knowledge scores show a skewed distribution with a tail extending into lower knowledge scores than seen in the student sample. The number of adults aware and unaware of their local river is almost equal (Figure 9).

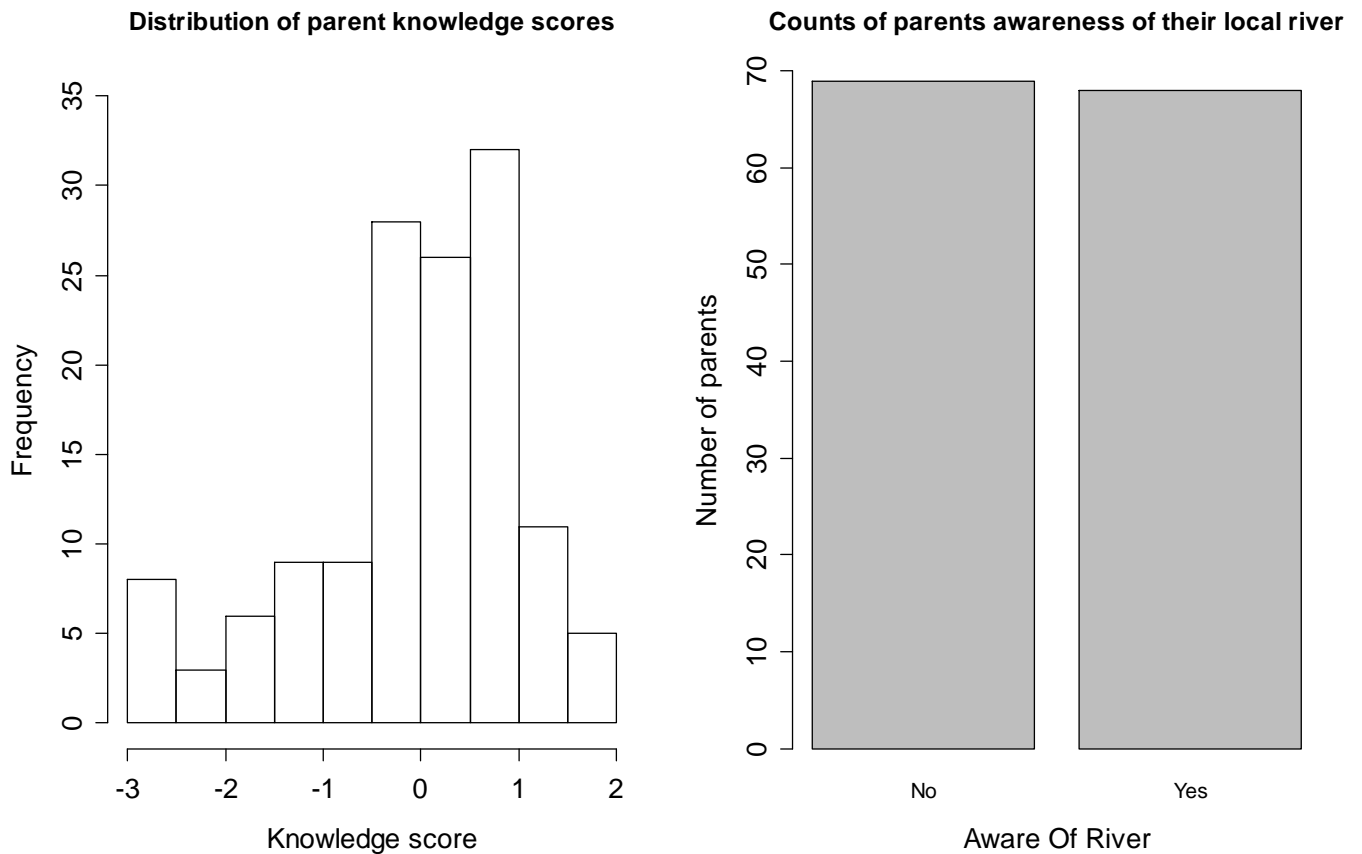


Figure 9: Distribution of parent knowledge scores and counts of individuals' awareness of their local river

The distribution of parent knowledge scores in the two sub-samples (Figure 10) is similar to that seen for students. A one tailed, Wilcoxon rank sum test with continuity correction shows parents of children who have undertaken wetland work have higher knowledge scores ($W = 2905.5$, $n = 137$, $p = 0.0049$) and a noticeably smaller variation in knowledge score. Pearson's Chi-squared test with Yates' continuity correction shows no significant difference in adults' river awareness between sub-samples ($\chi^2 = 0.1947$, $df = 1$, $p = 0.6591$)

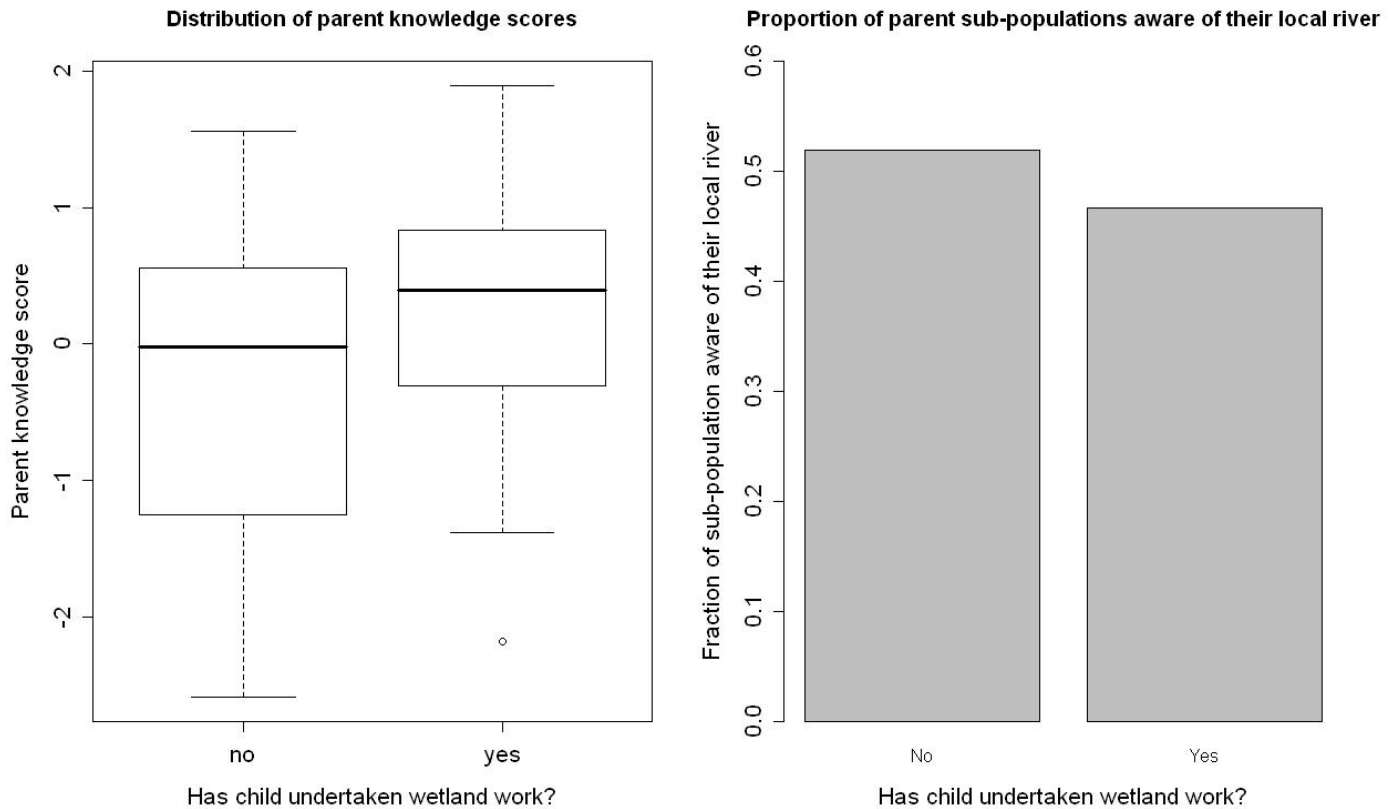


Figure 10: the distribution of parent PC1 scores and the proportions of individuals aware of their local rivers location per sample sub-set.

Both student and parental knowledge scores are significantly higher when wetland work has been undertaken, however there is no difference in the proportions of people aware of their local river between those who have or have not undertaken wetland work. This is suggestive of wetland EE dependence for the formal wetland knowledge score and a lack of association between wetland EE and local knowledge of the surroundings

7.3.2 Variation in explanatory variables between wildlife clubs

Kruskal-Wallis rank sum tests show three explanatory variables with significant variation between clubs; the additive time attending WCS for all of a parent's children (Kruskal-Wallis $X^2 = 29.85$, $df = 14$, $p = 0.0079$), whether students report telling their parents about environmental work (Kruskal-Wallis $X^2 = 38.48$, $df = 14$, $p = 0.0004$) and the number of years the parent has lived in their current community (Kruskal-Wallis

$\chi^2 = 26.29$, $df = 14$, $p = 0.024$; Figure 11). Mixed effects models accounting for the pseudoreplication generated by sampling multiple students from a single wildlife club were therefore used when any of the variables exhibiting significant variation were found to be significant predictors.

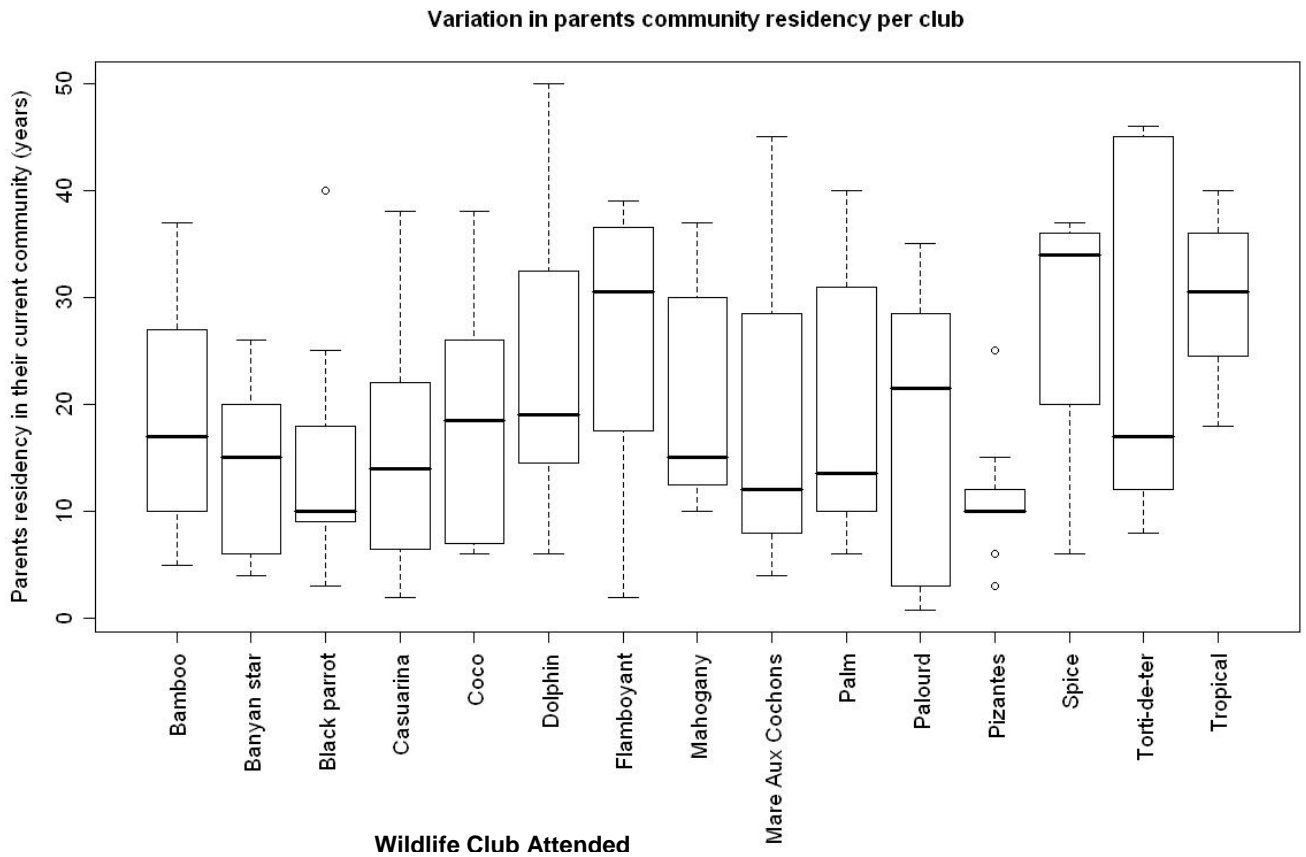


Figure 11: Inter-club variation in parents' community residency time.

7.3.3 Reported knowledge sharing behaviours

Parents who reported that their children talked about environment work had significantly higher knowledge scores (Figure 12); one tailed Wilcoxon rank sum test with continuity correction ($W = 2055.5$, $n = 137$, $p = 0.0024$).

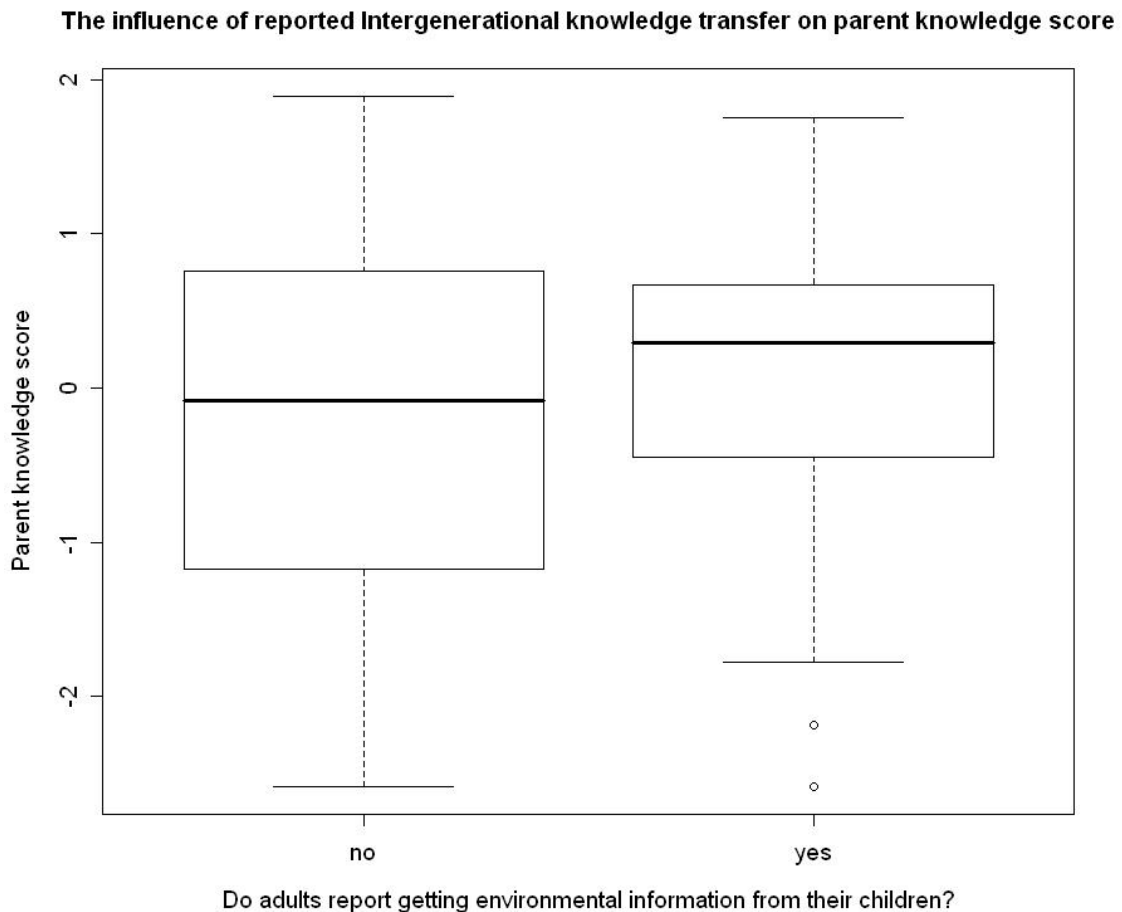


Figure 12: Parent knowledge scores grouped according to reported intergenerational discussion of environmental work undertaken at school and Wildlife Club Seychelles

Contrastingly there was no significant difference between knowledge scores of adults that reported getting environmental information from their children and those that did not (Figure 13). Welch Two Sample t-test ($t = 1.208$, $df = 89.18$, $p = 0.230$).

The influence of parent and child discussions on parent knowledge score

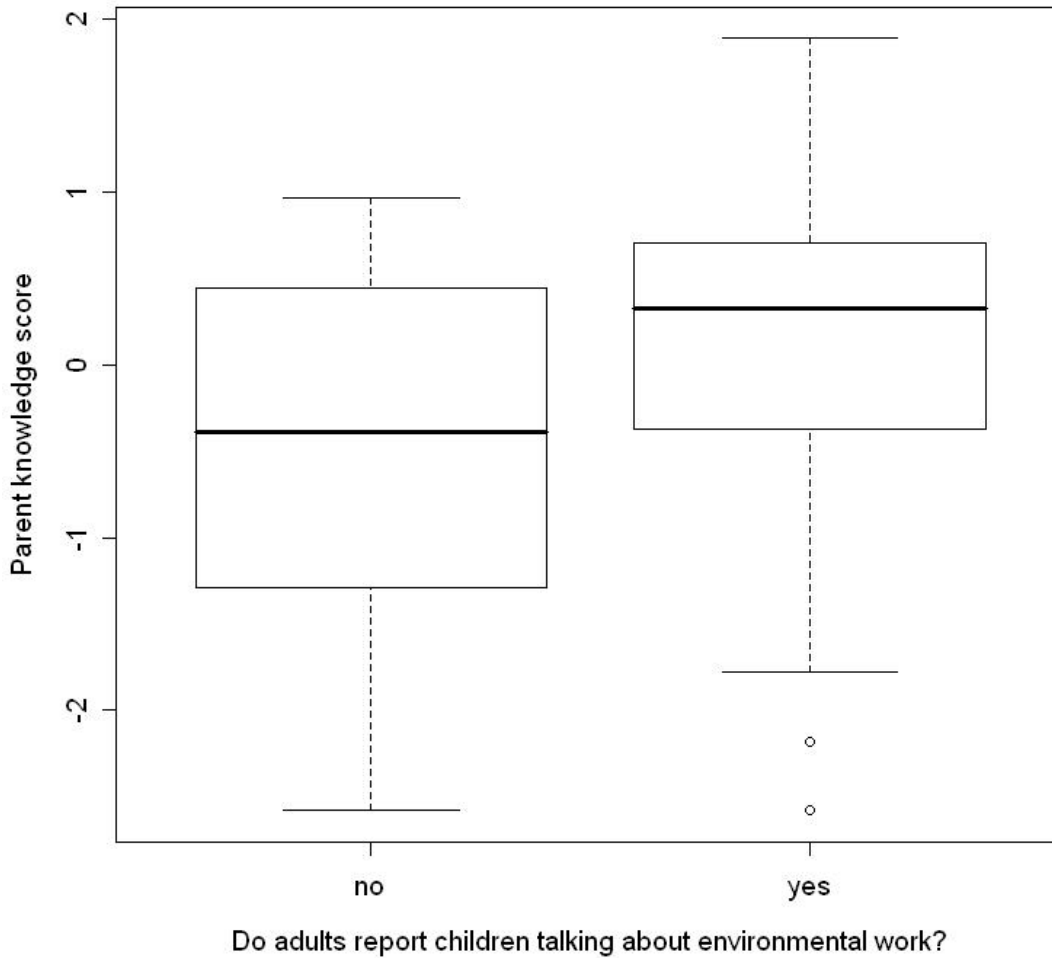


Figure 13: Parent knowledge scores grouped according to the presence or absence of intergenerational knowledge acquisition.

7.4 Predictors of knowledge scores

7.4.1 Student knowledge scores

Three variables that were shown by univariate analyses to be influential in defining student knowledge score ('awareness of river'; $S = 291639.9$, $n = 137$, $p = 0.0001$), 'undertaken wetland work'; ($S = 287414.2$, $n = 137$, $p = 8.517e-05$) and 'time attending Wildlife Club Seychelles'; ($S = 280614.2$, $n = 137$, $p = 3.613e-05$) were also found to be highly influential in a regression tree model for student knowledge score (Figure 14). The tree model readout for the model presented in figure 14 is located in appendix 4.

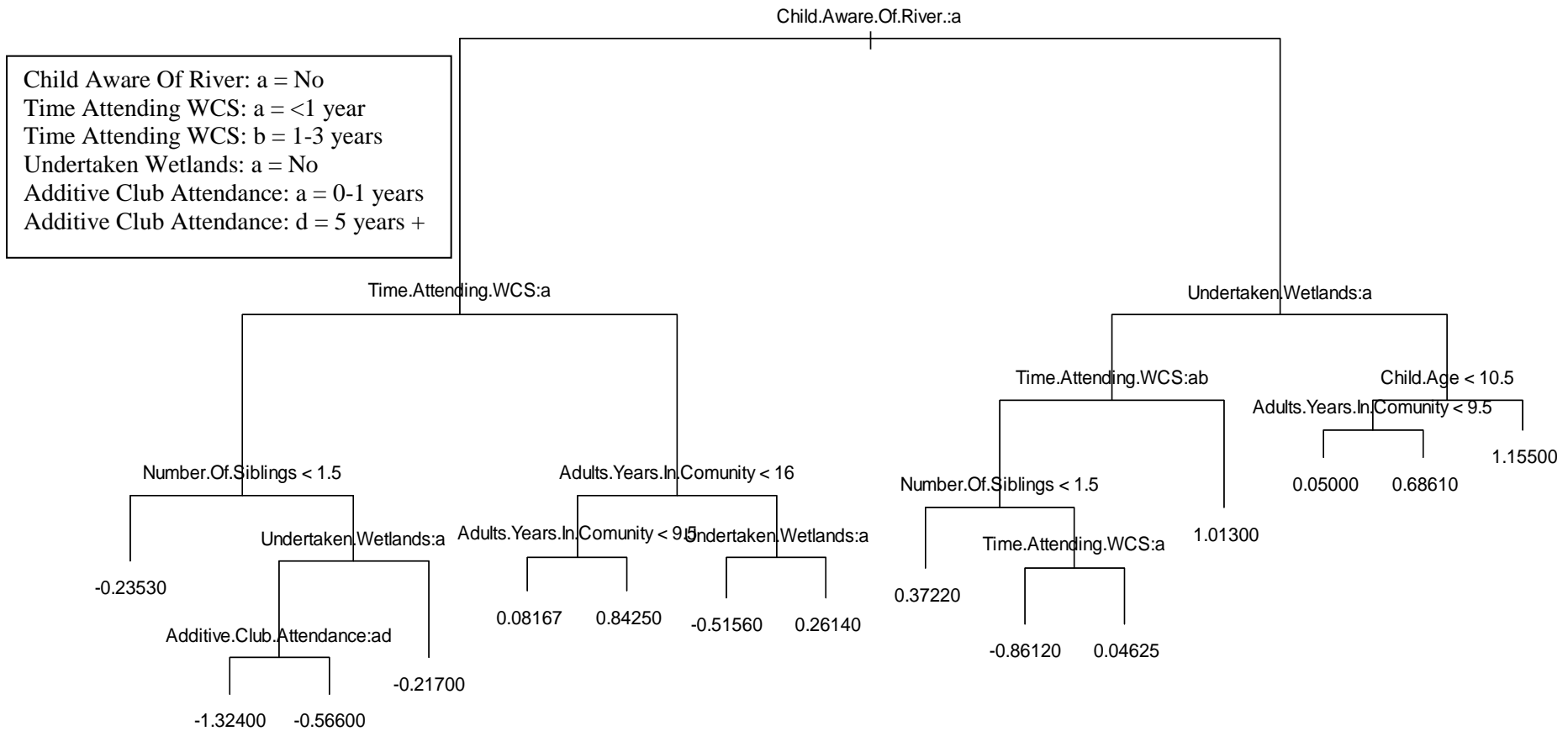


Figure 14: Student knowledge score regression tree. Terminal nodes showing above average knowledge scores (>0) are principally associated with student awareness of their local river, attending WCS for more than 1 year and undertaking wetland work

The seven explanatory variables highlighted by the tree model and their first order interactions were included in a general linear model with Gaussian errors to determine the explanatory variables that best define student knowledge score. The MAM contains three highly significant explanatory variables. For the sampled student population, being aware of the local river, undertaking wetland work and attending WCS for progressively longer periods increase knowledge scores (Table 8).

Table 8: The minimum adequate model for student 'wetland knowledge score', using a generalised linear model with a Gaussian error structure.

Coefficients:	Estimate	Std. Error	T value	Pr(> t)
(Intercept)	-0.7916	0.1252	-6.323	3.67e-09 ***
Undertaken Wetlands Yes	0.5989	0.1446	4.143	6.09e-05 ***
Student Aware Of River yes	0.5660	0.1466	3.861	0.0001 ***
Time Attending WCS1 - 3 years	0.5511	0.1563	3.526	0.0006 ***
Time Attending WCS 3 years +	0.9041	0.2539	3.561	0.0006 ***

Significance codes: P < 0.001 = '***' 0.001 ≤ P < 0.01 = '**' 0.01 ≤ P < 0.05 = '*' 0.05 ≤ P < 0.1 = '.'

Partial correlation coefficients for undertaken wetland work = 0.298 and time attending WCS = 0.326 can be said to explain approximately a third of the unique variance in student knowledge scores.

Student awareness of river

Having seen the influence of undertaking wetland work on child knowledge score a model was developed to see if a similar pattern is evident for students' awareness of their local river. A classification tree (with a categorical response variable) was produced based on six explanatory variables. Terminal nodes indicating students are aware of their local river were typically defined by high student knowledge scores and parents reporting they are aware of their local river.

A GLM with binomial errors produced a MAM with two significant explanatory variables; parental awareness of local river and student knowledge score (Table 9).

Students are more likely to be aware of the local river when they have good wetland knowledge and parents who are aware of their local river's location.

Table 9: The minimum adequate model for student awareness of their local river, using a generalised linear model with a Binary error structure.

Coefficients:	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	-0.9871	0.2855	3.457	0.0005 ***
Parent Aware Of River Yes	1.3805	0.3898	3.542	0.0004 ***
Student Knowledge Score	0.7887	0.2170	3.634	0.0003 ***

7.4.2 Parent knowledge score

To provide evidence for the occurrence of intergenerational knowledge transfer models were developed to determine the predictors of parental wetland knowledge and awareness of their local river.

A regression tree model with nine explanatory variables was used to partition the response variable, parental knowledge score, which indicated that above average scores were principally defined by high student knowledge scores. A GLM with Gaussian errors showed student knowledge scores as the most significant explanatory variable with adult river awareness, high additive child attendance at WCS and the interaction between these two factors also influencing parental knowledge scores (Table 10). Student knowledge score shows a strong positive relationship with parental knowledge score and explains half of the response variables variance (partial correlation coefficient = 0.500).

Table 10: The minimum adequate model for parental ‘wetland knowledge scores’, using a generalised linear model with a Gaussian error structure.

Coefficients:	Estimate	Std. Error	T value	Pr(> t)
(Intercept)	-0.2964	0.1446	-2.051	0.0423 ***
Parent Aware Of River Yes	0.5213	0.2194	2.375	0.0190 *
Student Knowledge Score	0.5644	0.0687	8.215	2.01e-13 ***
Additive Attendance 1- 3 Years	-0.1752	0.2197	-0.798	0.4265
Additive Attendance 3 - 5 Years	-0.6568	0.2744	-2.393	0.0182 *
Additive Attendance 5 Years +	-0.5586	0.3095	-1.805	0.0734.
Parent Aware Of River Yes : Additive Attendance 1- 3 Years	0.2842	0.3077	-0.924	0.3575
Parent Aware Of River Yes : Additive Attendance 3 - 5 Years	0.8904	0.4453	1.999	0.0477 *
Parent Aware Of River Yes : Additive Attendance 5 Years +	1.2474	0.4254	2.932	0.004 **

The additive Wildlife Club attendance of a parent’s offspring was one of the variables shown to vary significantly between sampled Wildlife Clubs (sect 7.3.2). A mixed effect model with the wildlife club attended as a random variable was constructed, but the additional variance explained was inconsequential (1.1195e-10). As a result the GLM illustrated in table 10 is preferred.

A second GLM was produced for parental knowledge score which excluded the explanatory variable ‘student knowledge score’. It was believed that the presence of this variable may be masking the expression of variables which could provide further evidence for the occurrence or absence of directional intergenerational knowledge transfer, specifically ‘undertaken wetland work’ and ‘time attending WCS’, both of which were shown to strongly influence student knowledge scores (Table 8). The removal of student knowledge scores from the analysis resulted in the creation of a more complex but more informative MAM (Table 11).

Table 11: The minimum adequate model for Parental 'wetland knowledge scores' excluding the explanatory variable 'Student knowledge score', using a generalised linear model with a Gaussian error structure

Coefficients:	Estimate	Std. Error	T value	Pr(> t)
(Intercept)	-1.5799	0.2440	6.476	2.17e-09***
Adult Aware Of River Yes	1.2289	0.1857	6.616	1.08e-09***
Undertaken Wetland Work Yes	1.0343	0.1988	5.202	8.25e-07***
Adult Education Higher Education	0.8474	0.2424	3.496	0.0007***
Adult Education Post Secondary	0.5307	0.1763	3.011	0.003**
Additive Attendance 1- 3 Years	0.2005	0.1938	1.035	0.3029
Additive Attendance 3 - 5 Years	0.5118	0.2623	1.951	0.0534.
Additive Attendance 5 Years +	1.0353	0.3599	2.876	0.0048**
How Often Attend Most Meetings	0.4587	0.2860	1.604	0.1114
How Often Attend Rarely Go	-0.5742	0.3176	-1.808	0.0731.
Adults Aware Of River Yes : Undertaken Wetland Work Yes	-0.7862	0.2762	-2.847	0.0052**
Additive Attendance 1-3 Years : How Often Attend Most Meetings	-0.7123	0.4056	-1.756	0.0817
AdditiveAttendance3-5 Years : How Often Attend Most Meetings	-1.9324	0.6894	-2.803	0.0059**
AdditiveAttendance5 Years +:How Often Attend Most Meetings	-0.9344	0.5068	-1.844	0.0677.
AdditiveAttendance1-3 Years : How Often Attend Rarely Go	0.5733	0.4735	1.211	0.2284
AdditiveAttendance3-5 Years : How Often Attend Rarely Go	-0.3620	0.8898	-0.407	0.6848
AdditiveAttendance5 Years +:How Often Attend Rarely	-1.7531	0.6503	-2.696	0.0080**

The presence of student knowledge score as an explanatory variable masked the highly significant positive effect that high levels of adult education, having a child that has undertaken wetland work at Wildlife Club Seychelles and having children with a high additive wildlife club attendance can have on parental PC1 scores.

The model shows the interaction between high additive attendance and infrequent presence at WCS is more negatively associated with parent knowledge than the baseline interaction of an additive attendance of 0-1 years and attending every

meeting. A second interaction; additive attendance of 3-5 years and attendance of most meetings, also has a significantly negative relationship with parent knowledge scores. These two interactions demonstrate the influence of attendance frequency on parental knowledge scores.

Parental awareness of their local river

Variables associated with student knowledge and knowledge acquisition have been shown to be influential in defining adult wetland knowledge. Models were developed to see variables such as undertaking wetland work and high levels of additive attendance are as influential on parent awareness of their local river. A classification tree model shows that river awareness is principally categorised by parental knowledge score. The MAM fitted with binomial errors shows three significant explanatory variables of which parental knowledge score is the most strongly influential factor (Table 12).

Table 12: The minimum adequate model for Parental awareness of their local river, using a generalised linear model with a Binomial error structure

Coefficients:	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	-0.698	0.2881	-2.422	0.0155 *
Parent Knowledge Score	1.848	0.3774	4.898	9.67e-07 ***
Student Aware Of River yes	1.609	0.4578	3.514	0.00045 ***
Student Knowledge Score	-1.003	0.3105	-3.229	0.00125 **

The partial correlation coefficient between student knowledge score and adults awareness of river is 0.2579438, showing a weaker relationship than that seen for student knowledge score and parent knowledge score. Additionally, student knowledge is seen to have a negative effect on parental awareness of the local river. This unexpected relationship prompted the development of a second model for parental river awareness excluding the variable student's knowledge score to investigate whether variables suggestive of directional knowledge transfer were

being masked by its presence. The MAM (Table 13) contained no new explanatory variables and a higher Akaike Information Criterion value (149.45 compared to 138.81). The model illustrated in table 9 is therefore preferred as a tool for explaining the factors which predict parental awareness of their local river.

Table 13: The minimum adequate model for Parental awareness of their local river with the explanatory variable ‘Student knowledge score’ excluded, using a generalised linear model with a Binomial error structure

Coefficients:	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	-0.5260	0.2660	-1.977	0.0480 *
Adult Knowledge Score	1.1864	0.2577	4.604	4.14e-06 ***
Student Aware Of River Yes	1.1995	0.4158	2.885	0.0039 **

7.5 Attitudes towards wetlands and family water use behaviour

Having investigated the influences of EE on both student and parent knowledge scores, three further GLMs were developed to determine the influence of knowledge measures on attitudes and behaviours.

7.5.1 Wetland attitudes

A regression tree model for students’ attitude to wetlands produced a complex output utilising eight explanatory variables. The number of years that parents had spent in a community and student knowledge scores explained the largest variance within the dataset. No relationships between explanatory variables and terminal nodes with high or low attitude scores were discernable. A GLM with Poisson errors was unable to identify any explanatory variables with a significant relationship to student wetland attitudes.

Inspection of the regression tree produced for adult wetland attitudes shows three variables explaining the majority of variation in the response variable. High parent knowledge scores, positive student attitudes and children discussing environmental work are all associated with root nodes containing elevated parental attitudes.

The interaction between parent knowledge scores and parents who reported that their children talked about environmental work is the only significant variable described by the MAM of a GLM with Poisson errors (Table 14). The influence of student attitude on parental attitude approaches the 0.05 significance level. Given the relatively small sample size in the study, the variable was retained in the model to allow a broad appraisal of the factors influencing adult attitudes towards the environment.

Table 14: The minimum adequate model for Parental attitudes towards wetlands, using a generalised linear model with a Poisson error structure

Coefficients:	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	-0.3807	0.2827	-1.346	0.1782
Parent Knowledge Score	0.2594	0.2051	1.265	0.2059
Student Attitude	0.2079	0.1092	1.905	0.0568.
Parents Report Kids discuss the Environment Yes	0.1612	0.2316	0.696	0.4865
Parent Knowledge Score : Adults Report Kids discuss the Environment Yes	-0.4991	0.2196	-2.273	0.0230 *

Student attitudes has a positive influence on parental attitudes, the partial correlation coefficient is calculated as 0.2092995. Student attitude can therefore be said to explain a small but noteworthy portion of the variance in parent wetland attitudes.

7.5.2 Family water use

To complete the analysis the influence of knowledge and attitudes on behaviour was undertaken. A regression tree model shows student knowledge scores to be the most important variable for explaining variance in family water use behaviour with positive student attitudes towards wetlands also associated with terminal nodes featuring water conscious actions. A GLM with Gaussian errors shows five significant explanatory factors and factor interactions (Table 15).

Table 15: The preferred model for family water use behaviour, using a generalised linear model with a Gaussian error structure

Coefficients:	Estimate	Std. Error	T value	Pr(> t)
(Intercept)	-1.4652	2.1631	-0.677	0.49941
How Many Kids	0.6301	0.3064	-2.056	0.04185*
Undertaken Wetland Yes	2.3060	0.7420	3.108	0.00233**
Student Gender Girl	-4.4069	1.6134	-2.731	0.00721**
Parent Age 26 - 35	3.8282	1.9659	1.947	0.05372.
Parent Age 36 - 45	3.1493	1.9496	1.615	0.10873
Parent Age 46 - 55	3.9245	2.0465	1.918	0.05741.
Student Attitude	-0.5923	0.5513	-1.074	0.28468
How Many Kids : Student Gender Girl	1.0826	0.3774	2.869	0.00483**
Undertaken Wetland Yes : Student Gender Girl	-2.2987	0.9631	-2.387	0.01849*
Student Gender Girl : Student Attitude	1.2630	0.6606	1.912	0.05814.

Given the small sample size in the study, a precautionary attitude was taken to further simplification of the model. The model shows very high measures of deviance (Null deviance: 1067.9 on 136 degrees of freedom, Residual deviance: 1002.7 on 133 degrees of freedom) suggestive of a poor overall fit. However the diagnostic plots for the model suggested that there were no problems with model specification, enabling preliminary conclusions about the factors which influence family water use behaviour to be drawn. The most significant variable defining water use behaviour is whether students have undertaken wetland work. Studying wetland topics shows a highly significant positive influence on water use behaviour, the explanatory variable explaining approximately a quarter of the variation observed in family behaviours, partial correlation coefficient = 0.2521214. Explanation of a notable portion of variance in a families behaviour scores by a variable shown to have a strong influence on student knowledge and parent knowledge is of considerable interest.

8. Discussion

In this chapter, the capacity of the observed results to answer the objectives is discussed prior to examining the implications of the observations on environmental educational on the Seychelles and more widely. The limitations of this study are critically examined with a view to assessing the robustness of the projects findings and making recommendations for further work around the subjects investigated.

8.1 The generated knowledge scores

For both students and parents 'wetland knowledge scores' were significantly higher for groups who had undertaken or had a child who had undertaken wetland work, whilst awareness of a local river showed no significant difference (Figure 8 & Figure 10). This information substantiates initial interpretations of the two knowledge measures which suggested that wetland knowledge score is a measure of taught knowledge whilst river awareness is more akin to 'folk knowledge'. Comparing the factors which contribute to wetland knowledge scores with those that predict river awareness enables firmer conclusions to be drawn about the role of EE in knowledge acquisition and knowledge transfer.

Observed correlations between wetland knowledge score and awareness of river reflect a relationship between awareness and factual knowledge as demonstrated on the Comoros where factual knowledge concerning fruit bats followed awareness raising (Trehwella *et al.*, 2005). Feedback loops between becoming aware of a habitat and acquiring factual information are predicted rather than a causal relationship, as a result wetland knowledge score and aware of river are expected to be associated throughout the analysis.

8.2 Aim 1: The influence of environmental education on student knowledge

This study has produced evidence to suggest that the environmental knowledge of learners is positively influenced by environmental education. Statistically higher wetland knowledge scores are seen for pupils who have undertaken wetland work, even when other explanatory variables are taken into account. Calculation of the partial correlation coefficient shows that attending WCS wetland modules explains approximately half of the variation seen in student knowledge scores. This finding that EE increases environmental knowledge supports the findings of Vaughn *et al.* (2003) and provides a new quantitative assessment of environmental education's capacity to influence learners' knowledge, noted by Bride (2006) as rare within the literature.

The significant positive effect on knowledge of attending WCS for progressively longer time periods (irrespective of whether wetland work has been undertaken in the last 12 months) can be interpreted as providing additional evidence that wetland based EE at WCS results in improved knowledge. The longer a pupil attends WCS the more likely they are to have experienced wetland work, which may have been before the 12 months considered in this study. An alternative explanation is that students who attend WCS for longer periods are demonstrating a commitment to the club as the result of a deep interest and genuine enjoyment of the natural world. Enthusiastic students engage more strongly with subjects covered and are shown to learn and recall more information (Turner & Meyer, 1999). Such an interpretation is supported by personal observations of a particularly enthusiastic secondary school student who, in addition to attending his school's wildlife club, would also return to his old primary school wildlife club to take part in activities and assist the club leader.

The final factor found to significantly predict higher student knowledge scores is student awareness of rivers. The predicted endogenous relationship between variables is likely to be enhanced in this study because the teaching of wetland topics frequently involves visits to local rivers (pers. obs.). An additional

interpretation for children who are aware of their local river having a higher knowledge score is based on studies that show practical; hands on interactions outside of the school environment enhances learning (Kusmawan, Reynolds & O'Toole 2006; Crater & Megs 1981; Aird & Tomera 1977).

Comparing the influence of EE related explanatory variables on students' knowledge scores and awareness of river, a knowledge measure which conceptually does not require specialist teaching, can be used to provide further evidence for the causality of undertaking wetland EE and elevated 'wetland knowledge scores'. Awareness of a local river, in contrast to knowledge score, shows no significant difference between students who have and have not undertaken wetland work. No evidence is found to suggest that student awareness of their local river is influenced by EE. A lack of association between river awareness and education is important to note. The equal awareness of both student groups shows that children who have not undertaken work on wetland habitats are not devoid of all wetland awareness or experience but it is only by undertaking EE that specific factual information is acquired and retained. This finding that actively taught EE is a successful technique in achieving elevated environmental knowledge in children agrees with findings by Blum (1987) that education is a major source of environmental knowledge for children.

Analysing the factors which define the two wetland knowledge scores enables this study to conclude that for the sample population the undertaking of EE has significantly improved students' factual knowledge of the topics covered.

8.3 Aim 2: Do parents learn from their children?

The results presented in this study provide evidence for the transfer of environmental knowledge from child to parent. Parents who have children that have undertaken wetland work were observed to have significantly higher wetland knowledge scores. Evidence that this observation is due to knowledge transfer is provided by the statistical analyses. Parents that reported having children who discussed environmental work with them exhibited significantly higher 'wetland

knowledge scores' than those who did not. This finding conflicts with the absence of a significant difference in 'wetland knowledge scores' between parents who reported learning about environmental issues from their children and those that did not. A probable explanation for this contrast is that some parents are unaware that the discussions they have with their children improve their own environmental knowledge. Many studies which investigate child influence on parents rely on adult reporting of the phenomena (Dillon, 2002; Hagestad, 1984; Peters, 1985). If adults are unaware of knowledge transfer from children then the capacity of investigations into child-parent influence that rely on parental reporting must be questioned.

The use of quantitative measures of adult knowledge in addition to parental reports of child influence allows further investigations into the occurrence of child-parent knowledge transfer. When potential explanatory variables for adult knowledge score are looked at alongside each other, student knowledge is seen to be the most significant predictor. This initial evidence for education based student knowledge affecting parental wetland knowledge scores is corroborated by the result that longer attendance at WCS is also a predictor of increased parental knowledge.

Further evidence for knowledge transfer occurring from child to parent is elicited by removing student knowledge from the model in order to explore the influence of other, confounded variables. In this model, the child undertaking wetland work is a highly significant predictor of parent knowledge score (Table 11), confirming the initial univariate test (Figure 8). Extended periods of time attending WCS are also shown to have a significant positive effect on parental knowledge score; however, the categories reflecting a longer time attending are also seen to feature in two significant interactions which negatively influence parental knowledge. Interpretation of the interactions between time attending and the frequency with which a pupil attends WCS shows the importance of children attending every meeting if they are to influence parental knowledge. The author is not aware of published studies that support the notion that a child frequently undertaking an activity is necessary for intergenerational influence to occur, however evidence that a single or infrequently conducted school based environmental activity has a small chance of influencing parents is presented by Ballantyne, Fien and Packer, (2001). An

alternative explanation is that children attend infrequently because of a lower commitment to the club and environmental activities in general. Children who are not enamoured with the work they are undertaking are less likely to talk about work they have done or activities they have experienced with family members (Ballantyne, Fien and Packer, 2001). The remaining significant variable; parental level of education, has previously been shown to influence environmental behaviours including reduced deforestation of tropical old growth forest (Godoy & Contreas, 2001, Godoy et al., 1998).

As with the student sample, no significant differences are seen in the proportions of parents aware of the location of their nearest river. This again suggests that, unlike knowledge, parental awareness of their local environment is not due to EE undertaken at WCS. The model produced for the sampled population provides no directional evidence of knowledge transfer. Student awareness is a significant factor, as parental awareness was for the analysis of student river awareness, but the direction of influence cannot be determined. It is likely that across the population, the influence is reciprocal in nature with parents and children making the other generation aware of their local environment through shared activities and conversation (Musser & Diamond, 1999). Student knowledge shows an unexpectedly negative influence on parental awareness and was removed from the model in an effort to determine whether, as with the student sample, it was masking explanatory variables that are suggestive of directional knowledge transfer. This was found not to be the case. In a scenario analogous to that seen for students it is only factual knowledge measures, taught at WCS for which evidence for knowledge acquisition can be demonstrated. The difference for parents is that they are indirectly receiving the knowledge via their children.

By providing evidence of child to parent transfer of quantitatively assessed, education dependent knowledge scores, the results of this suggest that by focusing EE on children it is possible to also influence the knowledge of immediate family members.

8.4 Aim 3: Does transferred knowledge influence attitudes and behaviour?

8.4.1 Attitudes

The study fails to find evidence of any variables, including those measuring knowledge, reliably predicting student attitude. This unexpected result is most likely due to difficulties encountered with measuring attitudes. Initially four questions were designed with the intention of using PCA to generate an attitudinal score for parents and students. Unexpected comprehension problems amongst a large number of student and parent respondents that were not highlighted by the pilot study impacted three of the questions. The remaining attitudinal question is at best an incomplete measure of respondents' attitudes towards wetlands.

Potential issues with the attitude measure are highlighted in the adult model where only one significant explanatory interaction (between adult knowledge score and having a child that discusses environmental work), is found. The interaction causes a counter-intuitive decrease in parental attitudes. This trend may be due to increasing environmental awareness in parents resulting in individuals prioritising ecological threats such as climate change and invasive species that could justifiably be defined as having a greater severity of impact on the Seychelles environment. The inadequacy of the utilised knowledge measure makes drawing conclusions about the role of knowledge in predicting either generation's environmental attitudes a meaningless exercise.

Despite the inadequacy of the attitudinal measures, the model investigating adult attitude provides an interesting insight into the possibility of a positive interaction between parent and student attitudes. The calculation of a partial correlation coefficient reveals that student attitude explains about a quarter of the observed variation in parental attitudes. This non-significant but notable finding provides a preliminary indication that the intergenerational influence observed for knowledge may extend to attitudes also. It is important to note that the direction of influence cannot be determined from the collected data. Similarities between parent and child

political attitudes have been well explored in the literature (Jennings & Niemi, 1968; Tedin, 1974; Glass, Bengtson & Dunham, 1986) however environmental attitudes have not received the same attention. Qualitative studies describing parents reporting child-induced changes to their environmental attitudes are given by Dillon (2002) and Ballantyne, Fien & Packer, (2001). However the reliability and longevity of these reported attitude changes requires quantitative support before firm conclusions about the capacity of children to influence parental environmental attitudes can be drawn.

8.4.2 Family water use behaviour

Analysing the factors which predict a family's water use behaviour reveals notable results. For the first time in the study child gender is revealed as a significant factor. When the child respondent to the survey is female, water use behaviour is significantly less conservative than for male students. The strong significant effect of a female child respondent is seen both for the factor on its own and in an interaction with the child undertaking wetland work. Studies of the comparative water demands in between genders outside of humanitarian crisis and water borne disease scenarios are not prominent in the literature; however personal observation would suggest that as in many parts of the world girls on the Seychelles place a higher emphasis on cleanliness than boys. Whether these increased cleanliness demands result in families with a female offspring opting to employ behaviours which are more water intensive requires much more detailed ethnographic study than was possible within the constraints of this study. When seen in an interaction with larger family size, having a girl respondent does not detrimentally influence family water use behaviour, it enhances it. Families with a higher number of children may be more likely to employ a more conservative set of behaviours to reduce the financial costs of water use, again detailed ethnographic study is needed to confirm or disprove these theories based on causal observations and conversations with Seychellois families.

Most significantly for this study, when the student respondent has undertaken wetland work families exhibit more conservative water use behaviours. Evidence that environmental education can have a significant effect on family behaviour related to the taught subject disagrees with the findings of Hungerford & Volk (1990), Palmer (1995) and Palmer & Birch (2005), who all demonstrate that environmental knowledge alone is insufficient to generate favourable environmental behaviours. Findings that show EE can have an influence on family behaviour have implications for the way in which EE is approached.

8.5 Environmental education on the Seychelles

The main conclusion that should be taken from this study is that EE being conducted on the Seychelles is working. Children are learning about their environment and are passing this information on to their parents. Preliminary evidence that knowledge transferred from children to parent influences family household behaviour is also found. Suggestions for why education on the Seychelles is achieving its goals are offered alongside recommendations to maintain and improve the influence of EE on Seychellois children and parents.

8.5.1 Suggested reasons for the observed successes

There is evidence to suggest that practical and integrated environmental activities that take place outside the classroom enhance students learning (Kusmawan, Reynolds & O'Toole 2006; Crater & Megs 1981; Aird & Tomera 1977) and are more effective at instilling attitudes which recognise the intrinsic value of nature (Van der Born *et al.*, 2000). Club visits are integral features of activities at WCS, varying from investigations of mangroves within the school grounds to whole day trips to Cousin Island Special Reserve. Club visits enable children to have direct experiences of nature and act as a major draw for children joining WCS. Van der Born (2000) shows that intense and direct experience of natural environments as a child are important in shaping future attitudes towards the natural world . It is also likely that by undertaking exciting and practical activities, children are more likely to discuss EE

with their parents than when activities are based around uninspiring writing tasks. By talking about the experience of undertaking a glass bottom boat ride or having a picture frame made of recycled materials to take home, a child brings their parents into direct contact with the education they themselves have experienced, facilitating active child influence on their parents. The study of intergenerational transfer of knowledge concerning scarlet macaws in Costa Rica presented by Vaughn *et al.* (2003) provides an option for further increasing student-parent discussion and the influence of environmental topics on parent behaviour in the Seychelles. Vaughn *et al.* (2003) describe a very impressive rate of knowledge improvement amongst parents which is catalysed by the shared parent-child completion of homework assignments comprising of colouring books and questions on aspects of macaw biology and conservation. By increasing parental involvement with WCS through homework or active participation in club activities, it may be possible to increase yet further the extent to which child-orientated wildlife clubs are influencing the knowledge of decision making adults on the Seychelles.

EE on the Seychelles is frequently placed in a reward structure. Individual prizes for essays, poems and songs may motivate pupils to work hard on specific pieces of work. Reward systems have a long history of success in encouraging environmental behaviours especially recycling. Hamad, Cooper & Semb (1977) showed that rewards were better at inducing newspaper recycling by primary school pupils than verbal instruction. Similarly lotteries have been shown to be effective ways of encouraging students to recycle, increasing paper recycling by 80% (Geller, Chaffee & Ingram 1975) and 13% (Diamond & Loewy 1991). For a discussion of the relationship between goals approach and intrinsic motivation see Heyman & Dweck (2005). The true strength of the reward systems in place on the Seychelles is that they extend to everyone involved with EE within the school community. Wildlife Clubs contribute to a schools yearly performance in the EcoSchools competition and prizes are sufficient to motivate staff, assistants and students alike.

8.5.2 Recommendations for environmental education on the Seychelles

A notable finding of the study is that despite the large age range of sampled students (7-15), no effect of age was seen on student knowledge scores. This would suggest that time spent in the formal school system does not affect students' wetland knowledge. This finding that the formal education system, despite its notable inclusion of environmental topics across subjects (Martin pers. comm.), is not providing students with knowledge on this specific topic and it is only by attending WCS that this knowledge is acquired. This finding should encourage WCS to expand the number of students attending Wildlife Club in order ensure that as many of the young Seychellois as possible benefit from the proven positive effects of attending WCS. If expansion of club intake is not feasible because of logistical constraints then the formal education system should be encouraged to learn from the successes being achieved by WCS.

Clubs should also aim to have their students continue attending the club for as long a time as possible. Attendance at WCS for over a year was shown to positively influence students' knowledge, suggesting that the policy of some schools to encourage students to rotate the extra curricular activities that they are involved with on a yearly basis could be hampering the ability of students to build the connections and associations between facets of environmental topics which assist the acquisition and retention of knowledge.

Approximately half of the students on the Seychelles are unaware of the location of their nearest river irrespective of the involvement with wetland projects. A goal of the wetland-orientated projects being undertaken at WCS is to restore some of the historic community-wide valuation of wetlands as habitat which existed prior to the wide scale availability of piped water. Such appreciation of the importance of wetland habitats is especially critical in light of a study by Payet & Agricole (2006) which highlights the potential water management issues faced by the islands as a result of climate change. Awareness of local wetland habitats is a key component of such a goal and the unexpectedly low awareness of students who have undertaken wetland work suggests that it is an aspect that should be expanded in club activities.

The 'stream teams' project does include an "adopt a local stream" policy (Vel & Morel, 2001), however the amalgamation of this specific project into more general wetland work has resulted in few clubs conducting ongoing work on a specific stream or river (T. Vel, pers.comm).

8.5.3 What lessons can be learned from the Seychelles?

The demonstrated successes of EE on the Seychelles provide lessons for educators across the globe. EE on the Seychelles is undertaken in a 'Creolised' format (Martin, pers. comm.) Education and its outputs are commonly expressed in an expansive and colourful style; shows featuring song and dance are common alongside parades and rallies. Integrating EE into the culture in such a way facilitates knowledge acquisition amongst students (Adams & Goldbard, 2002) and is likely to facilitate knowledge transfer to parents. The adoption of culturally suitable educational resources is also necessary for education to be effective. The production of resources for club leaders by Seychellois WCS staff ensures that educational materials produced in western cultures are not simply recycled into the Seychelles education network without thought for their suitability (pers. obs.).

A key factor for the success observed on the Seychelles is the opportunities for students to directly interact with the natural world. Students are actively encouraged to explore and engage with their natural surroundings as part of club activities. The benefits of such interaction have been shown across cultures (Kusmawan, Reynolds & O'Toole 2006; Crater & Megs 1981; Aird & Tomera, 1977) however, as health and safety regulations become more prohibitive on the activities that children can undertake with schools and clubs the benefits of such interactions are lost. In American schools the hijacking of science curricula by corporate sponsorship means that children may visit a Pepsi Cola bottling factory as part of their science education (Manning, 1999) but undergraduate students attending the California State University, College of Natural Sciences and Mathematics "must wear safety glasses or goggles whilst moving through areas with tree branches"(CNMS, 2008). This is an extreme example of health and safety legislation restricting

students' ability to interact freely with nature, however, it also provides evidence of another facet of EE on the Seychelles that is a likely contributor to its success. The conceptualisation of the environment on the Seychelles is very rarely negative. Habitats, species and ecosystem services are all celebrated whilst environmental threats are portrayed as challenges which the Seychellois, united, can solve (pers. obs.). Negative conceptualisation of the environment is often the norm in western societies and can inhibit the formation of positive attitudes of the environment and the capacity of humans to solve ecological problems (Bush, Morratt and Dunn 2002).

Logistically EE at WCS is a part of an EE network which includes the Seychelles government, NGOs and school communities. Sanders *et al.* (1993) state that science teachers current knowledge is an important influence on the quality of their teaching. Wildlife club leaders are not typically environmental experts, however the support offered by the EE network in the form of teaching resources, assistance devising action plans and equipment use, enables club leaders to achieve the successes described in the study. Support networks are seen as cross disciplinary conservation tool and have been implemented in conservation efforts for subjects as varied as invasive species in the pacific islands (Fisher, 2005) and planning global conservation strategies (Mace *et al.*, 2000). EE programs around the world would do well to take note of how a supporting network can enable volunteer club leaders meet the goals of EE as laid down at international level.

8.6 Limitations of the study and further work

A principal constraint of this study is the lack of a baseline measure of knowledge prior to work on wetland subjects being studied. The counterfactual student group represent students who have not been taught about wetland ecosystems within the last year however the extended attendance time of many students mean that they may have undertaken wetland work previously. An attempt to account for this variation is made in the interpretation of the generated models by inferring that the length of time a student has attended is likely to also influence whether they have undertaken wetland work. An ideal experimental scenario would follow Vaughn *et*

al. (2003) who used a longitudinal experimental design in which data from children and adults was collected at three points in time. Measuring knowledge, and potentially attitudes and behaviour prior to delivering an education program allows a baseline measure to be established and facilitates the identification of causality in child and parent influences (Taris, 2000). Undertaking a longitudinal study in this manner not only requires an extended data collection period it also requires that a positive decision to analyse EE effectiveness is made prior to the education program taking place. Such decisions are rarely made and as a result the precision of studies such as this one is negatively affected.

This study has provided evidence for the intergenerational transfer of knowledge however no attempt has been made to quantify the amount of knowledge being transferred. Running two separate PCA analyses, one for students and one for parents means that adult wetland knowledge scores are quantitatively comparable within the adult sample but not with student knowledge scores. Prior to submitting, for consideration, a journal paper on the findings of this study a joint PCA analysis of student and parent knowledge measures will be conducted which will enable preliminary conclusions regarding the quantity of knowledge being transferred. Time restrictions prevent such an analysis being included in this thesis.

Unforeseen issues with the survey questionnaire have prevented any firm conclusions regarding the influence of WCS on student attitudes and the effect of student knowledge on parent attitudes from being drawn. In order to investigate the potential of EE to reduce the 'habiatitude' noted by Murray & Henri, (2005) and initiate a revival of the historic community wide appreciation of wetland habitats, an understanding of altitudinal influence would be beneficial. The lack of data concerning environmental attitudes is a missing link in the chain from knowledge acquisition through to behaviour however evidence that behaviour modification has occurred allows attitudinal modification to be inferred (Ajzen, 1991).

The discovery that child attendance of an EE program can influence related family behaviours is important for assessing the conservation merit of EE. Strong

conclusions should be avoided however until observational (rather than reported) data on a range of behaviours relating to the taught subject is collected for students and parents in a broad range of circumstances. Until such data is presented the extrapolation of the findings in this study (which represent a single environmental subject, within a single educational framework, in a single location) to represent applicable trends across the breadth of EE should be undertaken with caution.

This study is rare in the EE literature in that it uses quantitative data to demonstrate a causal link from EE induced knowledge acquisition through to its desired goal, a behavioural change. By illustrating the capacity of EE directed at children to modify parental knowledge and behaviour this thesis also provides evidence that the decision to educate children or adults need not be mutually exclusive. It is hoped that this will be the first of many studies which assess the strength of EE as a conservation intervention so that a clearer picture of when, where and how to implement this innately powerful but understudied conservation technique can emerge. Whilst such evidence is being accumulated educators around the world should take inspiration from the EE work taking place on the Seychelles, learn from its successes and implement their own, scientifically monitored, EE programs to a human population in great need of a deeper knowledge and appreciation of the natural world.

9. References

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10. Appendices

10.1 Appendix 1

Twelve principles for the development of international environmental education (UNESCO, 1977)

- 1 Consider the environment in its totality-natural, built, technological and social (economic, political, cultural-historical, moral, aesthetic);
- 2 Be a continuous, lifelong process, beginning at the preschool level and continuing through all formal and non-formal stages;
- 3 Be interdisciplinary in its approach, drawing on the specific content of each discipline in making possible a holistic and balanced perspective;
- 4 Examine major environmental issues from local, national, regional, and international points of views so that students receive insights into environmental conditions in other geographic areas;
- 5 Focus on current and potential environmental situations, while taking into account the historical perspective;
- 6 Promote the value and necessity of local, national, and international cooperation in the prevention and solution of environmental problems;
- 7 Explicitly consider environmental aspects in plans for development and growth;
- 8 Enable learners to have a role in planning their learning experiences and provide an opportunity for making decisions and accepting their consequences;
- 9 Relate environmental sensitivity, knowledge, problem solving skills and values clarification to every age, but with special emphasis on environmental sensitivity to the learner's own community in early years;
- 10 Help learners discover the symptoms and real causes to environmental problems;
- 11 Emphasize the complexity of environmental problems and thus the need to develop critical thinking and problem solving skills;
- 12 Utilize diverse learning environments and a broad array of educational approaches to teaching/learning about and from the environment with due stress on practical activities and first hand experience.

10.2 Appendix 2

Sampled wildlife clubs on the island of Mahé with the number of student respondents from each club

Wildlife Club name	Associated school	Wildlife club leader	Location of the school	Number of students sampled
Bamboo	La Rosier Primary	Gracia Labiche	Victoria	16
Banyan star	Anse Etoile Primary	Christelle Jacques	Anse Etoil	10
Black parrot	Bel Eau Primary	Wilna Figaro	Victoria	15
Casuarina	Plaisance Primary	Assunta Julienne	Mont Fleuri	14
Coco	Glacis Primary	Karen Julie	Glacis	8
Dolphin	Beau Vallon Secondary	Wilfred Uranie	Beau Vallon	13
Flamboyant	Mont Fleuri Primary	Jina Andimignon	Mont Fleuri	10
Mahogany	Grand Anse Primary	Milicent Vidot	Grand Anse	7
Mare Aux Cochons	Bel Ombre Primary	Betty Cecile	Bel Ombre	5
Palm	English Rive Secondary	Marguerita Hoareau	Victoria	10
Palourd	Cascade Primary	Bernadette Rosalie	Cascade	11
Pizantes	Mont Fleuri Secondary	Brigitte Philoe	Mont Fleuri	10
Torti-de-ter	Anse Aux Pins Primary	Damienne Thomas	Anse Aux Pins	8
Tropical	Pointe Larue Secondary	Lucille Volcy	Pointe Larue	9
Spice	Anse Royal Secondary	Debra Desaubin	Anse Royal	15

10.3 Appendix 3

10.3.1 Student questionnaire

Dear student,

My name is Peter Damerell; I am a masters degree student from Imperial College London. I am in the Seychelles to do research work on environmental education. You have been randomly selected to take part in a study that I am conducting in association with Wildlife Clubs of Seychelles. Part of this study will look at the environmental attitudes of young people and adults across the Republic of Seychelles. As part of this study we are asking students and their parents to fill out questionnaires. The envelope you have been given contains a questionnaire for yourself and one for an adult family member or guardian to complete.

The questionnaire for you to complete is 23 questions long and should take less than 20 minutes. You can answer in Creole or English. The questionnaire is completely **anonymous** meaning that no-one will be able to tell the answers you give belonging to you. All of the information you provide will be treated in the **strictest confidence**. **Please answer the questions truthfully and individually.** The **only** person to see your answers will be me.

After finishing the questionnaire please ask an adult family member or guardian to complete the adult questionnaire. Then put both questionnaires in the envelope, write your name and wildlife club on the envelope and return it to your Wildlife Clubs leader. All returned envelopes containing completed copies of the adult and student questionnaires will be entered into a prize draw. The winner of the prize draw will win 500 SR for themselves and 500 SR for their wildlife club.

Please ensure questionnaires are returned before the **26th of June** or else you will not be entered into the prize draw.

Remember, there are **no** wrong or right answers, only your answers. If there are questions you don't know the answer to then tick the box marked I'm not sure

Thank you in advance for taking part in this important study.

If you have any questions about the study or the way in which the information you provide will be used feel free to contact me with any questions. I will be visiting your wildlife club regularly during May and June or you can use the contact information below.

Peter Damerell
Research Scientist
Imperial College London
Telephone: 5648877
Email: Pd1108@imperial.ac.uk

1. How old are you? _____

2. Are you a boy girl

3. How many brothers and sisters do you have? _____

4. Which schools have you been to

5. What do you think about the role of nature to the lives of Seychellois?

Very important Important Neutral Unimportant Very unimportant
I don't know

6. If you worked for the government and were able to give the Ministry of Environmental 10 million Seychelles Rupees to spend tackling **Four** issues, which **Four** issues would you give the money to?

Climate Change	<input type="checkbox"/>	Land Reclamation	<input type="checkbox"/>
Invasive species	<input type="checkbox"/>	Protecting Mangroves	<input type="checkbox"/>
Overfishing	<input type="checkbox"/>	Freshwater Shortages	<input type="checkbox"/>
Air quality	<input type="checkbox"/>	Damage to coral reefs	<input type="checkbox"/>
Pollution of Freshwater	<input type="checkbox"/>	The loss of forest habitat	<input type="checkbox"/>
Protecting marshes and swamp	<input type="checkbox"/>	Another issue (please describe)	<input type="checkbox"/>

7. What do you think about the amount of money that the government spends on protecting the environment?

Much too much Too much The right amount Too little Much too little
I don't know

8. Please **rank** these **uses of freshwater** (1=most important, 2=less important... and 7=least important).

- | | | | |
|-------------------------------|--------------------------|---------------------------------------|--------------------------|
| Water for humans to drink | <input type="checkbox"/> | A habitat for plants and animals | <input type="checkbox"/> |
| Watering Plants in gardens | <input type="checkbox"/> | An area for relaxation and recreation | <input type="checkbox"/> |
| Watering crops in plantations | <input type="checkbox"/> | An educational area | <input type="checkbox"/> |

9. Protecting freshwater costs money which could be spent on other environmental issues or on public services such as healthcare, crime prevention and education.

tick the minimum cleanliness acceptable for the following uses of freshwater

Water for humans to drink:

- Very clean Clean Not clean or polluted Polluted Very polluted
 I'm not sure

A habitat for plants and animals:

- Very clean Clean Not clean or polluted Polluted Very polluted
 I'm not sure

For watering plants or crops

- Very clean Clean Not clean or polluted Polluted Very polluted
 I'm not sure

An area for relaxation and recreation:

- Very clean Clean Not clean or polluted Polluted Very polluted
 I'm not sure

10. Please write the names of species you can find in or near freshwater like rivers, streams marshes and mangroves.

11. Please **tick the three largest threats** to animals and plants which live in freshwater and wetlands.

- | | | | |
|---------------------------------|--------------------------|----------------------------|--------------------------|
| Freshwater Shortages | <input type="checkbox"/> | Pollution from industries | <input type="checkbox"/> |
| Pollution from homes | <input type="checkbox"/> | Pollution from agriculture | <input type="checkbox"/> |
| Litter | <input type="checkbox"/> | Collection by people | <input type="checkbox"/> |
| Blockages of streams and rivers | <input type="checkbox"/> | Other (please describe) | <input type="checkbox"/> |

12. Please write three functions of marshes or swamps

Function 1:

Function 2:

Function 3:

If you can't think of any please tick this box

13. How far away from your home is the nearest stream or river?

I'm not sure

14. Please write the name of

A stream or river on Mahé _____ I'm not sure

A marsh or swamp on Mahé _____ I'm not sure

Somewhere you can find mangroves on Mahé _____ I'm not sure

15. How would you describe wetlands in your area?

Very Clean Clean Not clean or polluted Polluted Very polluted

I'm not sure

16. How regularly do you attend Wildlife Club?

I go to every meeting I go to nearly every meeting

I go to most meetings I go to about half of the club meetings

I don't go to many meetings I rarely go

17. How long have you been a member of Wildlife Clubs of Seychelles for? _____

18. Why did you join Wildlife Clubs of Seychelles?

19. If you attend the Wildlife Club Seychelles have you been involved with any freshwater activities which looked at streams, rivers, marshes, swamps or mangroves? Yes No

20. Please list some organisations you could contact to get more information about the animals and plants that live in or near freshwater.

I'm not sure

21. Do you regularly discuss with you your parents or guardian the work that you have been carrying out at school or as part of after school clubs. Yes No

If yes, which topics do you talk about most often?

- | | |
|--|--|
| Sporting activities | <input type="checkbox"/> |
| Academic subjects such as Maths, Science etc. | <input type="checkbox"/> |
| Vocational subjects such as Music, art, crafts | <input type="checkbox"/> |
| Environmental work like Wildlife Clubs | <input type="checkbox"/> |
| Other | <input type="checkbox"/> (please describe) |
-

22. Where do you find out about environmental issues, **please tick all that are relevant**

- | | | | |
|-------------------------|--------------------------|------------------------------------|--------------------------|
| Adult friends or family | <input type="checkbox"/> | Newspapers | <input type="checkbox"/> |
| Television | <input type="checkbox"/> | Wildlife organisation events | <input type="checkbox"/> |
| Radio | <input type="checkbox"/> | Friends or family who are children | <input type="checkbox"/> |
| Leaflets or posters | <input type="checkbox"/> | Other (please describe) | <input type="checkbox"/> |
-

23. Have you been aware of any of the following occurring in an area of freshwater in your area in the last year?

- | | | |
|-----------------------------------|------------------------------|-----------------------------|
| Foam or oil on the waters surface | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| Dead plants or animals | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| Litter | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| Soil the water | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| A bad smell coming from the water | Yes <input type="checkbox"/> | No <input type="checkbox"/> |

Thank you for completing this questionnaire.

Please write your name and wildlife club on the envelope you have been given and put the questionnaire you have completed and the questionnaire that your parent or guardian has completed inside. Return the envelope to your Wildlife Club leader so that you can be entered into the prize draw to win 500 Sr for you and 500Sr for your wildlife club.

Please use the space below to provide any additional information or observations regarding any part of this questionnaire.

Thank you once again

Peter Damerell

10.3.2 Adult questionnaire

Dear Sir or Madam,

My name is Peter Damerell; I am a masters degree student at Imperial College London. I am in the Seychelles to conduct research work on environmental education. Students from your child's wildlife club have been randomly selected to take part in a study that I am conducting whilst working with Wildlife Clubs Seychelles. Part of this study will look at the environmental attitudes of young people and adults across the Republic of Seychelles. Your child has a questionnaire to complete and this one is for an adult member of the child's family. The questionnaire is 26 questions long and should take less than 20 minutes to complete. The questionnaire is completely **anonymous**, meaning that no-one will be able to tell the answers you give belonging to you. All of the information you provide will be treated in the **strictest confidence**. **Please answer the questions truthfully**. The **only** person to see your answers will be me.

When you have finished the questionnaire please put both completed questionnaires in the envelope provided and return them to your child's school. All children returning envelopes containing completed copies of the adult and student questionnaires will be entered into a prize draw. . The winner of the prize draw will win 500 Sr for themselves and 500 Sr for their wildlife club.

Please ensure questionnaires are returned before the **26th of June** or else you will not be entered into the prize draw.

Remember, there are **no** wrong or right answers, only your answers. If you are not sure of the answer to a question please mark the box labelled I'm not sure

Thank you in advance for taking part in this important study.

If you have any questions regarding the completion of the study or the way in which the information you provide will be used feel free to contact me with any questions

Peter Damerell
Research Scientist
Imperial College London
Telephone: 564887
Email: Pd1108@imperial.ac.uk

1. Please **rank**, with the numbers 1 to 7, the issues which affect your **quality of life**. (1 being the most important, 2 is less important..... and 7 being the least important)

Job security	<input type="checkbox"/>	The threat of crime	<input type="checkbox"/>
The ability to relax	<input type="checkbox"/>	Having enough clean water	<input type="checkbox"/>
A stable economy	<input type="checkbox"/>	Environmental quality	<input type="checkbox"/>
Social activities	<input type="checkbox"/>	Other (please describe)	<input type="checkbox"/>

2. Which **three** environmental issues do think are the **most important** for the Republic of the Seychelles to take action on?

Climate Change	<input type="checkbox"/>	Freshwater Shortages	<input type="checkbox"/>
Invasive species	<input type="checkbox"/>	Damage to coral reefs	<input type="checkbox"/>
Overfishing	<input type="checkbox"/>	Pollution of Freshwater	<input type="checkbox"/>
Air quality	<input type="checkbox"/>	The loss of forest habitat	<input type="checkbox"/>
Land Reclamation	<input type="checkbox"/>	Protecting marshes	<input type="checkbox"/>
Protecting Mangroves	<input type="checkbox"/>	Another issue (please describe)	<input type="checkbox"/>

3. What do you think about the amount of money that the government spends on protecting the environment?

Much too much Too much The right amount Too little Much too little
 I'm not sure

4. Please **rank** these **reasons for protecting** areas of freshwater like streams, rivers, marshes, swamps and mangroves. (1=most important, 2=less important.....and 7=least important).

They provide water for humans to use	<input type="checkbox"/>
For future generations to use	<input type="checkbox"/>
They are a habitat for plants and animals	<input type="checkbox"/>
They are an area for relaxation and recreation	<input type="checkbox"/>
We might need them in the future	<input type="checkbox"/>
We have a duty to protect all parts of the environment	<input type="checkbox"/>
Other (please describe)	<input type="checkbox"/>

5. Keeping areas of freshwater clean costs money which could be spent on other environmental issues or on public services such as healthcare, crime prevention and education.

tick the minimum cleanliness acceptable for the following uses of freshwater.

Water for humans to drink:

Very clean Clean Not clean or polluted Polluted Very polluted I don't know

A habitat for plants and animals:

Very clean Clean Not clean or polluted Polluted Very polluted I don't know

For watering plants or crops

Very clean Clean Not clean or polluted Polluted Very polluted I don't know

An area for relaxation and recreation:

Very clean Clean Not clean or polluted Polluted Very polluted I don't know

6. Please write the names of species you can find in or near freshwater.

7. Please **tick the four largest threats** to animals and plants which live in freshwater.

Freshwater Shortages	<input type="checkbox"/>	Pollution from industries	<input type="checkbox"/>
Pollution from homes	<input type="checkbox"/>	Pollution from agriculture	<input type="checkbox"/>
Litter	<input type="checkbox"/>	Collection by people	<input type="checkbox"/>
Blockages of streams and rivers	<input type="checkbox"/>	Other (please describe)	<input type="checkbox"/>

8. Please write three functions of marshes or swamps

Function 1:

Function 2:

Function 3:

If you can't think of any please tick this box

9. How far away is your nearest stream or river? _____
If you are not sure please tick this box

10. Please write the name of

A stream or river on Mahé _____	I'm not sure	<input type="checkbox"/>
A marsh or swamp on Mahé _____	I'm not sure	<input type="checkbox"/>
Somewhere you can find mangroves on Mahé _____	I'm not sure	<input type="checkbox"/>

11. How would you describe areas of freshwater in your area?

Very Clean Clean Not clean or polluted Polluted Very polluted

I don't know

12. Have you ever taken part in any environmental activities based around freshwater?
Yes No

13. Please list the **organisations** that can provide you with more information about the animals and plants in a river or stream? _____

I'm not sure

14. Where do you find out about environmental issues, **please tick all that are relevant**

Adult friends or family	<input type="checkbox"/>	Newspapers	<input type="checkbox"/>
Television	<input type="checkbox"/>	Radio	<input type="checkbox"/>
My children	<input type="checkbox"/>	Wildlife organisation events	<input type="checkbox"/>
Leaflets or posters	<input type="checkbox"/>	Other (please describe)	<input type="checkbox"/>

15. Do your children regularly discuss with you work that they have been carrying out at school or as part of after school clubs. Yes No

If yes, which topics do they discuss most often?

Sporting activities	<input type="checkbox"/>
Academic subjects such as Maths, Science etc.	<input type="checkbox"/>
Vocational subjects such as Music, art, crafts	<input type="checkbox"/>
Environmental work	<input type="checkbox"/>
Social aspects of their time in school	<input type="checkbox"/>
Other (please describe)	<input type="checkbox"/>

16. Please **tick all the options which apply** to you.

Do you.....

Take showers	<input type="checkbox"/>	Take baths	<input type="checkbox"/>
Wash vegetables under a running tap	<input type="checkbox"/>	Wash vegetables in a bowl	<input type="checkbox"/>
Put half loads through the washing machine	<input type="checkbox"/>	Put full loads only through the washing machine	<input type="checkbox"/>
Hand wash clothes in a bucket	<input type="checkbox"/>	Hand wash clothes under a running tap	<input type="checkbox"/>
Use rainwater for watering the garden	<input type="checkbox"/>	Use treated water for watering the garden	<input type="checkbox"/>
Wash your car with a hose pipe	<input type="checkbox"/>	Wash your car with a bucket	<input type="checkbox"/>
Have a full-flush toilet	<input type="checkbox"/>	Have a dual-flush toilet	<input type="checkbox"/>
Brush your teeth with the tap running	<input type="checkbox"/>	Brush your teeth using a cup of water	<input type="checkbox"/>

17. Have any of the following signs of pollution occurred in an area of freshwater in your area in the last 12 months?

- Discolouration of the water Yes No
- Foam on the water surface Yes No
- Dead plants or animals Yes No
- Litter Yes No
- Soil the water Yes No
- A bad smell coming from the water Yes No
- I don't know

Please remember that all of your answers are **anonymous** and **confidential** and that you should answer the questions as **honestly** as you can.

18. Which age category are you: (Please tick)

- less than 25 26-35 36-45 46-55 56-65 65+

19. Are you... Female Male

20. How many children do you have? _____

Please provide the following information for each child:

Child	Age	Sex:	Schools attended:	Did they attend Wildlife Clubs Seychelles:	If yes when did they start and finish attending the club?
1		Female <input type="checkbox"/> Male <input type="checkbox"/>		Yes <input type="checkbox"/> No <input type="checkbox"/>	Start _____ Finish _____
2		Female <input type="checkbox"/> Male <input type="checkbox"/>		Yes <input type="checkbox"/> No <input type="checkbox"/>	Start _____ Finish _____
3		Female <input type="checkbox"/> Male <input type="checkbox"/>		Yes <input type="checkbox"/> No <input type="checkbox"/>	Start _____ Finish _____
4		Female <input type="checkbox"/> Male <input type="checkbox"/>		Yes <input type="checkbox"/> No <input type="checkbox"/>	Start _____ Finish _____
5		Female <input type="checkbox"/> Male <input type="checkbox"/>		Yes <input type="checkbox"/> No <input type="checkbox"/>	Start _____ Finish _____
6		Female <input type="checkbox"/> Male <input type="checkbox"/>		Yes <input type="checkbox"/> No <input type="checkbox"/>	Start _____ Finish _____

21. Have **any** of your children taken part in freshwater or wetland activities with Wildlife Clubs of Seychelles? Yes No I don't know

22. What is your relationship to the student who was given this questionnaire to take home?

23. What is the highest education qualification achieved by a member of the household

24. What jobs do adult household members have?

25. What is the name of your village or town? _____

26. How long have you lived within your current community? _____

Thank you for completing this questionnaire.

Please seal the questionnaire you have completed and the questionnaire your child has completed within the provided envelope and have your child return it to their wildlife club teacher so they can be entered into the prize draw to win 500 SR and 500 SR for their wildlife club.

Please use the space on the last page to provide any additional information or observations regarding any part of this questionnaire.

Thank you once again

Peter Damerell

10.4 Appendix 4

Students knowledge score tree model

node)	split	n	deviance	yval
1)	root	137	135.2	-0.0146
2)	Child.Aware.Of.River.: no	77	63.06	-0.3174
4)	Time.Attending.WCS: <1 year	47	31.93	-0.614
8)	Number.Of.Siblings < 1.5	17	10.55	-0.2353*
9)	Number.Of.Siblings > 1.5	30	17.56	-0.8287
18)	Undertaken.Wetlands: No	20	9.187	-1.135
36)	Additive.Club.Attendance: 0 - 1 Years,5 Years+	15	4.739	-1.324*
37)	Additive.Club.Attendance: 1- 3 Years	5	2.294	-0.566 *
19)	Undertaken.Wetlands: Yes	10	2.759	-0.217 *
5)	Time.Attending.WCS: 1 - 3 years,3 years +	30	20.52	0.1473
10)	Adults.Years.In.Comunity < 16	14	5.476	0.5164
20)	Adults.Years.In.Comunity < 9.5	6	1.205	0.08167*
21)	Adults.Years.In.Comunity > 9.5	8	2.286	0.8425*
11)	Adults.Years.In.Comunity >16	16	11.47	-0.1756
22)	Undertaken.Wetlands: No	9	7.397	-0.5156*
23)	Undertaken.Wetlands: Yes	7	1.692	0.2614*
3)	Child.Aware.Of.River.: yes	60	55.98	0.374
6)	Undertaken.Wetlands: No	31	27.96	0.09387
12)	Time.Attending.WCS: <1 year,1 - 3 years	25	18.98	-0.1268
24)	Number.Of.Siblings < 1.5	9	3.578	0.3722*
25)	Number.Of.Siblings > 1.5	16	11.90	-0.4075
50)	Time.Attending.WCS: <1 year	8	3.651	-0.8612*
51)	Time.Attending.WCS: 1 - 3 years	8	4.959	0.04625*
13)	Time.Attending.WCS: 3 years +	6	2.688	1.013*
7)	Undertaken.Wetlands: Yes	29	22.98	0.6734
14)	Child.Age < 10.5	23	19.14	0.5478
28)	Adults.Years.In.Comunity < 9.5	5	1.259	0.050*
29)	Adults.Years.In.Comunity > 9.5	18	16.30	0.6861*
15)	Child.Age > 10.5	6	2.085	1.1550*

* denotes terminal node