

Reefs and learning: Education evaluation techniques

Carl M. Stepath, PhD

**Publication information: Presented to National Marine Education Association Conference,
New York City, July 20, 2006; Website: <http://saveourseas.org/stepath.htm>**

.

Reefs and learning: Education evaluation techniques

By Carl M. Stepath, PhD

Abstract: Marine education research designs are discussed, and student learning outcomes while monitoring a coral reef is evaluated. Changes in environmental knowledge and attitudes, ecological intention to act, and direct reef experience were investigated. Differences between student pre-test and the post-test responses were observed, and analysis is considered consisting of empirically generated results and student accounts. Environmental knowledge, environmental attitudes and intention to act were evaluated using a multi-method quasi-experimental design, and their affect by reef experience is investigated. Initial environmental knowledge scores were low and were most changed by a classroom presentation and reef monitoring trip combination, the reef learning experience elicited the largest positive shift in environmental attitudes as well as ecological intention to act, and students who had never been to the reef showed the greatest amount of change. This article reports on methodologies developed for evaluating marine education and investigating outdoor marine learning with Australian high school students. Research limitations are also discussed, and information is provided for researchers interested in evaluating education programs.

Introduction

Marine studies are offered in Queensland, Australia high schools, and key elements of this program include experiential learning in marine environments at the Great Barrier Reef. Field visits are designed to enable greater understanding and increased awareness of special places, and it is often stated that outdoor, experiential education is an effective dimension of education. My paper presents a research approach, which evaluates and explores eruditional outcomes related to marine education.

Coral reefs are very special places and the Great Barrier Reef, a World Heritage site, is worth billions of dollars annually to the Queensland economy because of tourism and fishing. Many Queensland high school campuses are located on the coast, and marine studies training is important to many interested in earning a living from marine-related work.

An aim of marine education, as stated in the Marine Studies Syllabus (Queensland Studies Authority, 2005a), is that “marine studies provides opportunities for students to develop

an awareness of the value of the sea and coastal zone necessary for the sustainable management of a healthy marine environment for present and future generations” (p.3). Marine study or marine environments emphasize “first hand experience” (p.1), and a minimum of three full fieldwork days (18 hours) a year is mandated.

This paper documents a methodology that analyzes the effects of taking senior high school students on a marine studies offshore reef trip in 2002 and 2003. These students were enrolled at five Queensland high schools, three Catholic high schools and two state high schools. The research was conducted as part of a doctoral study where the effectiveness of differing educational strategies were tested. Evaluation techniques and results are reported concerning this research, and the use of reef trips and coral reef monitoring as pedagogical devices for enhancing learning. Empirical data is presented on the students’ learning experiences, as well as a description of techniques used to measure the effectiveness of reef experience and coral reef monitoring as a structured learning strategy.

In past teaching experiences, a change was noted in students’ relationship to the natural environments after participating in outdoor coral reef learning programs (Stepath, 1997). It seemed the students’ way of relating to the reef and its ecosystem was different, or had been transformed (O’Sullivan, 1999). Student interactions with plants and animals have been noted by other outdoor education studies (Bogner, 1998; Kruse & Card, 2004), but very few are found that relate to the marine environment. After this was noted, a specific research design was developed to analyze changes in student perspectives toward the reef.

While being inspired by students’ behaviour on the reef, I also became aware how environmental experiential education was in danger of being dropped from many formal education systems, despite its educational potential (Fien, 2004; Finger, 1994). Interest exists in the learning potential of this type of education, and well as concern for its marginalisation (Gough, 1997), hence, this study was designed to investigate students’ learning change after monitoring a reef.

The economic and cultural focus on the Great Barrier Reef, and the existence of a well-developed high school marine studies programs made it an optimum location for this unique research. This paper discusses the effectiveness of the current teaching strategy in Queensland, as well as presenting an evaluation methodology available to education researchers.

Methods

Marine education issues are interdisciplinary and wide ranging, and implementation into schools has been fragmented (Fortner, 1978, 1983; Gough, 1997). The implementation of Marine Studies in Queensland has been supported by teachers' organizations such as Marine Education Society of Australasia (MESA) and Marine Teachers Association of Queensland.

The Three A's of coastal and marine education: Awareness, Attitudes and Action, are promoted by MESA. Research demonstrates that raising awareness does not lead to positive environmental action (Hines, Hungerford, & Tomera, 1986/1987; Hungerford & Volk, 1990; Marcinkowski, 2001), or is this knowledge, attitude action relationship linear (Kuhlemeier, Van Den Bergh, & Lagerweij, 1999). A research project by Kruse and Card (2004), argued participants' attitudes and behavior became more environmentally friendly with camping experience, but found a decreasing trend of self-reported conservation behavior as experience increased. Zelezny (2000) questioned whether non-traditional educational interventions effectively improved environmental actions, and argued classroom interventions produced more change in environmental behavior than experience. My article explores whether coral reef education and experience promotes a greater connection between knowledge, attitudes and action.

The research employed a quasi-experimental survey methodology (Kerlinger & Lee, 2000), as well as limited semi-structured interviews. The quantitative aspect of the study contrasted two educational interventions (classroom presentations and reef monitoring experience) with respect to dependent variables using a pre-test/post-test data collection design. The independent variables were (1) classroom presentations and (2) coral reef experience, and the dependent variables were changes in environmental knowledge, attitudes and reported intention to act. A convenience study population of senior high school students (n = 389) was used with quantitative analysis techniques and *in situ* student accounts to evaluate changes in learning. Employing differing methodologies to investigate the same phenomena has been shown to expand and add depth to findings (Neuman, 2004) on learning experiences.

The study population

A sizeable study population (Table 1) was desired since larger studies are more likely to

provide statistically significant results than smaller studies (Sowell, 2001). The senior high school students were predominately Year 11 (88%). Over half the students were enrolled in Marine Studies subjects, while 43% were selected by teachers from other classes, and are shown in the ‘Other courses’ column. Members of the study group were as consistent as possible from one school to the next.

Table 1. *Study Group Make-up by School and Course of Study*

<u>School</u>	Marine <u>education</u> (Yr 11)	Other <u>Courses</u> (Yr 11)	Year 12 <u>Students</u>	Total <u>students</u>
School A (State school)	53	21	24	74
School B (Catholic school)	66	33		99
School C (Catholic school)	38	17		55
School D (Catholic school)	20	27	22	47
School E (State school)	43	71	2	114
Total students	220	169	48	389

The quantitative study population was divided into four groups. The four categories (Figure 1) are: (1) the classroom presentation and reef visit group, Group 1 (n = 85) who received both the new classroom presentation and an offshore reef monitoring experience; (2) Group 2 (n = 64), who received a classroom presentation, but were not taken to the reef; (3) Group 3 (n = 97), who received only a reef monitoring experience, and did not have the associated classroom presentation; and (4) Group 4 (n = 74), the contrast group, who received neither learning a classroom presentation or a reef trip. Separation of participating students into groups provided the possibility of comparing the effect of different educational interventions.

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

Figure 1. Study groups and respective educational interventions.

The final quantitative analysis utilized a total of 320 students, of which 195 were male and 125 were female with an average age of 16.0 years (ranging from 15 to 20 years). Certain responses were not used because the students had declined to continue in the research, some surveys were determined to be inaccurate, or students were not in class on the day of the survey.

A power analysis, G-Power (version 2.1.2, <http://www.psychologie.uni-trier.de:8000/projects/gpower.html>), was employed to determine the approximate number of subjects necessary. The optimum determined sample size was $n = 280$, and the actual sample size of $n = 320$ was 12.5% larger. The group sizes varied ($n = 64$ to $n = 97$) as participating classes differed in size from one school to the next.

Pilot study

A pilot study trialed the interview questions, research techniques, and the educational interventions and procedures. Reflections and suggestions from the pilot study were incorporated, and conceptual formations were metamorphosed as praxis.

Quantitative methodology

Experimental design

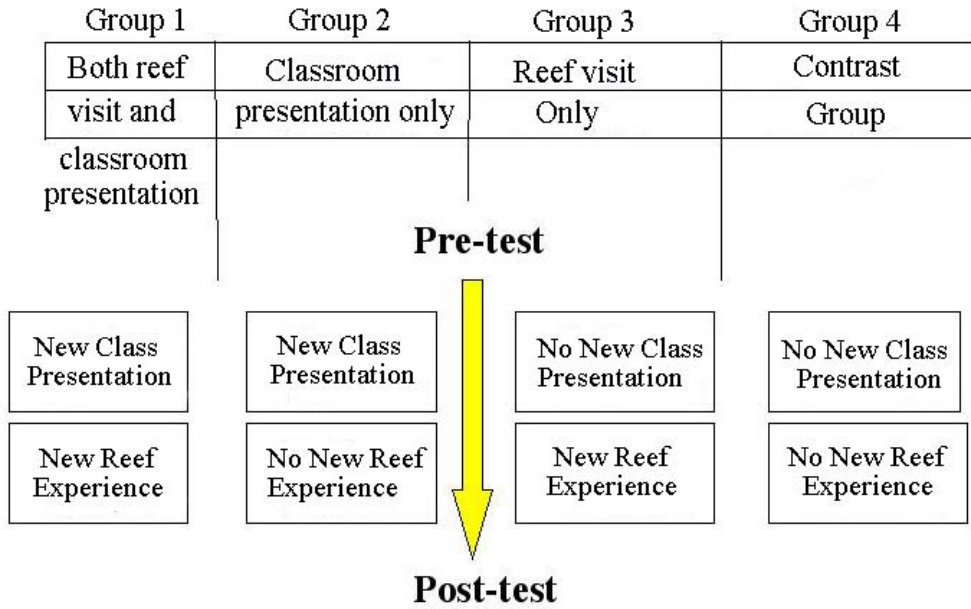


Figure. 2. Project experimental design.

My hypothesis was that students in Group 1 (both a classroom presentation and new reef experience) would have the greatest positive change in environmental knowledge, attitudes and ecological intention to act responses. The research was designed to test learning and new reef experience compared with classroom learning interventions against a contrast group (Group 4), who had neither of these learning interventions.

Design of survey questionnaire

Reported changes in environmental knowledge, attitudes and intention to act responses were calculated quantitatively. Knowledge responses used a multiple choice answer format. In comparison, attitude and intention to act questions employed a six- point response scale: 6 = strongly agree, 5 = somewhat agree, 4 = mildly agree, 3 = mildly disagree, 2 = somewhat disagree, and 1 = strongly disagree. A higher score meant a more positive the intention to act. A six-point response scale was preferable, as a high percentage of the adolescent participants on the pilot study answered the five-point questions in the middle or 'no opinion' category. The survey contained 14 questions: 9 pertaining to knowledge, 5 to attitude and 5 to intention to act (questions available in Stepath, 2006).

To compile the knowledge questions, I modified questions from the Coral Reef Quiz listed on the Environment News Network website (Environment News Network, 2003), and questions from the Great Barrier Reef Marine Park Authority (GBRMPA) Reef Ed materials (Great Barrier Reef Marine Park Authority, 2006). The attitude and intention to act questions were derived from: Investigating and Evaluating Environmental Issues and Actions (IEEIA) (Hungerford, Litherland, Peyton, Ramsey, & Volk, 1996), Dunlap & Van Liere’s (1978) new environmental paradigm, Kaiser, Wölfing, & Fuhrer’s (1999) discussion of environmental attitude and ecological behavior, and *Constructing a TpB questionnaire: conceptual and methodological considerations* (Ajzen, 2002). My pre-test and post-test survey instruments were tailored to Australia and tropical marine education conditions.

Restating and negatively wording survey questions, and then comparing answers was used to check reliability (Babbie, 2004). Literacy issues could have affect students’ ability to complete the questionnaires, and this issue was not addressed, as students’ literacy histories were not available to the researcher.

Research orientation

The dependent and independent variables are described in the Table 2 matrix. The dependent variable comparisons used were knowledge (K), attitude (A) and intention to act (Ac), since long-term action could not be measured in the context of this study design. The type of knowledge and intention to act questions relating to reef ecology are designated with an ‘X’ (Table 2).

Table 2. *Component Relationships to Independent and Dependent Variables*

Dependent Variable (DV)	Independent Variable (IV)		
	Knowledge	Attitude	Reef Experience
Knowledge of reef ecology	X	X	X
Attitudes toward reef ecology	X	X	X
Intention to act toward ecology	X	X	X

Cronbach’s *alpha* co-efficient was used to calculate the internal consistency of the pre-test and post-test, and it indicated that participants consistently responded to the questions. The

calculated Cronbach’s alpha for responses were greater than 0.7 and therefore indicated reliability (Pollant, 2001; Sowell, 2001). The responses on my pre-test and post-test were 0.830 and 0.839, respectively, and the test/re-test was 0.90.

The study population was not randomly selected, and therefore statistically, the results are not applicable to students outside the schools involved. However, the results can be seen as educationally significant, since there is little fieldwork conducted with high school students’ marine environment experience. There were no other educational studies of this type about coral reef education found in the literature.

Schedule of School Research

The five participating high schools’ data collection coincided with each school’s scheduled reef trip. The project proper started with School A in March 2003 and the data collection continued until November 2003, as shown in Table 3.

Table 3. *Schedule of High School Research by School in 2003*

School	Pre-test	Class Present	Reef Trip	Post test
School A	18-Mar	25-Mar	3-Apr	14-May
School B	28-Mar	7-Apr	15-Apr	26-May
School C	29-Jul	6-Aug	9-Aug	6-Oct
School D	18-Aug	25-Aug	29-Aug	23-Oct
School E	13-Oct	21-Oct	13-Oct	21-Nov

Quantitative Data Analysis

Associations between marine experiential education and environmental knowledge, attitudes and ecological intention to act were analyzed to determine if evidence of change existed after learning experiences. Interrelationships were explored by the statistical procedures of SPSS11 exploratory statistics, ANOVA, Spearman’s *rho*, Kruskal-Wallis and the two-tailed Mann-Whitney U test (Miller, Acton, Fullerton & Maltby, 2002).

Qualitative research methodology and analysis

Qualitative approach

A set of limited interviews was used to provide information concerning the symbolic content relating to student reef experience and learning. As “the reference point in experiential learning is the learners’ [experience]” (Greenburg, Rice & Elliot, 1993, p. 21) then qualitative research enables the presentation of participating students’ perspectives on their experiences of a coral reef including coral reef monitoring. Interviewing is a central component in qualitative research (Baker, 2004; Bell, 2003; Berry, 1999; Denzin & Lincoln, 1994; Huberman & Miles, 2002; Sowell, 2001; Strauss & Corbin, 1998). The model of analysis followed in the qualitative aspect of this research was that of comparative method (Huberman & Miles, 2002). This information gathered in this study evaluated whether students were able to locate their experiences in space and place (proximity). Proximity is defined as attachment, kinship and nearness in space or time.

In social research, qualitative interviews “are very widely used in the context of quantitative research projects” (Hopf, 2004, p. 203). Interviews in this research generated additional perspectives and insights about students’ environmental learning. My own limited training as a quantitative researcher placed limitations on understanding the methodology.

I conducted short and limited *in situ* interviews, and since there was only one opportunity, it was considered preferable to have short answers from a large number of students. We were in outdoor situations such as on-board boats or on a beach, and these situations are not conducive to longer more personal, detailed accounts. The time available to interview students on the occasions was limited, leaving little opportunity to delve into their themes and meanings. Nonetheless, this firsthand information increased the accuracy of findings and depth of the research as a whole, and presented student accounts of aquatic learning experiences (Stepath, 2006).

Inductive approach research begins with specific examinations and moves to develop general patterns between factors that emerge from different cases (Denzin & Lincoln, 2000). I used student interview questions similar to the empirical research. Interview questions (reproduced in full in Stepath, 2006) were specific and consistent for all student interviews, attempting to create a basic understanding of how students derive meanings from their reef experiences.

To enable the students to feel more comfortable with the interviewing, I conducted group rather than individual interviews, involving 2 to 4 students, so that students could gain confidence from each other's words and stories (Bell, 2003). The interviews took place after the reef experience, with the tapes transcribed and the transcripts analyzed later. If a student did not feel comfortable with the interview process he or she would not be interviewed.

The combination between the quantitative and qualitative methodologies was difficult to implement. At times, these two investigative procedures, from differing perspectives, made the act of mentally moving from one to the other extremely confusing for the researcher (Lincoln & Guba, 1985, p. 37). However, for the most comprehensive results, meeting the difficulties associated with this combined form of research design was worthwhile.

Interviews

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

Structured interviews were conducted using a standard set of questions to inquire into students' experiences of learning in coral reef environments. Question prompted answers intended to provide a mechanism for capturing the verbal accounts of a student's experience, and then intertwining these data into the research story (Bell, 2003). Complications associated with the interviews, came from the limited nature of the structured interviews and standard set of questions derived from the quantitative framework. Utilizing structured questions produced insufficient data for a truly inductive narrative study. The fact that these students were adolescents and the researcher was only with them briefly, made accurate and significant communication difficult (Huberman & Miles, 2002), and the interviews were analyzed with consideration of these factors.

In the recorded interviews, the students gave brief and apparently accurate accounts of their learning in reef environments, and these were generally consistent with their lived experiences (Rudestam & Newton, 2001). The interview data enables the reader to empathetically share thoughts and emotions associated with students' reef trip experiences. These interviews are central to understanding the student views about learning at a coral reef and what the coral reef learning experience meant to them. From interviews we get a glimpse of students as active constructors of their own learning as they attempt to articulate their impressions.

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

The interviews offered insights about the meaning of marine experiential learning outside of empirical explanations. Structured interviews were used for a number of reasons. The same questions on all the trips were used to maintain a degree of reliability between different schools and student groups. Structure was necessary in order to complete the interview process successfully in the short time available, especially since it minimized opportunities for a lack of concentration that might disrupt the process. From a large number of interviews, it was anticipated that general patterns of responses would emerge. A comparative method of analysis was utilized (Miles & Huberman, 1994), and involved reading and re-reading the transcripts to establish whether patterns of repetition and differentiation were found.

No data processing program used to analyze the scripts, and the transcripts of responses were read and sorted manually. Analyses were conducted twice - first to make subjective but consistent judgments of responses to the structured questions according to question topic and then further analyzed and sorted looking for concepts of proximity in student accounts to assess whether students were able to locate their experiences in space and place. Proximity as a relationship between learners and marine environments is promoted in the Queensland Studies

Authority (2005b) Marine Studies Syllabus, as teachers are encouraged to treat marine environments as sites of learning and not just as objects of study.

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

Limitations

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

Limitations of the research methodology

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

Attempts were made to lessen the effects of extraneous variables such as age, education level and social background by incorporating students in real learning situations. The students

were approximately the same education level, being of approximately the same age and living in Australian society. Disparity in age, culture and educational attainment did exist, but were minimized as much as possible. The high school students did not all monitor the same reef, or travel on the same boat. Even though consistency was a major aim, the classroom presentations did differ from school to school. Effects of uncontrollable differences were minimized by the large population size.

Logistical and time-management problems arose for the solitary researcher, especially with the collecting of late consent forms, conflicting meeting schedules at geographically separate schools, while making sure all the necessary consent and field trip forms were completed with every reef trip, and collecting interview data from the students. Scheduling became a problem on occasion, with classes being at different times, on different days of the week, and this did require substantial traveling. The differing reef sites had to be surveyed prior to visits and the schools had to be contacted for the selection of the contrast group. The monitoring and organizational duties at the reef required total concentration. Nonetheless, I was sometimes distracted or tired and the quality of my interview data collection may have suffered.

Limitations of the research data collection

Limitations in the data collection are that the student group selected for the research was a convenience sample and not truly random. A number of students were in marine studies programs and clearly self-selected, because they were interested in ocean related studies. This might imply that they came to the study with a positive attitude toward the environment. Nonetheless, all the students were tested at the beginning of the project to minimize this bias, and then the change was calculated in responses at the end of the project.

The contrast group was selected by school staff from similar available classes without researcher input, and these students did not go to the reef, or receive a classroom presentation. Some students generated inappropriate answers, wondering, “why answer questions, when there is no reward for me?” and withdrew from the research. These are perfectly understandable responses, and I am grateful to all the students who provided contrast group data.

Some of the student groups visiting the reef were large with over 56 students, 6 teachers, 3 JCU student helpers, and one researcher, and it proved difficult to teach and keep so many students focused whether they were on the boat or in the water. On some trips with large classes,

it was possible to keep only sixty percent or so of students actively participating in reef monitoring, even though the remainder were still actively snorkeling in the reef site.

On a few occasions the pre-test and post-test survey questionnaires were administered a few days late, and there were some problems getting the finished post-test surveys delivered back to the researcher in a timely manner. This problem of delinquent survey completion occurred a number of times and could have been avoided if the teachers had been provided more support. In retrospect, as a researcher, I would go into the classroom to administer the pre-tests and post-tests myself.

More time needed to be spent with the students during the interview phase following up on ideas they expressed. Once the high school student groups on the day trip became large, the students' answers to the questions sometimes became short and repetitive. Thus, a data collection limitation was basing this qualitative project "on the same realist and objectivist assumptions as quantitative studies" (Imel et al., 2002, p. 6).

Limitations of the research analysis

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

The size of the different student treatment groups was dissimilar and could have affected final results, but the sample was large, and should have compensated for this limitation. Long-term learning effects were not studied in this research project, as the scope of this work did not allow for a longitudinal study. It also did not allow for ascertaining the effects of family, school, peer groups and predisposing factors. All of which can have an impact on the formation of adolescent knowledge, attitudes and actions.

When conducting a study of this type, the results could have become a self-fulfilling prophecy. This work only measures and analyses the variables of knowledge, attitudes and intention to act, therefore these results are the only ones generated. Other variables are missing from the model and there is no indication which unknown variables could be responsible for any

effect. The experimental design attempts to control for this, but it is extremely difficult to incorporate every possible variable into this type of study. Since variables are not measured other than knowledge, attitude and intention to act, it is not possible to include others in the analyses. Therefore, there is no basis to determine which relationships are stronger or weaker than others. The scope of this research was limited to logistically available options. Consequently, this work is a baseline study in Australian reef education and more variables can be investigated in future research.

Review of Significant Findings in Light of Existing Research

Educational outcome analysis results showed the combination of a reef experience and classroom presentation had the highest positive effect on increasing environmental knowledge scores; while higher environmental attitude and ecological intention to act responses were achieved with coral reef monitoring alone (Stepath, 2006). It appears necessary to consider new approaches to marine education, where attitudes, feelings or actions are a focus rather than just knowledge. Feelings of being at and experiencing a coral reef affected the students, and this appeared to be what triggered large changes in their intention to act responses. This was substantiated by the qualitative interview data, as students gave accounts of their learning experiences with a clear preference shown for learning at the reef over classroom environments (Stepath, 2006).

Changes in students' environmental knowledge, attitudes and ecological intention to act were significantly and directly correlated to previous reef experience. The students' previous experience of coral reefs, camping and snorkeling correlated strongly to knowledge (awareness), attitudes and intention to act responses (Stepath, 2006).

These findings make sense when considering how students come to form their views, which were tested through the surveys. Students who had previous active, but informal, learning experiences of marine environments had more knowledge, as well as more positive attitudes and ecological intention to act towards the conservation of coral reefs. These findings further substantiate the collected qualitative evidence that personal experience with swimming, snorkeling and being immersed in marine environments builds 'connections' with and to these environments (Stepath and Whitehouse, 2006). Students familiar with marine recreational

activities reported higher levels of environmental awareness and ecological intention to act (Stepath, 2006).

Research Summary

Dependent and independent variables were operationalized concerning environmental knowledge, attitudes and intention to act, and research hypotheses were established. A mixed-method research approach was utilized to better understand students' perspectives concerning their reef learning experiences and to demonstrate the particular effectiveness of reef monitoring learning experiences.

My work expands the studies of Fortner (1978, 1983) on oceanic knowledge, attitudes and experience; Kaiser, Wölfing, and Fuhrer (1999) on attitudes and ecological behavior; Hines, et al. (1986/1987) on responsible environmental behavior; and Hungerford and Volk (1990) on learning and changing learner behavior. I utilized Rickinson's (2001) review of learning and environmental education, and built on existing Australian studies (Blaikie, 1993; Blum, 1987; Clarke, 1996; Connell, Fien, Sykes, & Yencken, 1998) to include marine reef education. I argued that even though the aims of marine education in Australia are documented, and there is agreement about improving coral reef and related environmental knowledge in schools (Kenman, 2005), little is known about the environmental understanding held by Australian adolescents.

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

Possibilities for Further Research

This study demonstrates that learning interventions associated with coral reef environments create positive student responses in terms of increased knowledge, reported attitudes and ecological intention to act in respect to coral reefs. This study is the first of its kind to investigate Australian adolescent experiences of reef education and examine educational outcomes for knowledge, attitudes and intention to act. Findings demonstrate strong research support for incorporating marine experiential education into formal senior secondary school curriculum. It is possible to extrapolate that experiential education in coral reef environments

would also be valuable to students in primary schools, and this would be a productive area of future research.

The research aims were addressed using both a quantitative and qualitative methodology and both proved useful and meaningful for addressing pedagogical questions in marine education. More effort could be made to analyze effective action skills, and to investigate situational influences such as teacher training as well as parental and peer pressure. Family, school, peer groups and other predisposing factors such as race, class and ethnic background may have a big impact on the formation of adolescent attitudes and intention to act towards coral reef environments, but were not explored in this study. Other areas for further investigation are gender differences. Female students had significantly greater positive intention to act response changes after the reef experiential intervention, and the educational significance needs to be considered.

Priority could be given to comparing the results of this study with a smaller but more detailed qualitative investigation on student learning to evaluate pedagogical techniques for improving environmental attitudes and ecological intention to act. Researchers and teachers could consider spending more time discussing students' future intentions *in* and *for* the coral reef environment, and developing related critical thinking and action skills.

Conclusion

A particular methodology was demonstrated for evaluating whether outdoor reef experiential education enhanced students learning outcomes. A condensed overview of a methodology, review of literature, and research argument addressing learning outcomes generated by marine education is provided. Since marine education has evolved as a small subset of both environmental and experiential education, little research has been done concerning learning in marine environments, and this article demonstrates several methodologies.

The work contributes to marine outdoor education research by examining and measuring student learning in relation to outdoor reef sites, and structured learning interventions. The quantitative data demonstrated significant contributions of experiential education in increasing student knowledge, attitudes and ecological intention to act. The qualitative aspect of this research afforded a rare opportunity to record student accounts of their reef immersion learning experience. The combination of different methodologies provided a more in depth evaluation and understanding of changes in student learning through these experiences. Since marine education

is a unique and diverse interdisciplinary field, particular research methodologies is needed with which to support future research. A number of limitations and problems concerning this type of research were also presented for interested researchers.

Past environmental education research reveals more about environmental knowledge than about students' educational experience and preferences, and more about learning outcomes than learning processes attitudes (Rickinson, 2001). This project's evaluation method provides an opportunity for additional foci to emerge concerning student learners and their experiences of marine learning. Understanding of learning in marine education was advanced by addressing the idea of moving "away from a linear model of the role of nature experience in environmental education" (Russell, 1999, p. 127). Changes in learning along with the introduction of learning interventions brought with them new and different conceptual approaches, and an evaluation methodology was explained that evolved to record them. Issues and challenges were identified, while a method of focusing on student learning, learners, and their experiences was supplied. A multi-method groundwork was developed from which to build upon or move forward with an improved understanding of adolescent learning in reef and marine education. This work took an elemental first step in addressing the question of proximal relations between humans and reef environments, while also providing methodological examples of evaluation tools.

About the author

Dr. Stepath currently teaches in Hawaii, and has an interdisciplinary PhD in marine science education (Schools of Education and Earth Science and Environmental Studies) from James Cook University. He is a JCU adjunct lecturer, and an International Sustainability Education Consultant with SaveOurSeas.org, email: carl@saveourseas.org, cstepath@yahoo.com.

Acknowledgements

Sincere thanks go to Dr. Hilary Whitehouse, Dr. Elaine Harding and Prof. Steve Turton of JCU; the Marine Teachers Association of Queensland, Education Queensland, the Queensland Catholic Diocese, the participating principals and teachers, and all the students from the five Queensland high schools, who so willingly and graciously participated in this research.

Referencing this article

Stepath, C.M. (2006). *Reefs and learning: Education evaluation techniques*. Presented to National Marine Education Association Conference (NMEA 2006), New York City, July 20, 2006. Retrieved from <http://saveourseas.org/stepath.htm>

References

- Ajzen, I. (2001). Nature and operations of attitudes. *Annual Review of Psychology*, 52, 27-58.
- Ajzen, I. (2002). *Constructing a TpB questionnaire: conceptual and methodological considerations* [Electronic version]. Retrieved February 14, 2006 from <http://www-unix.outil.umass.edu/~ajzen/pdf/tpb.measurment.pdf>
- Ajzen, I., & Fishbein, M. (2005). The influence of attitudes on behavior. In D. Albarracín, B. T. Johnson, & M. P. Zanna (Eds.), *Handbook of attitudes* (pp. 173-221). Mahwah, NJ: Erlbaum.
- Babbie, E. (2004). *The basics of social research* (2nd ed.). Toronto: Wadsworth Publishing.
- Baker, C. (2004). Membership categorization and interview accounts. In D. Silverman (Ed.), *Qualitative research: Theory, method and practice* (pp. 162-176). London: Sage.
- Bell, A. (2003). A narrative approach to research. *Canadian Journal of Environmental Education*, 8(Spring), 95-110.
- Berry, R. S. Y. (1999). *Collecting data by in-depth interviewing*. Paper presented at the British Educational Research Association Annual Conference, University of Sussex at Brighton, September 2-5. BERA 99. Retrieved February 14, 2006 from <http://www.leeds.ac.uk/educol/documents/000001172.htm>.
- Blaikie, N. (1993). Education and environmentalism: ecological world views and environmentally responsible behavior. *Australian Journal of Environmental Education*, 9, 1-21.
- Blum, A. (1987). Students' knowledge and beliefs concerning environmental issues in four countries. *Journal of Environmental Education*, 18(3), 7-13.
- Bogner, F. X. (1998). The influence of short-term outdoor ecology education on long-term variables of environmental perspective. *Journal of Environmental Education*, 29(4), 17-29.
- Clarke, B. (1996). Environmental attitudes and knowledge of Year 11 students in a Queensland high school. *Australian Journal of Environmental Education*, 12, 19-26.

- Connell, S., Fien, J., Sykes, H., & Yencken, D. (1998). Young people and the environment in Australia: Beliefs, knowledge, commitment and educational implications. *Australian Journal of Environmental Education, 14*, 39-48.
- Denzin, N. K., & Lincoln, Y. S. (1994). *Handbook of qualitative analysis*. Thousand Oaks, CA: Sage Publications.
- Denzin, N. K., & Lincoln, Y. S. (Eds.). (2000). Introduction: The discipline and practice of qualitative research. In N. K. Denzin, & Y. S. Lincoln (Eds.), *Handbook of qualitative analysis* (2nd ed.) (pp. 1-28). Thousand Oaks, CA: Sage Publications.
- Dunlap, R. E., & Van Liere, K. V. (1978). New environmental paradigm. *Journal of Environmental Education, 9*(4), 10-19.
- Dunlap, R. E., Van Liere, K. V., Mertig, A. G., & Jones, R. E. (2000). Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues, 56*(3), 425-442.
- Environment News Network. (2003). *Coral Reef Quiz* [Electronic version]. Retrieved August 5, 2003 from <http://www.enn.com>
- Fien, J. (2004). Education for sustainability. In R. Gilbert (Ed.), *Studying society and environment: A guide for teachers* (3rd ed.) (pp. 184-200). Southbank, Victoria: Thomson Social Science Press.
- Finger, M. (1994). From knowledge to action? Exploring the relationship between environmental experiences, learning, and behavior. *Journal of Social Issues, 5*(3), 141-160.
- Fortner, R. W. (1978). Experiences related to oceanic knowledge and attitudes of tenth grade students in Virginia. (Unpublished doctoral dissertation, Virginia Polytechnic Institute, 1978). *Dissertation Abstract International 39/04-A, 2166*.
- Fortner, R. W. (1983). Knowledge, attitudes, experiences: The aquatic connection. *CURRENT: The Journal of Marine Education, 5*(1), 7-11.
- Gough, A. (1997). *Education and the Environment: Policy, Trends and the Problems of Marginalization*. Melbourne: The Australian Council for Educational Research Ltd.
- Great Barrier Reef Marine Park Authority. (2006). *Educational Resources* [Electronic version]. Retrieved March 2, 2006 from <http://www.reefed.edu.au/teaching/resources/index.html>
- Greenburg, L., Rice, L., & Elliot, R. (1993). *Facilitating emotional change*. New York: Guilford Press.

- Hines, J., Hungerford, H., & Tomera, A. (1986/87). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *Journal of Environmental Education*, 18(2), 1-8.
- Hopf, C. (2004). Qualitative interviews: An overview. In U. Flick, E. von Kardorff, & I. Steinke (Eds.), *A Companion to Qualitative Research* (English edition) (pp. 203-208). London: Sage Publications.
- Huberman, A. M., & Miles, M. B. (2002). *The qualitative researcher's companion*. Thousand Oaks: Sage Publications.
- Hungerford, H. R., Litherland, R. A., Peyton, R. B., Ramsey, J. M., & Volk, T. L. (1996). *Investigating and evaluating environmental issues and actions: Skill development program*. Champaign, IL: Stipes Publishing.
- Hungerford, H. R., & Volk, T. L. (1990). Changing learner behavior through environmental education. *Journal of Environmental Education*, 21(3), 8-21.
- Imel, S., Kerka, S., & Wonacott, M. E. (2002). *Qualitative research in adult, career and career-technical education: Practitioner file* [Electronic Version]. Washington, DC: Office of Educational Research and Improvement. US Department of Education. (ERIC Document Reproduction Service No, ED472366). Retrieved January 21, 2006 from http://www.eric.ed.gov/ERICDocs/data/ericdocs2/content_storage_0100000000b/80/28/12/c7.pdf
- Kaiser, F. G., Wölfing, S., & Fuhrer, U. (1999). Environmental attitude and ecological behavior. *Journal of Environmental Psychology*, 19(1), 1-19.
- Kenman, S. (2005). *Evaluation of the marine studies trial-pilot senior syllabus 2002-2003: Final report to the Science Syllabus Advisors Committee* [Electronic version]. Brisbane, Qld: Queensland Studies Authority. Retrieved January 14, 2005, from http://www.qsa.qld.edu.au/yrs11_12/subjects/ marine_studies/eval.pdf
- Kerlinger, F. N., & Lee, H. B. (2000). *Foundations of behavioral research* (4th ed.). New York: Harcourt College Publishers.
- Kruse, C. K., & Card, J. A. (2004). Effects of a conservation education camp program on campers' self-reported knowledge, attitude, and behavior. *Journal of Environmental Education*, 35(4), 33-45.

- Kuhlemeier, H., Van Den Bergh, H., & Lagerweij, N. (1999). Environmental knowledge, attitudes, and behavior in Dutch secondary education. *Journal of Environmental Education*, 30(2), 4-14.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage Publications.
- Marcinkowski, T. (2001). An overview of an issue and action instruction program for stewardship education. In A. Fedler (Ed.), *Defining best practices in boating, fishing, and stewardship education* (pp. 98-128). Alexandria, VA: Recreational Boating and Fishing Foundation.
- Miller, R. L., Acton, C., Fullerton, D. A., & Maltby, J. (2002). *SPSS for social scientists*. New York: Palgrave Macmillan.
- Neuman, W. L. (2004). *Basics of social research, qualitative and quantitative approaches*. New York: Pearson Education.
- O'Sullivan, E. (1999). *Transformative learning: Educational vision for the 21st century*. New York: Zed Books.
- Pollant, J. (2001). *SPSS survival manual: A step by step guide to data analysis using SPSS for Windows (Version 10)*. Buckingham: Open University Press.
- Queensland Studies Authority. (2005a). *Marine studies senior syllabus 2004* [Electronic version]. Brisbane, Qld: Author. Retrieved January 14, 2005 from http://www.qsa.qld.edu.au/yrs11_12/subjects/marine_studies/syllabus.pdf
- Queensland Studies Authority. (2005b). *Marine studies subject guide* [Electronic version]. Brisbane, Qld: Author. Retrieved January 14, 2005 from http://www.qsa.qld.edu.au/yrs11_12/subjects/marine_studies/guide.pdf
- Rickinson, M. (2001). Learners and learning in environmental education: A critical review of the evidence. *Environmental Education Research*, 7(3), 207-320.
- Rose, G. (1999). Performing space. In D. Massey, J. Allen, & P. Sarre (Eds.), *Human geography today* (pp. 247-259). Cambridge: Polity Press.
- Rudestam, K. E., & Newton, R. R. (2001). *Surviving your dissertation: A comprehensive guide to content and process* (2nd ed.). Thousand Oaks, CA: Sage Publishing.
- Russell, C. L. (1999). Problemizing nature experience in environmental education: The interrelationship of experience and story. *Journal of Experiential Education*, 22(3), 123-128.

- Sowell, E. J. (2001). *Educational research: An integrative introduction*. Boston: McGraw Hill Higher Education.
- Stepath, C. M. (1997). "Ocean pulse" coral reef monitoring project (*meaningful science education*). Unpublished master's thesis, Gonzaga University, Spokane, Washington.
<http://saveourseas.org/stepath.htm>
- Stepath, C. M. (2006). *Coral reefs as sites for experiential environmental education: Australian students – a foundational study*. Unpublished PhD dissertation. Cairns, Australia: James Cook University. (ERIC Document Reproduction Service No. ED491658).
- Stepath, C. M., & Whitehouse, H. (2006). *Encouraging proximal relations: Queensland high school students go to the reef*. Published in proceedings of NZAEE (New Zealand Association for Environmental Education) Conference, Turning Point. January 22-25, at University of Auckland. Auckland: New Zealand Association for Environmental Education. (ERIC Document Reproduction Service No. ED494918).
- Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks: Sage Publications.
- Zelezny, L. (1999). Effectiveness of environmental interventions to improve proenvironmental behavior: A meta-analysis. *Journal of Environmental Education*, 32, 5-14.