MARINE EDUCATION: LEARNING EVALUATIONS

BY CARL M. STEPATH, PH.D.

Education research related to the field of marine education is limited and evaluating students' learning outcomes associated with outdoor experiences is important for improving pedagogies. It is difficult to learn about related research designs because the amount of research literature, regarding marine education learning evaluation is small. In this article a multi-method research evaluation technique is presented and its advantages and limitation are discussed. The research consisted of a quasi-experimental design utilizing empirical analysis and structured interviews and investigated a hands-on reef monitoring experience compared to a classroom presentation. Direct reef experience, as well as student changes in environmental knowledge, attitudes, and ecological intention toward future action was investigated. This was looked at through analyses consisting of an empirical comparison of survey responses and in situ student accounts. An example of a research design and methodology was developed for evaluating outdoor marine learning with high school students. The research revealed that students who had limited experience demonstrated the greatest amount of change, and the students' original environmental knowledge was low. The combination of classroom and outdoor experience had the most impact on environmental knowledge, while the outdoor reef experience elicited the largest positive shift in attitudes and ecological intention to act. Notions of interrelations and proximities toward natural settings are important in learning, and student responses suggest a more intimate connection after reef monitoring. The study investigated both empirically and qualitatively how reef trips affect environmental learning outcomes important in marine education programs.

Keywords: marine education research and evaluation, learning outcomes, and experiential learning relationships

Students' snorkelling at Northwest Island in the Great Barrier Reef in 2003.

INTRODUCTION

Field visits are thought to be important marine education learning experiences, but outcome-based research about this pedagogy is limited. My argument is that more information concerning marine education related research designs and methodologies is necessary to improve related pedagogies. An interdisciplinary, multi-method research design was implemented and its advantages and limitations discussed. A number of associated interdisciplinary sources were assembled, and the positive and negative implications noted.

The motivation for this research derived from observing eighth grade students at a fringing reef in Kaua'i, Hawai'i. During the first visit, students were running along "picking-up" bits of the reef and throwing them; two weeks later on the next visit I noticed a change. The students began looking and calling to their friends to look, too. One usually distracted student showed another student a part of the reef, saying, "Look at this Padina [genus of seaweed], it's just like the picture we saw in the book." They placed it back into the water and continued their reef walk, with the students being more interested in the place's living plants and creatures than during the previous visit. The students' way of relating to the reef appeared to have transformed (O'Sullivan 1999) with more experience. Literature indicates a change occurs in relationships to the natural environments after outdoor learning (Stepath 1997) and interactions with plants and animals affect learning (Bogner 1998; Kruse and Card 2004); however, few studies were found relating to marine education (Fortner 1983; Stepath 2006). Observed students appeared to be affected, so a formal research design was developed to analyze changes in student learning by reef encounters.

While personally inspired by students' reef learning, it became apparent environmental experiential education was utilized in few formal education systems, despite its educational potential (Fien 2004; Finger 1994; Gough 1997). This reef-learning investigation provided information about related educational outcomes and an analytical tool for educators to use while considering implementation of learning programs. I assert that even though the aims of marine education are documented and there is agreement about low environmental knowledge in schools (Kenman 2005); little is known about researching adolescent environmental understanding (Walker and Loughland 2003), and the effectiveness of pedagogical techniques associated with marine education field trips are in question.

This work utilizes studies and theories from a number of associated fields of environmental education and psychology. The studies expanded are Fortner (1978, 1983) on oceanic knowledge and experience; Kaiser, Wölfing, and Fuhrer (1999)

on ecological behavior; Hines, Hungerford, and Tomera (1986, 1987) on responsible environmental behavior; and Hungerford and Volk (1990) on learning and changing learner behavior. Rickinson's (2001) review of environmental education was compared to existing studies of other Australian students (Blaikie 1993; Blum 1987; Clarke 1996; Connell, Fien, Sykes, and Yencken 1998) to include reef education. An aim of marine education, as stated in the Marine Studies Syllabus (Queensland Studies Authority 2005a), is to provide "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). Is this aim being realized, and how can it be evaluated?

Many educational studies demonstrate that awareness does not lead to environmental action (Hines et al. 1986, 1987; Hungerford and Volk 1990; Marcinkowski 2001), nor can education and learning be thought of as a linear relationship (Kuhlemeier, Van Den Bergh, and Lagerweij 1999; Russell 1999). In considering the affects of experience, Kruse and Card (2004) argued students' attitudes and behavior became more environmentally friendly with increased outdoor experience, but they also noted a decreasing trend of self-reported conservation behavior with increased experience. Even though experiential education has many positive outcomes, its values concerning knowledge, attitude, and actions are under scrutiny. For example, Zelezny (2000) questioned whether non-traditional educational outdoor interventions effectively improved environmental actions and argued that classroom interventions produced more change in behavior. So, research concerning coral reef experience seemed necessary.

METHODS

Marine education is interdisciplinary and implementation into schools has been difficult (Fortner and Wildman 1980; Keener-Chavis 2001; Salter and Hearn 1996). The Marine Education Society of Australasia (MESA) has supported the teaching of marine studies in the Australian school system. Their three A's of coastal and marine education are awareness, attitudes, and action, each provide learning outcomes upon which this eruditional research is based.

A quasi-experimental methodology (Babbie 2004; Kerlinger and Lee 2000; Neuman 2004) was employed and it was decided to utilize pre- and post-test surveys (Ajzen 2002; Hungerford, Litherland, Peyton, Ramsey, and Volk 1996), as well as accompanying interviews (Baker 2004; Bell 2003; Berry 1999; Denzin and Lincoln 1994; Denzin and Lincoln 2000; Huberman and Miles 2002; Sowell 2001; Strauss and Corbin 1998). Differing educational interventions, a classroom presentation, and a reef monitoring experience, were contrasted and compared with respect to the dependent variables (awareness, attitudes, and action).

Study population and experimental design

A power analysis, G-Power (version 2.1.2, http: www.psychologie.uni-trier.de: 8000/projects/gpower.html) was used to determine at least 280 subjects were necessary for statistical significance in this four-group testing. A pilot study trialed interview questions, research techniques, procedures, and educational interventions. Reflections and improvements noted from this initial study were incorporated into the design and methodology.

The study predominately utilized Year 11 (88%) high school students. Most students were enrolled in Marine Studies subjects, while teachers selected the remaining 43% from other classes (see Table 1, 'Other courses'). The study groups were as consistent as possible from one school to the next and even though not randomly selected, the researcher was not involved in this convenience sample selection process.

SCHOOL	Marine Studies (yr 11)	Other Courses (Yr 11)	Year 12 Students	Total Students
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

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

In the quantitative experimental design (see Figure 1), the study population was divided into four groups. The four categories were: Group 1 (n = 85), students with both new

classroom presentations and an offshore reef monitoring experience; Group 2 (n = 64), students with a classroom presentation, but no reef visit; Group 3 (n = 97), students with only reef monitoring, and no classroom presentation; and Group 4 (n = 74), the contrast group with no learning interventions.

Separation of the students into groups provided comparisons of the changes in student responses from the beginning to the end of the five-week project (pre-test and post-test) due to the educational interventions, and this comparison was critical in the analysis of the results (see Figure 2).

There were a total of 389 participants in the study, and the quantitative analysis utilized 320 students. There were 195

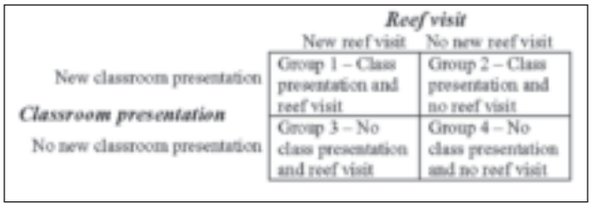

Figure 1. Study groups and respective educational interventions.

males and 125 females and their average age was 16 (range: 15 to 20 years). Certain pre- and post-test surveys were not used for reasons such as inaccurate responses, students not in class on the survey day, or students declining research participation.

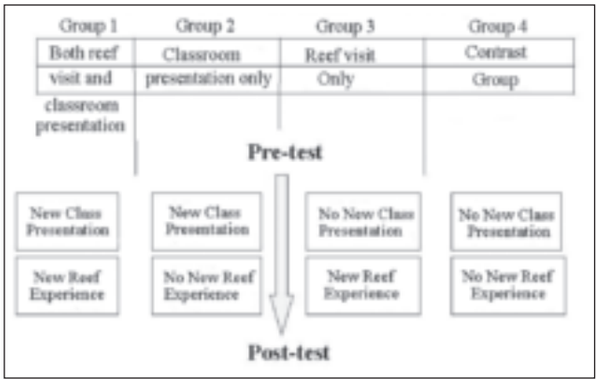

Figure 2. Project experimental design.

The hypothesis was that Group 1 (both a classroom presentation and new reef experience) would have the greatest positive change in environmental knowledge, attitudes, and ecological action (intention to act) responses, and Group 4 (contrast group) the least. Predictive modeling compared learning relationships in the Model of Ecological Intention to Act (Stepath 2006).

Survey Questionnaire

The questionnaires investigated environmental issues, attitudes, and actions (Dunlap and Van Liere 1978; Dunlap, Van Liere, Mertig, and Jones 2000; Hungerford et al. 1996), while measuring conceptual considerations (Ajzen 2002; Kaiser, Wölfing, and Fuhrer 1999) in the cognitive component. A multiple-choice answer format was used for knowledge responses. In comparison, attitudes and action 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, and a higher score meant more positive change. A six-point response scale was utilized since many of the adolescent pilot study participants answered five-point questions in the middle or 'no opinion' category. This component of the survey contained 14 questions: nine knowledge, five attitudes, and five action questions (Stepath 2006). Pre- and post-test survey instruments were tailored to Australia and tropical marine education situations.

Research Orientation

A Cronbach's alpha co-efficient computed the internal consistency of the pre- and post-test. Pre- and post-test responses greater than 0.7 indicated reliability (Miller, Acton, Fullerton, and Maltby 2002; Pollant 2001; Sowell 2001). The pre- and post-test responses were 0.830 and 0.839, respectively, and the test and re-test was 0.90.

The study population was not randomly selected, so the results may not be applicable outside the schools involved. However, the results are educationally significant, since there is little empirical research on high school students' marine and reef fieldwork experiences.

Schedule of School Research

Data collection at the five high schools coincided with pre-scheduled reef trips. The project started with School A in March 2003 and the data collection continued until November 2003 (one Australian school year), as shown in Table 2.

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

Table 2. Schedule of High School Research by School in 2003

Quantitative Data Analysis

Interrelationships were evaluated with SPSS11 exploratory statistics statistical procedures of ANOVA, Spearman's rho, Kruskal-Wallis and two-tailed Mann-Whitney U test (Miller, Acton, Fullerton, and Maltby 2002).

QUALITATIVE RESEARCH METHODOLOGY AND ANALYSIS

Qualitative Approach

Limited and structured interviews provided symbolic content relating to student reef experience and learning. The student responses and their relationship to a "reference point in experiential learning" (Greenburg, Rice, and Elliot 1993, p. 21) were compared to understand students' reef-learning experiences. The analysis followed the comparative method (Baker 2004; Bell 2003; Berry 1999; Denzin and Lincoln 1994; Huberman and Miles 2002; Sowell 2001; Strauss and Corbin 1998). Qualitative interviews "are very widely used in the context of quantitative research projects" (Hopf 2004, p. 203), and generated additional perspectives and insights about students' environmental learning.

There was one opportunity per class to conduct the in situ interviews and it was preferable to have short answers from a large number of students. The interviews were outdoors, on-

board boats, and in situations not conducive to long personal, detailed accounts. Time available was limited, leaving little opportunity to delve more deeply into themes and meanings. Nonetheless, this firsthand information increased the research depth, and presented adolescent accounts of aquatic learning experiences. Interview questions similar to the empirical research were used. The interview questions (Stepath 2006) were specific and consistent and created a basic understanding of meanings derived from reef experiences.

The group interviews, involving two to four students, enabled the students to feel more comfortable. The students gained confidence from each other's words and stories (Bell 2003). They were interviewed after the reef experience, with tape transcribing and analysis later. Parental, Education Queensland, and school principals' permission were required to use minors in this research, and if students did not feel comfortable, they were not interviewed.

Interviews

Structured interviews were conducted using a standard set of questions and provided the students' personal views about reef-learning. These verbal accounts of student experiences were intertwined into the research story (Bell 2003). These interviews provided insight into the students' viewpoints about reef-learning, and what the reef monitoring experience meant to them.

The interviews took place immediately following the reef visit, in situ, on the beach, or during the boat ride home. The students recalled their reef experiences and had an opportunity to discuss their value. This included their likes and dislikes, while it was still fresh in their minds. Many studies focus on high school students' environmental knowledge, but few concern their viewpoints and perspectives (Rickinson 2001). These interviews enable readers to empathetically share thoughts and emotions associated with reef experiences. From these statements evolve a glimpse of students as active constructors of their own learning, as they attempt to articulate their impressions.

Structured interviews allowed for the same questions on all trips and maintained a degree of reliability between different schools and student groups. The structure helped the interview process to be completed in less time and minimized disruptions from potential lack of concentration. General response patterns emerged from a large number of these interviews. The comparative method of analysis utilized (Miles and Huberman 1994) involved reading and re-reading the transcripts to establish patterns of repetition and differentiation.

No data processing program was used to analyze, read, and sort the transcripts. Analyses were conducted twice, first to make subjective and consistent judgments of responses to the structured questions; further sorting and analyzing looked for proximity concepts assessing students' abilities to locate their experiences in space and place. Proximity is defined as attachment, kinship, and nearness in space or time. In the Queensland Studies Authority (2005b) Marine Studies Syllabus, teachers are encouraged to treat marine environments as sites of learning and not just as objects of study--and this process promotes a relationship between learners and marine environments.

On the premise that environmental education research investigates relations and relationships between differing bodies, both social and physical, the research questions concern actual learning at differing sites. The initial 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? Addressing the question of "the space of relation" (Rose 1999, p. 252), a conceived space between differing bodies, and whether this changes for the student learners. The second question was: do senior high school students express a further ecological intention to act as a result of their reef immersion experiences? These inductively developed themes were categorized in these questions and re-checked against the entire list of interviews, looking for confirming or disconfirming evidence.

LIMITATIONS

Research Methodology

There were limitations relating to this methodology. Literacy, which affects students' ability to complete questionnaires, was not addressed, as student histories were not available. Only limited time was allotted for research interventions in both the classroom and at the reef. The classroom presentations were only 50 minutes with a single 50-minute, reef-monitoring experience, so the interventions were not fully developed temporally. With more time, a more methodologically developed series of interventions could have been implemented. Consistency was a major aim, but presentations and reef experiences differed slightly from school to school. These differences may have a bearing on results.

Extraneous variables such as socio-economic background, age, and education can affect research results. This homogeneous group of Australian students had approximately the same education level and age. Disparity in age, cultures, and educational attainment did exist, but were minimized because of the large sample size. Researching students in outdoor learning situations is difficult; however, the experimental design and sample size minimized the effect of extraneous variables.

Logistics and time-management were problematic for the solitary researcher, especially collecting field trip and parental consent forms, meeting schedules at geographically separate schools, and collecting interview data from students. Scheduling was an occasional problem, with classes at different times, on different days, and on different campuses, so substantial traveling was involved. The differing reef sites were surveyed prior to visits and schools were contacted for the contrast group selection in order to establish groups of students available for the research.

Limitations of the Research Data Collection

The students were not selected at random and were a convenience sample. Some were in marine studies programs and could be self-selected with an interest in ocean-related studies. This might imply they came with a positive attitude toward the environment. Nonetheless, students were tested at the beginning and end of the project and change was calculated to minimize this bias.

The contrast group was selected by staff from available classes without researcher input. Some students generated inappropriate answers, wondering, "why answer questions, there is no reward for me" and withdrew from the research. Enough students remained and provided valuable contrast group data.

Some reef visit student groups were large with 56 students, six teachers, three JCU student helpers, and one researcher. It proved difficult to teach and maintain focus with so many students on the boat and in the water. On large class trips, it was possible to keep only 60% or so of students participating in monitoring, but the remainder were actively snorkeling and experiencing the reef. The monitoring and organizational duties at the reef required total concentration and sometimes, the researcher got distracted or tired, and the quality of the interview data collection may have suffered. These situations could have affected research results.

On a few occasions the pre- and post-test survey questionnaires were administered late and problems arose retrieving the finished post-test surveys in a timely manner. These survey completion problems could have been avoided with more teacher support. In retrospect, the researcher should administer all the pre- and post-tests.

More time with the students during the interview phase would have allowed them to better expand their expressed ideas. The large student groups appeared to affect answers, as some became short and repetitive and could have been influenced by the proximity of friends and classmates. The interview experience of the researcher was a limitation, as was basing the qualitative research "on the same realist and objectivist assumptions as quantitative studies" (Imel, Kerka, and Wonacott 2002, p. 6).

Limitations of the Research Analysis

Students can hold more than one attitude simultaneously about the same phenomena (Ajzen 2001) and these can change from moment to moment (Azjen and Fishbein 2005), affecting the research analysis. Hence, different responses are assumed depending upon the situational constraints or timing involved in a student's 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. But these limitations remain extant.

The student treatment group size was dissimilar and could have affected final results, but the sample size and statistical analysis compensated for this limitation. Long-term learning effects were not studied, as the scope of this work did not allow for a longitudinal study. The effects of family, school, peer groups, and predisposing factors were not ascertained. These factors could impact the formation of adolescent knowledge, attitudes, and actions and deserve future study.

With a study of this type, the results could become self-fulfilling. Sample size, insolating variables, and utilizing analysis techniques that compared separate groups addressed this problem. Variables are missing from the model and unknown variables could be responsible for an effect, but this was out of the control of the researcher. The experimental design attempts to control for this, but it is not possible to incorporate every variable. Consequently, this work is a baseline study in Australian reef education and investigation of more variables in future research is possible.

REVIEW OF SIGNIFICANT FINDINGS IN LIGHT OF EXISTING RESEARCH

Results documented the combination of a reef experience and classroom presentation (Group 1) as the highest positive effect on increasing environmental knowledge scores. The highest changes in attitude and ecological intention to act responses were achieved by reef monitoring only (Group 2). This differed from the original hypothesis; and outdoor approaches to education are important if changes in attitudes and action are desired outcomes. Feelings of visiting and experiencing a reef affected the students and appeared to trigger large changes in their learning outcome responses (Stepath 2006; Stepath and Whitehouse 2006).

Students' environmental knowledge, attitudes, and ecological intention to act were significantly and directly correlated to previous reef experience. Previous experiences of reefs, camping, and snorkeling correlated strongly to knowledge and intention to act responses. Students with previous experiences of marine environments are more knowledgeable and have higher ecological intention to act toward reef conservation (Stepath 2006), and the findings substantiate that marine experience builds 'connections' with and to these environments (Stepath and Whitehouse 2006).

SUMMARY

This educational research overview presented various methodological processes and hypotheses testing techniques. Information concerning improved student learning and test scores related to specific outcomes is presented to continue the rejuvenation of education. A mixed-method research approach helped understand learning and students' reef experiences.

This process addressed the question of proximal relations between humans and reef environments and related learning outcome evaluation. It provides understanding of learning research methods and ways to use different learning interventions and conceptual evaluation in outdoor experiential education. Since marine education is a unique interdisciplinary field, research methodologies are sometimes difficult to bring together and actuate because they originate in different disciplines. It is hoped that this work can help in

the formulation of marine education research designs and pedagogical development.

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