CORAL REEF EDUCATION AND AUSTRALIAN HIGH SCHOOL STUDENTS

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Abstract: This paper reports on a PhD research project investigating marine education in coral reef environments along the Queensland coast. The study explored relationships between awareness, attitudes and ecological skills of high school students who were trained in coral reef ecology and monitoring in offshore sites along the Great Barrier Reef in 2002 and 2003. The research investigated the question of whether experiential marine education can change the reported environmental knowledge, attitudes and ecological agency of student participants. Some key data outcomes are presented and implications for effective marine education strategies discussed.

Introduction

Educational programs that focus on humans and their relationship to coral reefs are becoming necessary, as reef structures along the Queensland coast come under mounting ecological pressure (GBRMPA, 2003; Hughes et al., 2003; Talbot, 1995). Marine education has been defined by Roseanne Fortner (1991) as that part of the total educational process that

enables people to develop sensitivity to and a general understanding of the role of the seas in human affairs and the impact of society on the marine and aquatic environments. Improving pedagogical techniques concerning aquatic environments is valuable since continuing intensification of human activity near coastline areas adversely affects marine and coastal ecosystems worldwide (NOAA, 1998). Education can have a pivotal role in drawing attention to these problems and this study investigates various techniques of promoting sustainable futures through student training.

This education research focused on a developing field that has very few formalised objectives and outcomes. Hence, it was necessary to establish a set of criteria with which to evaluate student participants' changes with respect to achievable learning outcomes. The Three A's of Coastal and Marine Studies, MESA's (Marine Education Society of Australasia) education guidelines for marine education, were used and they relate to improvement in awareness, attitudes and agency/action (MESA, 2004). In this research, the terms of awareness, attitude and agency were defined in the following manner. Environmental awareness was understood to relate to a thing we know, as incorporated in an act of knowing or being aware of issues and action skills related to the coastal and marine environments. An environmental attitude relates to recognising the importance of ecologically sustainable development, and the conservation value of coastal and natural environments. The meaning of ecological agency was the degree of a person's intention to act in a particular situation with regard to the marine environment. The research project described in this paper investigated these factors and was carried out in Queensland during 2003.

What we have here is a story about taking senior high school students out to coral reefs, and then measuring the educational effects of their marine environmental experiences in relation to similar groups of students from varied exposures to learning. The students came from five Queensland high schools, with most of the students enrolled in senior school

marine studies programs. These students and their teachers worked with the researcher both in the classroom and at coral reef sites, with assistance provided by the Marine Teachers Association of Queensland. The students were taught about coral reef ecology in a classroom setting and then taken on a subsequent reef trip to learn coral reef monitoring. A commercial vessel was chartered, and while at the reef site students learned more about reef ecology. Once in the water they collected data about environmental indicators, such as fish and invertebrates, along a 50 m transect line. The snorkel sites chosen were Hastings Reef, Breaking Patches. Michaelmas Cay, Fitzroy Island and Green Island off shore from the city of Cairns in far north Queensland and Northwest Island offshore from Gladstone, Queensland.

All the students involved in the study live in coastal cities in what are known as 'reef neighbouring communities'. The research reviewed different types of learning situations with separate student groups and measured changes in environmental awareness, attitudes and agency. Even though the link between environmental attitudes and ecological agency has not appeared strong, the literature suggests that without a change in attitudes toward the environment and ecology there can be no change in ecological agency (Ajzen, 1988; Ajzen & Fishbein, in press). Hence, research concerning marine education and impacts in reef neighbouring areas are important when considering students' ecological relationships.

My research explored ways of thinking about a possible change process and the nexus between marine experiential education, environmental awareness, attitudes, and ecological agency. The challenge was to develop methods for answering questions about how marine experiential education performs with respect to outcomes. This study builds upon a number of previous studies regarding Australian students' environmental awareness (e.g. Alphabetised - Blaikie, 1992, 1993; Clarke, 1996; Connell et al., 1998; Fien, Yencken, Connell, & Sykes, 2002; Finger, 1994; Schaper, 2002; Skamp, Boyes, & Stanisstreet, 2003;

and Whitehouse, 2002). The benefit to participating students was they learned fieldwork skills, learned more about reef ecology and gained insight into marine work.

Methods

The effectiveness of classroom learning and reef trips were investigated by collecting both descriptive and survey data to evaluate which types of marine education interventions and strategies worked best to enhance young adults' propensity for positive attitudes and actions towards coral reef sustainability. Students were subjected to differing levels of exposure to classroom learning and direct experience with reefs. Self-reported changes of students' awareness, environmental attitudes and ecological agency intentions were analysed after they participated in a coral reef monitoring program and were compared to a control group from the same schools who received no educational interventions. This program consisted of a classroom presentation and an actual reef experience.

Classroom presentations consisted of PowerPoint and hands-on education conducted by the researcher, who explained reef ecology and relationships between terrestrial environments and coral reefs. The 30 to 60 minute presentations introduced pictorial representations of reef creatures to be counted, a coral polyp role-playing dance involving the students, and a classroom demonstration of coral reef monitoring activities. All this was done in preparation for the students' trip to the reef.

The reef experience consisted of a trip to the reef on a charter vessel with 26 to 55 students, and a review of the indicator species for identification purposed in preparation for monitoring. The students snorkelled along the transect line on the reef, recording information on their underwater slates and were assisted by the researcher and their teachers. The monitoring methodology was developed by Reef Check International (Hodgson & Stepath, 1999), which is a coral reef monitoring program developed for use by volunteer groups all around the world (www.reefcheck.org). The data collected by the students was not submitted,

as this was a training exercise, providing an opportunity to structure the reef experience and for the students to learn a useful marine monitoring technique. The monitoring procedures provided a context for the students to learn the reef ecology, actually get in the water with the animals and physically write down what they saw, while also enhancing the relationship building experience between students and the reef.

Figure 1

Educational Intervention Sample Groups
Reef Experience

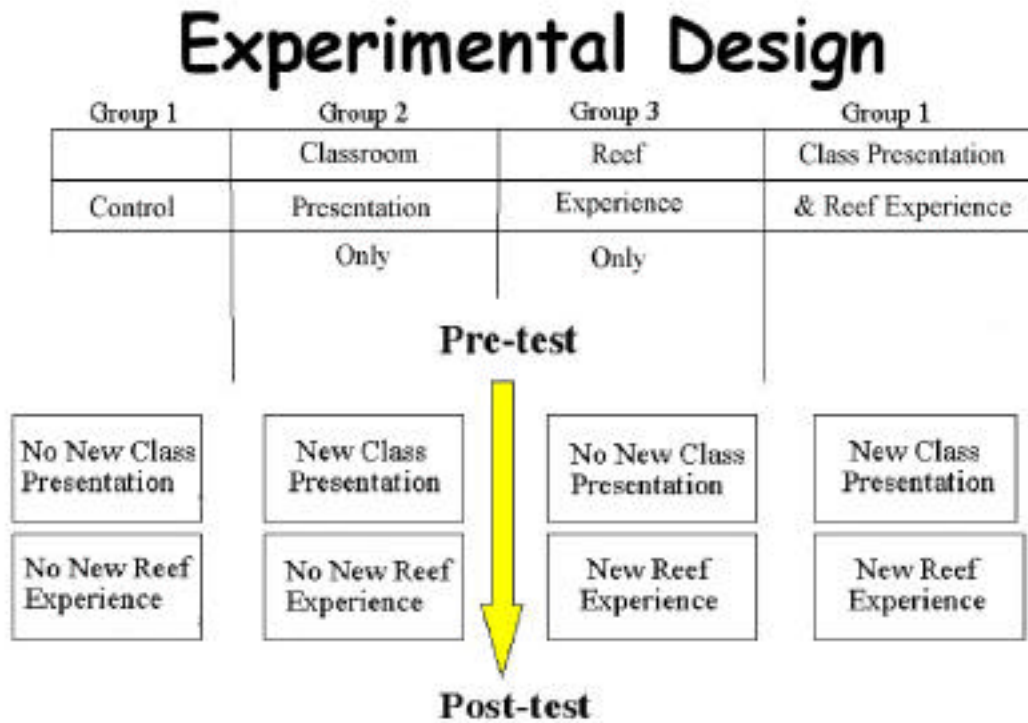|	New reef experience	No new reef experience
New classroom presentation	Group 1- reef trip & Class presentation	Group 2-No reef trip &Class presentation
Classroom Presentation No new classroom presentation	Group 3-reef trip & No Class presentation	Group 4-No reef trip, No Class presentation

The total number of high school students used in this analysis was 320 (n = 320), and the sample was divided into the four groups depicted in Figure 1, and then compared. Students groups were surveyed and observed in a number of learning situations to gather educational outcome data. The categories were a control group (Group 4, n = 74), who were surveyed over the same length of time, but were not given the classroom presentation or a reef trip (Figure 1). This group had no contact with the researcher. Group 3, was a collection that only received new reef experience, and did not receive the prior classroom presentation (n = 97). Group 2 received the classroom presentation, but was not taken to the reef (n = 64). The marine experiential education group (Group 1, n = 85) was exposed to both the classroom presentation and an offshore reef experience (Figure 1).

A pre-test post-test experimental design was used to measure reported changes in environmental awareness, attitudes and agency and provided the data analysed in this research. It incorporated a survey questionnaire, which was answered both before and after

the educational interventions (pre-post test) as shown in Figure 2. Attitude and agency

questions were designed using a six-point response scale: 6=strongly agree, 5=somewhat

Figure 2

Experimental Design

Group 1	Group 2	Group 3	Group 1
	Classroom	Reef	Class Presentation
Control	Presentation	Experience	& Reef Experience
	Only	Only	

Pre-test

No New Class Presentation	New Class Presentation	No New Class Presentation	New Class Presentation
No New Reef Experience	No New Reef Experience	New Reef Experience	New Reef Experience

Post-test

agree, 4 = mildly agree, 3 = mildly disagree, 2 = somewhat disagree, and 1 = strongly

disagree. Therefore, a score of 6 on a statement denotes the most positive attitude or agency

and a score of 1 denotes the most negative score, so the higher the score the more positive the

attitude or agency. It was decided not to have a middle or noncommittal score, and the scale

was designed such that the participants had to choose to be either positive or negative.

Numerical scores assigned to responses were reversed for negatively worded statements, and

this was done to prevent an individual from developing a pattern of answering the statements

in a certain way, such as agreeing with all the statements (Babbie, 2002). The answers from

the nine questions in the awareness portion of the questionnaires were scored in both the pre

and post-test and then, the two were subtracted to get a measure of change. This survey

instrument was used to test the hypothesis that the control group (Group 4) would not have

increased awareness, attitudes or agency in regard to coral reefs, and Group 1 with new reef experience and awareness would have the most increased awareness, attitudes and agency or all the groups. The student groups each answered the pre-test in a classroom situation at the beginning of the project, and then were subject to the designed educational interventions. One week after their last educational intervention, the students answered the post-test survey instrument. Information such as gender, age, education level, previous reef, snorkelling and camping experience was collected on the pre-test.

Results

A few key initial results from an exploratory analysis in SPSS (Statistical Package for the Social Sciences, version 11) showed that students in Group 1, who were given both a classroom presentation followed by a reef trip, demonstrated the greatest change in their awareness scores. A significant relationship was also seen between past reef experience and changes is attitude and agency questions noted it this results section. In this report, no results are shown about the relationship between awareness, attitudes and agency since a measure across scales has yet to be analysed.

A comparison of awareness change between the four different student groups are shown in Figure 3. The changes in positive answers for the nine awareness questions from the pre-test to the post-test is shown along the vertical axis, with the groups shown along the horizontal axis. Group 1, which had both reef ecology information and reef experience displayed the most change in survey scores, while Group 3 and Group 4 showed little change. The effect of the classroom presentation was seen in the results from group 2, whose changes in knowledge/awareness scores were higher than both groups 3 and 4, so a positive outcome was also displayed here. This was expected since neither Group 3 nor Group 4 received the classroom presentation on reef ecology. However, the students that received both the

classroom and reef learning intervention had the highest amount of positive change on their knowledge/awareness scores.
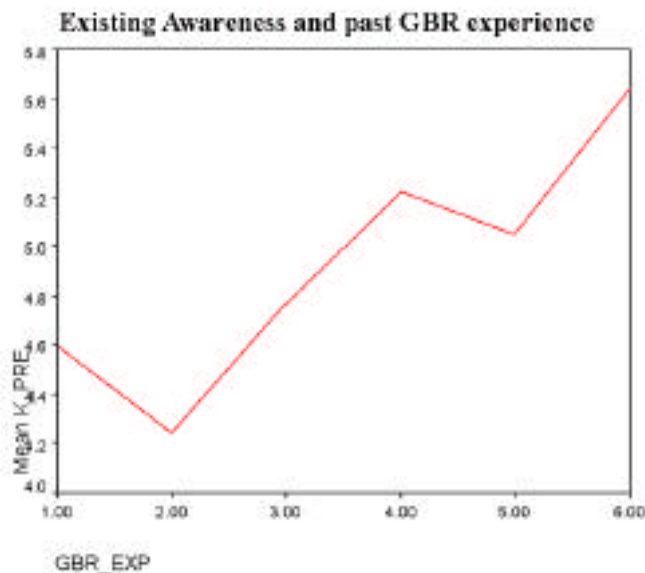

Figure 3
Knowledge/Awareness per Group
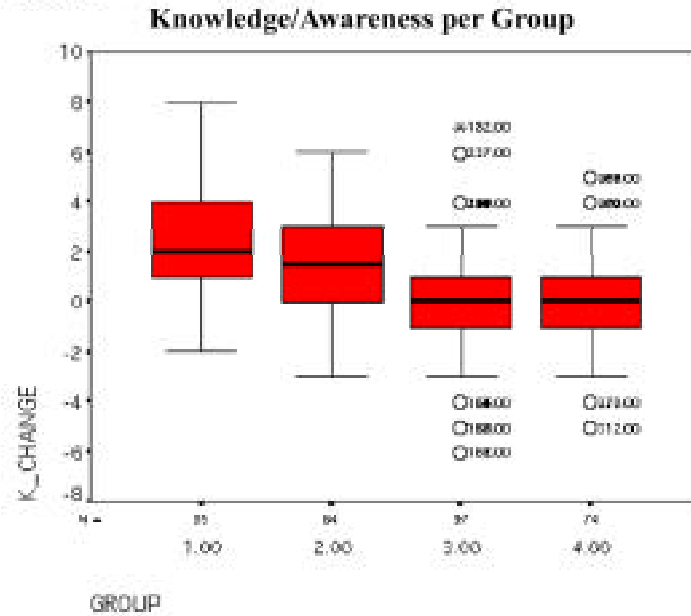
Another related item to note was that on the pre-test, students scored very low on knowledge and awareness concerning coral reef habitat. Clarke (1996) and Skamp et al. (2003) had stated in their writings that Australian students scored low on knowledge survey questions concerning the environment, and this research found similar results for the senior high school students in the five schools surveyed. For example, the survey question: The Great Barrier Reef is located off the coast of mainland Queensland because - Corals need clear water which is low in nutrients; was only answered correctly by 18% of the students overall on the pre-test. Other areas of learning outcomes were also investigated, and these related to past experience with the reef environment.

Previous experience at the Great Barrier Reef appeared to influence the change in environmental awareness because of a high number of correlations of GBR experience to awareness change. In Figure 4, we see that mean awareness scores in the initial survey (pre-test) are positively related to past GBR experience. The horizontal axis represents an

increasing amount of past reef experience as the numbers approach 6.00, and the vertical axis represents the arithmetic mean of students' knowledge/awareness scores on the pre-test. The graph (Figure 4) shows that as the awareness increases, so does the amount of past reef experience, so there appears to be a direct relationship between the two.

Figure 4

Existing Awareness and past GBR experience

Previous experience at the Great Barrier Reef (GBR) appears to also influence a change in attitudes. In Figure 5, the relationship between increased past GBR experience and positive attitudinal answers can be seen on the graph showing the answers concerning question 36 (Q36) on the pre-test. As the amount of past GBR experience increases (horizontal axis), so do the students' positive answers concerning their propensity to give generous support for environmentally sensitive issues such as financial support for solar energy (vertical axis). This environmental attitude was shown to be positively related to past GBR experience in this case, since the mean attitude score (answers from 1-6) increased on the horizontal axis. The amount of past GBR experience was measured along the horizontal

axis, with the answer 1 representing having never visited the GBR, and 6 representing twelve

or more visits. The positive relationship revealed in Figure 5 demonstrates that

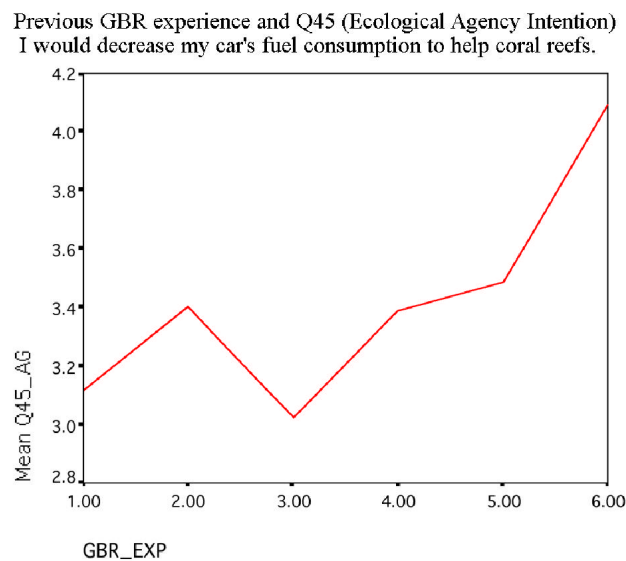environmental attitudes in this study were affected by past experience with reefs.

Figure 5

Change in Q36 and GBR Experience
The government should give generous financial support to solar energy
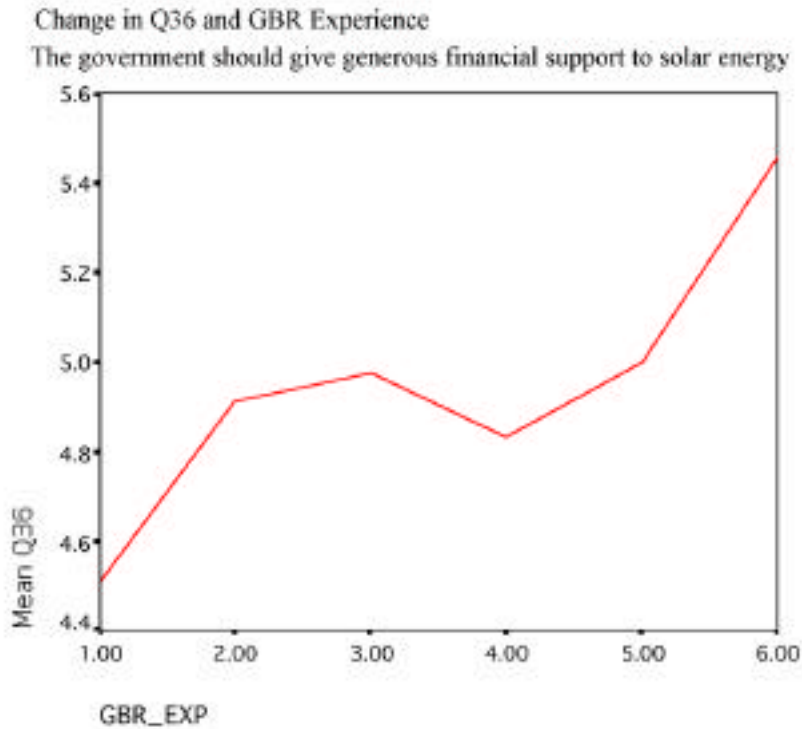
Previous experience at the Great Barrier Reef also appears to influence changes in

ecological agency. There were high correlations between past GBR experience in participants

and agency intention questions. One sample of this is the graph in Figure 6, which shows that

previous experience at the GBR had a positive effect on an ecological agency answers to

question 45 (Q45) on the pre-test. As the amount of past GBR experience increases

(horizontal axis), so do positive responses to Q45 (vertical axis), which is a self-reported

ecological agency intention question (The government should give more financial support for

solar energy). The amount of past GBR experience was measured along the horizontal axis,

with 1 representing having never visited the GBR and 6 representing twelve or more visits.

Agency intention was shown to be positively related to past GBR experience on Q45, since

the arithmetic mean of positive answers to the question increased on the vertical axis, as the amount of past reef experience increased. A scale incorporating the entire array of agency questions has not yet been found, at this time, so all the agency questions are being analysed individually.

Figure 6

Previous GBR experience and Q45 (Ecological Agency Intention)
I would decrease my car's fuel consumption to help coral reefs.

A complete data analysis for this project is not contained in this piece of writing. The article was too short to include all the results and the analysis has not been completed. Scales incorporating the entire array of environmental attitude and ecological agency questions has not been formalised at this time, so all the attitude and agency questions have been analysed individually. More analysis results will be available later in the complete PhD thesis.

Discussion

A formal theoretical framework and rigorous epistemological methodology has been used in this Australian baseline marine educational research study. The study's experimental design contains the use of a control group; the participation of students from five different schools from a number of demographic and educational backgrounds, and the experimental

design is based on several established theories that cross a number of academic disciplines.

The number of awareness survey questions was limited to nine, but this data substantiated the findings of previous studies that have shown low scores for Australian students to questions about the environment (Clarke, 1996 and Skamp *et al.* 2003). This problem could be a reflection of the marginalisation of environmental education in Australian schools (Gough, 1997; Walker & Loughland, 2003), and indicated a need for more training in marine studies and reef ecology. If students will be expected to make wise marine related decisions in the future, then this score needs to be improved. A unified curriculum throughout entire educational school systems incorporating marine and environmental subjects likely to improve the test scores for students concerning the environment. These results demonstrate that environmental awareness of students was highest in the group that received both a classroom and a related direct experience at a reef. They also point to a positive link between past experience with the reef and knowledge, attitude and agency scores. These results illustrate positive reasons for promoting continued visits to the reef by Queensland students if an increase in environmental awareness, attitudes and ecological agency is desired.

Marine education in Australia aims to assist students to develop the awareness and skills, which enable them to contribute to ecologically sustainable marine environments (Duncan, 1998). The educational outcome guidelines for marine education established by MESA (2004) mention the importance of the Three A's of Coastal and Marine Studies, awareness, attitudes and agency, and this study has investigated them in an experiential context. Outdoor types of marine education exhibited a positive effect on the awareness and agency of participants. If Australia and the oceans are indeed in the midst of an environmental crisis then it is time "to take seriously the *means* by which we come to conduct our lives as this will offer us opportunities for conducting them differently" (Ferreira, 2000, p.34). One of the *means* to conduct our lives differently is 'agency', and

hence research methodologies that enhance learning strategies related to improved ecological agency are vital. The results of this study indicated that experiential education, which uses learning experiences from both the classroom and a coral reef setting, was effective in producing improvements in environmental awareness and attitudes, along with increased ecological agency. It demonstrated that marine field trips and outdoor experiences were very important in increasing environmental knowledge, attitudes and agency of the student participants in this project.

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