

The Effectiveness of a Marine Environmental Education Program in the Maldives



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Disclaimer

I, Florence Barraud, declare that I understand the University's regulations pertaining to plagiarism and that every aspect of this dissertation is my own work. All sources that I have used have been acknowledged and cited in the reference list. My word count is 4,999 excluding the project title, disclaimer, acknowledgements, reference list, figures, tables, legends and appendices.

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Abstract

The Maldives relies heavily on healthy marine biodiversity, which is poorly protected and increasingly vulnerable to anthropogenic and climate-change associated threats. Environmental education is a key tool for effective marine environmental management. Incorporating environmental education at school is a key way to develop environmentally aware individuals that can mitigate environmental issues and assist sustainable development. A four-month marine environmental education program was developed and implemented in a Maldivian secondary school. Pre-program and post-program surveys were used to assess students' marine environmental engagement, knowledge and awareness, and the effectiveness of the program. Statistical tests were performed to identify categorical relationships, assess differences in pre and post-program survey results and examine the influence of gender or school grade. Students' marine engagement, awareness and knowledge increased after the program. The program was highly effective, and increased participants in-water confidence, proenvironmental behaviour and recreational and academic interest in the sea. Considerable gender disparity was identified, with females scoring lower than males in all categories. Religious principles or cultural norms could have impacted females' significantly lower marine engagement scores. Lower marine participation may be linked to lower awareness or knowledge. Further research is necessary to examine categorical relationships and address gender disparities in marine participation. The study shows environmental education could increase the number of young Maldivian's in marine conservation occupations and mitigate a prevalent secondary-school environmental education deficiency.

Environmental education that incorporates learn-to-swim components should be instated nationwide to increase marine environmental participation, awareness and knowledge, and improve environmental management.

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Introduction

Marine ecosystems are under increasing threat from anthropogenic and climate change-associated stressors globally (Gross *et al.* 2016).

Advancements in technology and resource availability mean humans have the ability to mitigate many of these environmental threats (Wals *et al.* 2014).

However, deficiencies of corporate, societal and individual environmental awareness and willingness to act environmentally responsibly are major impediments to achieving marine environmental protection (Fah and Sirisena 2014).

Environmental education (EE) was developed in the 1960's, aiming to engage people in sustainability challenges in response to growing environmental crises (Wals *et al.* 2014). The goal of EE is to enhance students' awareness and concern about ecosystems and ecosystem problems and increase environmental and conservational behaviour (Bogner 1998). Young people that are environmentally aware and empowered may be the greatest catalysts of change for the long-term protection of the environment, and EE is a key driver for this change (Erhabor and Don 2016). Integrating EE at school plays a vital role in developing environmentally sensitive individuals who possess sufficient knowledge to solve environmental problems and assist sustainable environmental development (Fah and Sirisena 2014).

The Republic of the Maldives is an island nation comprising 26 geographical atolls and ~1,190 islands, 196 of which are inhabited by local communities or a growing tourist resort industry (MEE 2015). It is an entirely Muslim nation,

as mandated by its constitution (Fulu 2007). The Maldives faces the bulk of issues posed by climate change, notably ocean warming, increased weather disturbances and sea level rise (Jaleel 2013). Additionally, pollution and waste management issues threaten the high biodiversity of the nation, and the ecosystem services this provides (Hamel and Andréfouët 2012). Tourism and fishing are the main income sectors and sources of employment in the Maldives, both of which are vulnerable to climate change and reliant on sustained biodiversity protection (Shareef 2016). Consequently, marine ecosystem protection is vital for sustainable development in the Maldives (Shareef 2016).

The Maldives has a high literacy (~98%) and school-enrolment rate, and formal education is valued amongst communities (Shareef 2010).

Environmental awareness is low amongst the Maldivian public (UNDP 2015) and EE - a key tool for effective environmental management – has not been utilised strategically to address this (Smith et al. 2006). 'Environmental studies' is a mandatory subject for primary school students in the Maldives, after which EE is dropped from the core curriculum (Shareef 2016). The environmental studies module has, however, been criticised for its focus on highlighting environmental issues without teaching students solutions (Smith et al. 2006). Additionally, the module is textbook-based and exam-orientated and does not incorporate enough outdoor activities to conduct activity-based learning (Shareef 2010). Secondary-school students study 'science' in the core curriculum, however interrogation of the syllabus reveals just 7% of the

109 hour-allocated annual science syllabus relates to environmental studies (Ismail *et al.* 2017).

In grades 8-10, some schools offer the option to study 'Fisheries science' as a Cambridge O'level, which encompasses education on fish ecology, biodiversity and physiology, and fishing industries (CIE 2009). However, many schools do not have sufficiently qualified teachers or resources to offer this, exacerbating the secondary school EE deficiency (Shareef 2010).

Considering this deficiency and the dependency of Maldivians on the ocean, initiatives to increase environmental awareness through EE appear essential (Smith *et al.* 2006). The marine environmental education program (MEP) piloted in this study aims to address EE gaps and assess how effective EE is in one Maldivian secondary school. The research questions comprised:

1. Can a MEP affect participant's marine environmental engagement, awareness, or knowledge, and how effective can it be?
2. Does school grade or gender affect marine environmental engagement, awareness, knowledge, or the effectiveness of the MEP?
3. Could an MEP fill secondary school EE deficiencies, and could an MEP be viable long-term?

Methods

The Program

The marine environmental education program (MEP) runs from July to November 2017. The program was implemented in one Maldivian school for students in 8th and 9th grades and 13-16 years old. The program was developed and implemented by myself and the education officer for the Maldivian Manta Ray Project (MMRP) (hereafter 'the researchers'). MMRP is the founding project of the Manta Trust, a UK registered charity that promotes conservation through research, awareness and education¹. The MEP was supported logistically and financially by Manta Trust and the 'Four Season's Resort at Landaa Giraavaru', the luxury tourist resort where MMRP is based.

The study school is situated on a small local island with an area of 0.18km², located in northern Baa Atoll, in the central-western Maldives². The island has a population of approximately 1000 people, and the major livelihoods comprise traditional fishing and thatch making³. The school was selected because it does not offer the Fisheries science O' Level, and therefore secondary-level students do not receive sufficient EE (Smith *et al.* 2006). A Memorandum of Understanding was signed by the schools headteacher and MMRP to establish an official partnership regarding the MEP. Additionally, permission to conduct the MEP was verbally obtained from the Ministry of Education.

Prior to the MEP, an inauguration day ceremony was held to inform students, parents and teachers about the MEP, after which students could choose to register. Following the ceremony, all eligible students were given a swimming and snorkelling lesson by the Four Seasons recreation team, designed to assess students' swimming ability and increase in-water confidence prior to snorkelling fieldtrips. The modules taught in the MEP comprised: tropical marine ecosystems, coral reef ecosystems, turtles and reef fish, waste, marine protected areas and biosphere reserves, and climate change. These topics were chosen in an aim to enhance Maldivian young peoples awareness of the most relevant issues to them in local (e.g. waste) and global (e.g. climate change) contexts (Jaleel 2013).

The course materials are shown in Table 1 and were created by the researchers, who possess extensive knowledge of marine science and practical experience in teaching and outreach. The program was taught in English, the required teaching language in all Maldivian schools (Shareef 2010). All students possessed a high level of English language. Each session included information on the wider context of the ecosystem or environmental issues, and Maldives or atoll-specific information, to ensure the material was relatable and engaged the students (Presley *et al.* 2013). For each topic, the researchers conducted a 30-minute theory presentation, 90-minute practical, half to full-day fieldtrip, and assigned homework, which was reviewed in the subsequent session. The MEP comprised 50 hours of teaching, and Figure 1 shows hours allocated to each teaching medium. Content for each module was collated on 16-gigabyte memory sticks provided for each student by Four

Seasons, reflecting the programs sustainability focus. This included 1000-2000 word topic handouts, which comprised textual information and graphics to help students understand each topic and complete the homework; an example is provided in Appendix A.

Table 1: Table to show the modules and associated activities included in the marine environmental education program. For each of the six modules, students were given a theory lesson, practical, fieldtrip and homework. Descriptions of content included for each topic are displayed in the table. The climate change module has not yet been completed. Hours assigned to each teaching medium are displayed in Figure 1.

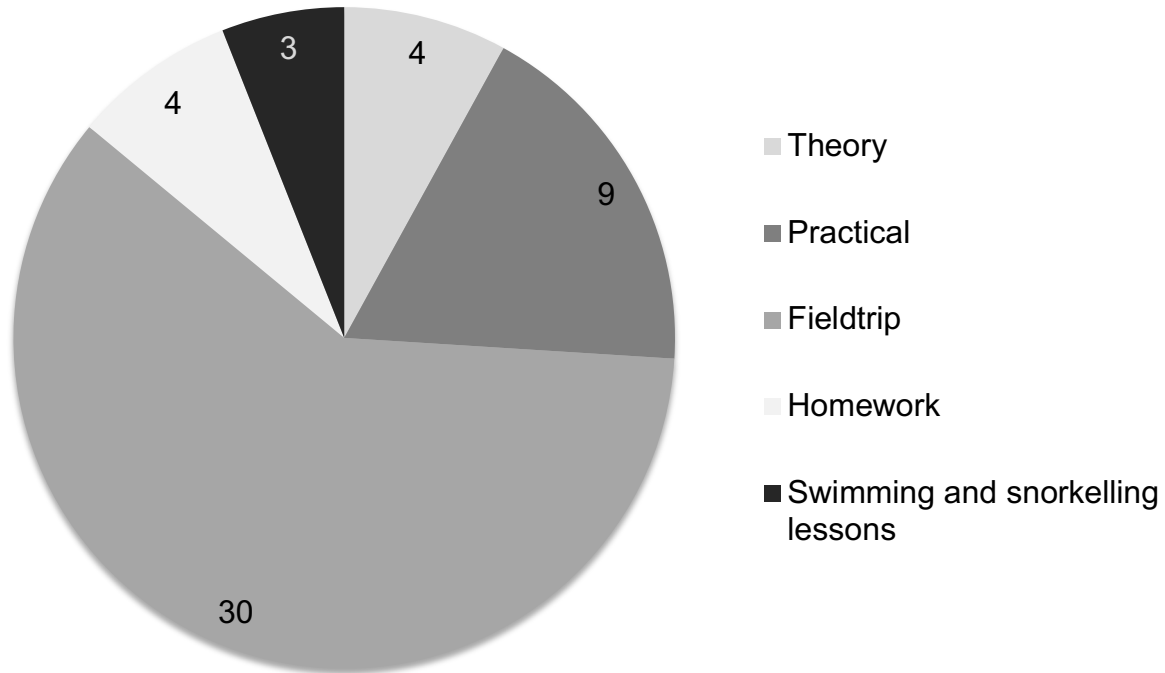
Topic	Theory Lesson	Practical	Fieldtrip	Homework
Inauguration day ceremony	Information provided for parents, teachers and students about the schedule and content of the program.			
Snorkelling and swimming lesson		2x 1-hour swimming and snorkelling lesson given to students by trained Four Seasons's recreation staff.		
Tropical marine ecosystems	Presentation on tropical marine ecosystems: Coral reefs, mangroves and sea grass beds. The importance, threats and protection strategies are discussed for each ecosystem.	Exploring the Kendhoo beach ecosystem using a sandy shore species, threats and values identification guide and discussing group discoveries.	Trip to Four Seasons Landaa Giraavaru - tour around Marine Discovery Centre, Turtle Rehabilitation area (turtle feeding and physiotherapy), and creation of coral frame.	Questions about the marine ecosystems discussed in the theory class and why we need to build artificial coral reefs and rehabilitate turtles at Four Seasons (Threats to turtles and coral in the Maldives).
Coral reef ecosystems	Presentation on coral reefs: Importance, threats and protection strategies, and reproduction and ecology.	Coral jenga: Students given cards with threats or protection strategies for coral reefs written on. On	Snorkelling on school islands house reef and having different species and threats to coral, and	Answering questions from photographs taken on fieldtrip about different

		their turn, they must read their card and remove blocks from the bottom of the Jenga if it is a threat and from the top if it is protection.	animals that utilise coral, pointed out by Four Seasons coral biologist for discussion.	species, ecology of coral and threats to coral.
Turtles, reef fish and sharks	Presentation on turtles, reef fish and sharks in the Maldives, comprising the importance, threats and protection strategies for each one.	Turtle hatchling survival game: Students must roll an 8-sided dice with photographs of different turtle threats and protection strategies. If students get a protection strategy when they roll they go through to the next round (three rounds: nesting, hatching, juvenile). Game illustrates how low turtles chances of survival are with human threats involved.	Snorkelling on islands house reef with different species and threats to turtles and reef fish pointed out by Manta Trust researcher and discussed with students.	Answering questions from photographs taken on fieldtrip about symbiosis, different species of turtles and reef fish, and ecology and threats to turtles and reef fish.
Waste	Presentation on different types of waste, environmental issues caused by poor waste	The Four Seasons housekeeping department made 26 shoulder bags	Tour around Soneva Fushi luxury resort waste management centre and	Practical group project: 3 groups of 17 students that attended field trip

	management and environmentally responsible waste management practices.	from old bed sheets and the researchers dyed the bags and created marine themed animal and eco message stencils. Students printed their own recycled, reusable shopping bags with the stencils to encourage reduction of single-use plastic bag use.	organic garden by Soneva Fushi Eco-team staff.	have to create recycled, reusable litter bins from rice bags and wood; a compost bin for the school, and organise a community beach clean-up. To encourage a proactive, creative environmental mind-set.
Marine Protected Area's and Biosphere reserves	Presentation on marine protected areas and Biosphere reserves: Why they are important and under-represented in marine management.	Presentation given by Hanifaru Bay Biosphere reserve rangers about the history, management and benefits of having the Baa Atoll Biosphere Reserve, and the ranger's daily jobs.	Tour around Hanifaru Bay by rangers and snorkelling with manta rays inside Hanifaru Bay with rangers and Manta Trust staff	Handout asking questions on manta rays, why we need marine protected areas and benefits of marine protected areas.
Climate change	Presentation on climate change: the greenhouse effect, ocean warming and acidification, sea level rise,	Watching 'Before the Flood', an educational documentary/film about climate change, and discussing it afterwards.	Painting climate change themed wall mural with artists from Four Seasons on a large public wall on the school	To be confirmed

	and the Maldives and climate change.		island (wall donated by the council).	
Examination	Will include multiple choice questions on each topic			
Discover Scuba Diver Course for 5 students	Awarded to student's with top exam results and provided by Four Seasons Dive Shop			

Figure 1: Pie chart to show hours allocated to each teaching medium of the marine education program. Numbers on the pie sections represent number of hours spent teaching each medium. There were 50 taught hours in total.



The Survey

The effectiveness of the MEP was assessed using the pre and post-treatment survey method, a valuable method for assessing treatment impacts in education research (Cohen *et al.* 2011). The treatment in this study was the MEP. The surveys are presented in Appendix B and C, and Table 2 illustrates the themes addressed by each survey question. The pre and post-program surveys comprised 18 questions that addressed participants' engagement, awareness and knowledge. An additional 11 questions in the post-program survey assessed MEP effectiveness directly. The surveys used a triangulated approach, combining quantitative and qualitative methods to achieve a rich and comprehensive understanding of the research phenomenon (Hussein 2009) and answers to the research questions (Bryman 2015). Many questions used a Likert-scale format, whereby ordinal responses are coded using a 5-point scale. This is a reliable method to collect and analyse survey data for useful statistical analyses (Li 2013). Participants have not yet completed the 'climate change' module so this was deducted from survey questions. Survey completion could not be delayed until completion of the MEP due to the researchers time constraints.

Table 2: Table to show research questions addressed in each of the five categories. The questions included for analyses in each category are listed alongside possible responses. When 'likert' is written next to a question, that question used an ordinal likert scale in which the first possible response was coded 1 and represented the lowest engagement/awareness/knowledge/effectiveness, and the last possible response was coded 5 and represented the highest engagement/awareness/knowledge/effectiveness. Some questions included in the surveys (Appendix B & C) were not analysed in this study because their purpose was to provide information for Manta Trust's future programs.

Topic	Research questions	Questionnaire questions
Demographics	Who is answering this survey? Does age or gender affect other responses in the survey?	What is your age? What is your gender? (Male/female)
Marine environmental engagement	How often do participants go in the sea, and are there barriers to participants going in the sea as often as they would like to?	Q1: How much time do you spend in the sea for fun? (Likert scale) Q2: Do you enjoy being in the sea? (Likert scale) Q3: How much time would you like to spend in the sea for fun? (Likert scale)
	Why is the sea important to participants (culturally, environmentally, recreationally or economically)?	Q4: How important is the sea to you? (Likert scale) Q5: If the sea is important to you underline the reasons that could explain why (list of 19 reasons split into cultural, environmental, recreational & economic options; response: yes=1, no=0) Cultural: a) My family are fishers b) I like to draw the sea and things that live in it c) I like to learn about the sea and things that live in it d) The sea gives me a good feeling in my heart e) My family has loved or valued the sea for a long time

		<p>Environmental:</p> <ul style="list-style-type: none"> a) I like the animals that live in the sea b) I want the ocean to be healthy c) I think the ocean should stay healthy for people in the future d) I think a healthy ocean can provide good things for humans e) I think we have a responsibility to care for the oceans <p>Recreational</p> <ul style="list-style-type: none"> a) I like fishing b) I like watching birds or other animals c) I like going on boats d) I like going to the beach or shoreline e) I like swimming in the sea f) I like snorkelling or diving in the sea <p>Economic:</p> <ul style="list-style-type: none"> a) The sea provides me/my family with a lot of our money b) The sea provides me/my family with a little of our money c) I collect some food from the ocean d) The sea is important for bringing money to my island
	<p>Where do participants get information about the marine environment?</p>	<p>Q6: From where do you get your information about the sea?</p> <ul style="list-style-type: none"> a) Television b) School/teachers c) Radio d) Internet e) Magazine/newspapers f) Family/friends g) Other...

Self-perceived marine environmental knowledge	How much do participants think they know about the marine environment and threats to the marine environment?	<p>Q7: How much do you think you know about the sea? (Likert scale)</p> <p>Q9: How much do you think you know about the threats to the sea listed below? (Likert scale for each threat)</p> <ul style="list-style-type: none"> a) Climate change b) Over fishing c) The idea of exploring the sea to find oil or gas d) Damage to marine habitats e) Ocean acidification f) Sea level rise g) Reduction in biodiversity h) Invasive animals or plants i) The effects of fishing on the sea j) Aquaculture (Farming fish for food) k) Pollution from human waste or farming l) Pollution from plastic or litter
Marine environmental awareness	How aware are participants about the importance of protecting marine environments?	<p>Q8: Do you think the sea in the Maldives is under threat? (Likert)</p> <p>Q11: Do you think threats to the sea in the Maldives will increase or decrease in the next 100 years? (Likert)</p> <p>Q12: Do you think it is important to work to decrease threats to the sea? (Likert)</p> <p>Q13: When an area of the ocean becomes a marine protected area, people who use the area may have to stop doing things like fishing, collecting or dredging, do you think this is OK? (Likert)</p> <p>Q17: On a scale of 0 (not important at all) to 10 (extremely important), how important do you think environmental conservation in the Maldives is? (Circle a number between 1 and 10)</p>

	If participants had one wish for the future of the sea in the Maldives what would it be?	Q18: If you had one wish for the future of the sea in the Maldives what would it be?
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<p>Marine environmental education program effectiveness</p>	<p>Has the MEP furthered participant's interest, passion or involvement for/in marine conservation?</p>	<p>Q16: Would you like to become a marine biologist or conservationist for your job?</p> <ul style="list-style-type: none"> a) No b) Yes c) Don't Know <p>Q19: Has taking part in this program made you want to learn more about the sea, or help to protect the sea in the future? (Likert)</p> <p>Q20: Has taking part in the program made you care more about the sea and environmental issues? (Likert)</p> <p>Q21: Since taking part in the program, have you made an effort to get involved in any activities to help the sea or environment?</p> <ul style="list-style-type: none"> a. No b. No, but I intend to: <i>Please explain what you intend to get involved in:</i> c. Yes <i>If yes, please explain what you have already gotten involved in:</i> <p>Q26: Would you like to have had more lessons about the sea and threats to the sea whilst you were at school? (Likert)</p> <p>Q27: Has taking part in the program made you change your environmental behaviour in any way?</p> <ul style="list-style-type: none"> a. No b. No, but I intend to <i>Please explain what you intend to change:</i> c. Yes <i>If yes, please explain how your environmental behaviour has changed:</i>
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	<p>Has the MEP increased participant's in-water confidence or marine environmental engagement?</p>	<p>Q1-3 (engagement) Q24: Did the swimming and snorkelling lesson make you feel more confident in the sea? (Likert scale) Q25: Did the fieldtrips make you feel more confident in the sea? (Likert scale)</p>
	<p>Have the participants shared their knowledge from the MEP?</p>	<p>Q28: Have you passed any of your knowledge/information learnt from the marine biology program onto others, like family members or friends? 1. No 2. Yes <i>If you answered YES to question 28, please answer the 3 questions below:</i> 28a. What knowledge/information did you pass onto others? 28b: Why did you want to tell others about what you learnt? 28c: Do you think you have affected your family or friends' environmental behaviour, knowledge or attitude in any way? Describe how.</p>
	<p>How could the MEP improve in the future?</p>	<p>Q29: Do you have any other comments about the marine education program? Please write anything you thought was good or bad about it and anything that could improve it in the future</p>

The surveys were self-completed by participants. A limitation of this method is participants do not have the opportunity to clarify concepts they do not understand, which could reduce the quality of the results (Denscombe 2014). To combat this, four students in the studies target group (Maldivian secondary-school students) completed a pilot survey comprising the core 18 questions, and consequently minor adjustments were made to improve clarity (Kim 2011). To ensure surveys yield valid and accurate responses for analysis researchers should develop clear and unambiguous questions that will elicit honest and unprejudiced answers (Denscombe 2014). The language and wording of the surveys was designed to be simple and easily interpretable for Maldivian students who speak English as a second language, to ensure genuine and valuable responses. Social desirability bias, whereby respondents overreport socially desirable activities, was minimised by ensuring questions or responses did not imply negative social desirability and participants understood results were anonymous and confidential (Krumpal 2013).

Analysis

Survey questions were grouped into four categories for analysis, shown in detail in Table 2. The groups were:

- **Marine Environmental Engagement**, hereafter 'engagement':
participants interaction with (e.g. swimming) and interest in the ocean
- **Marine Environmental Awareness**, hereafter 'awareness':
Awareness about the ocean and threats to the ocean

- **Self-perceived Marine Environmental Knowledge**, hereafter 'knowledge': participants perception of their own knowledge about the sea and threats to the sea
- **Marine Education Program Effectiveness**, hereafter 'effectiveness': Effect of program on participants' ocean confidence, interest in marine studies and environmental behaviour (only assessed for post-program survey)

Survey responses were collated, transcribed and coded in Microsoft Excel. Table 3 shows Likert questions assembled for each category and statistical analyses performed*. For the categories listed above, relevant questions were grouped and responses were coded using a 5-point Likert-scale. This ranged from least to most environmentally engaged/aware/knowledgeable/effective with a minimum score of 1 and maximum score of 5, respectively. 'Don't know' responses were recorded separately. The mean value for each participant across the questions in each category was calculated and used for quantitative statistical analyses in the software program R. It was appropriate to use the mean and not the median score because responses were categorised and averaged over multiple questions (Sullivan and Artino 2013). Total scores were used to analyse effectiveness as this was only assessed post-program and therefore comparative analyses were not possible.

Statistical tests are shown in Table 3 and were used to identify categorical differences from pre to post-program, determine per-category influence of age or gender, and identify relationships between categories. A 95% alpha level

was used. Non-parametric tests were used, due to a small sample size ($n \leq 21$) and non-normal data distribution (Gibbons and Chakraborti 2011). Endpoint adjustment was conducted using the False Discovery Rate criteria when multiple tests were performed on the same response variable, to reduce likelihood of Type I errors (Victor *et al.* 2010). Prior to analyses the data was checked for skew, outliers, significant heteroscedasticity and intercorrelation, which can confound results (Zurr *et al.* 2010). Some variables were power transformed to improve distribution, these comprised pre-program: engagement⁵, awareness² and time desired in sea²; and post-program: engagement⁵, awareness², effectiveness³ and female time spent² and desired² and overall time desired³ to spend in sea.

For qualitative data, wordclouds were generated from combined textual responses using online software 'WordItOut' (<https://worditout.com/>), which display more frequently used words in larger text (Cidell 2010). This allowed for visualization and extraction of common themes (DePaolo and Wilkinson 2014). Additionally, the frequency of responses for key themes was recorded to quantify thematic dominance.

*Some survey questions are not analysed in this report, as their purpose was to provide the MMRP with information to improve future EE programs.

Table 3: Table showing questions included and statistical tests performed for each of the four categories analysed. In each category the mean of each participant's responses to all the questions included in that category was calculated, and these values were used for statistical analyses. Details of statistical tests performed on different variables are shown below. The data were non-normal so non-parametric tests were used. False Discovery Rate correction was applied to all repeatedly tested response variables to reduce the likelihood of Type I errors (Victor *et al.* 2010).

Likert-Scale Categories	Questions and points analysed	Statistical Analysis	Variables analysed
Marine environmental engagement	Q1-4 5 points per question Max score: 20 The mean score for each participant across these questions was calculated and statistically analysed.	Unpaired two-samples Wilcoxon Test (Wilcoxon rank sum test) <i>*each predictor variable was tested against each response variable</i>	Response variable: pre-program engagement Predictor variables: pre-program age (Categorised: 8 th (age 13-14) and 9 th (age 15-16) grades) Pre-program gender (female/male) Response variable: Post-program engagement Predictor variables: post-program age, post-program gender
		Wilcoxon rank sum test <i>Variables tested for differences in median before and after the program</i>	Pre-program engagement Post-program engagement
	Q1, Q3	Wilcoxon Signed Rank Test <i>Paired variables tested for difference in median. Tests were conducted separately on pre and post-program variables</i>	Male: Time spent in sea for fun Desired time spent in sea for fun Female: Time spent in sea for fun Desired time spent in sea for fun Total sample (both genders): Time spent in sea for fun

			Desired time spent in sea for fun
		<p>Wilcoxon Rank Sum Test (unpaired)</p> <p><i>Variables tested for difference in median.</i></p>	<p>Time spent in sea for fun (male) vs. time spent in sea for fun (female)</p> <p>Desired time spent in sea for fun (male) vs. desired time spent in sea for fun (female)</p> <p>Pre-program time spent in sea vs. post-program time spent in sea</p> <p>Pre-program desired time spent vs. post-program desired time spent</p>
Marine environmental awareness	Q8, 11-13 5 points per question Max score: 20	<p>Unpaired two-samples Wilcoxon Test (Wilcoxon rank sum test)</p> <p><i>*each predictor variable was tested against each response variable</i></p>	<p>Response variable: pre-program awareness</p> <p>Predictor variables: pre-program age</p> <p>Pre-program gender</p> <p>Response variable: Post-program awareness</p> <p>Predictor variables: post-program age, post-program gender</p>
		<p>Wilcoxon rank sum test</p> <p><i>Variables tested for differences in median before and after the program</i></p>	<p>Pre-program awareness</p> <p>Post-program awareness</p>
Self-perceived marine environmental knowledge	Q7 & 9 5 points for Q8 60 points for Q9 (split into 12 parts) Max score: 65	<p>Unpaired two-samples Wilcoxon Test (Wilcoxon rank sum test)</p>	<p>Response variable: pre-program knowledge</p> <p>Predictor variables: pre-program age</p> <p>Pre-program gender</p> <p>Response variable: Post-program knowledge</p>

		<i>*each predictor variable was tested against each response variable</i>	Predictor variables: post-program age, post-program gender
		Wilcoxon rank sum test <i>Variables tested for differences in median before and after the program</i>	Pre-program knowledge Post-program knowledge
Marine education program effectiveness	Q19, 20, 24 – 26 5 points per question Max score: 20	Unpaired two-samples Wilcoxon Test (Wilcoxon rank sum test)	Response variable: Program effectiveness Predictor variables: age, gender
		Spearman's Rank correlation test	Pre-program engagement vs. pre-program awareness Pre-program engagement vs. pre-program knowledge Pre-program awareness vs. pre-program knowledge Post-program engagement vs. post-program awareness Post-program engagement vs. post-program knowledge Post-program awareness vs. post-program knowledge Post-program effectiveness vs. post-program engagement Post-program effectiveness vs. post-program awareness Post-program effectiveness vs. post-program knowledge

Results

The Program

All of the eligible students (n=26) registered for the MEP following the inauguration day ceremony. Attendance is shown in Figure 2 and ranged from 15 to 23; three students did not attend any sessions. Female attendance was consistently high and male attendance fluctuated.

Figure 2: Graph showing female and male attendance to each module's combined theory and practical session and each module's fieldtrip. The climate change module has not been conducted at the time of writing so is not included in the graph. Maximum possible attendance is 26.

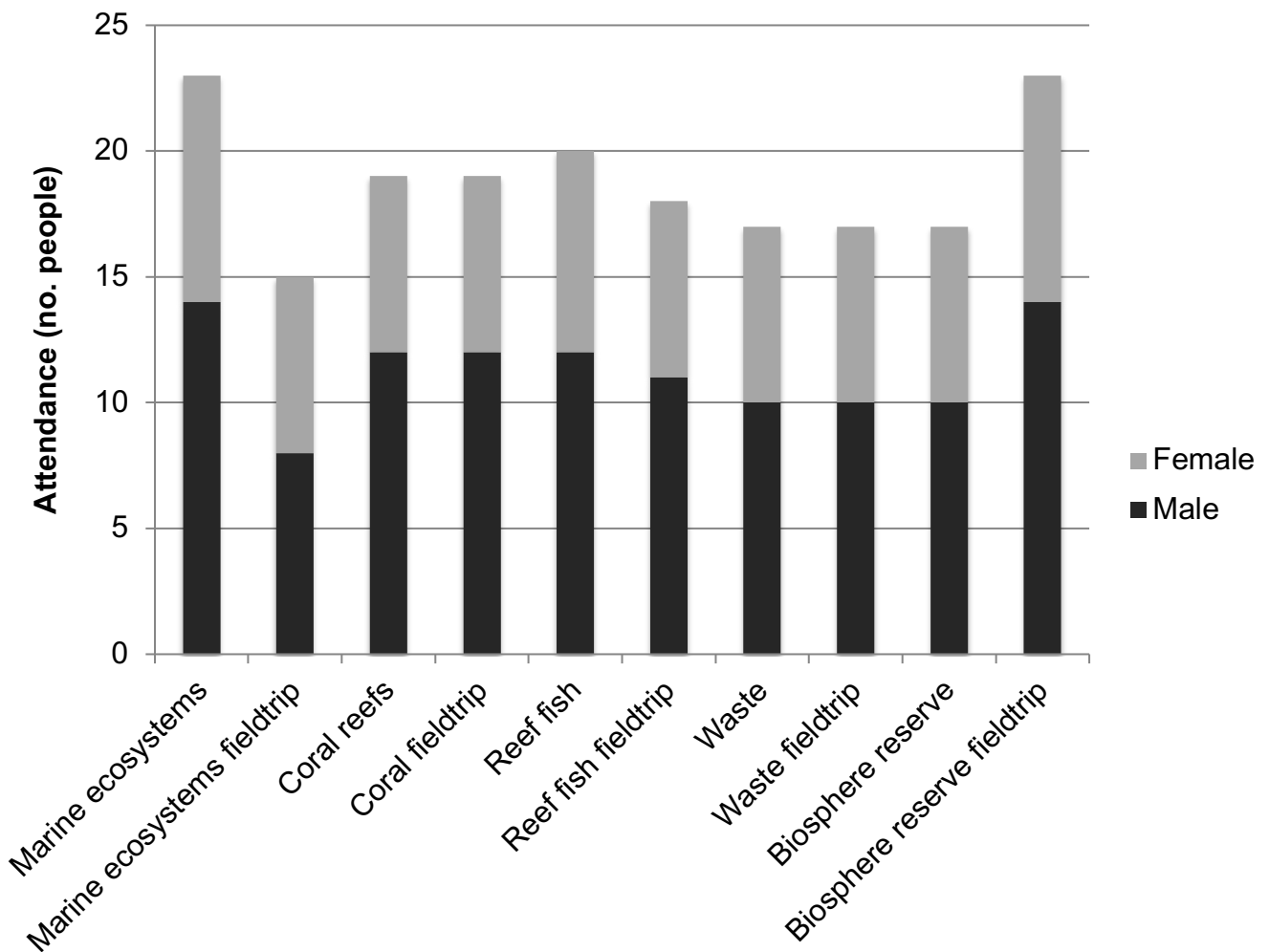


Table 4a and 4b show survey respondents demographics. The pre-program survey had 20 respondents (55% male, 45% female) and post-program survey had 21 (77% male, 33% female), from the same overall-registered population of 26 students (65% male, 35% female) between 13-16 years old. Although the majority of post-program respondents will be the same individuals who completed the pre-program survey, anonymity agreements meant this could not be verified and surveys were not paired by individual. Student absence and surveys lost by students reduced the response rate (Pers. Obs.).

Table 4a: Table showing respondent demographics for the pre-program survey

Pre-program survey gender		Pre-program survey age			
Female	Male	Grade 8		Grade 9	
9	11	Age: 13	14	15	16
		4	10	4	2

Table 4b: Table showing respondent demographics for the post-program survey

Post-program survey gender		Post-program survey age			
Female	Male	Grade 8		Grade 9	
7	14	Age: 13	14	15	16
		3	8	7	3

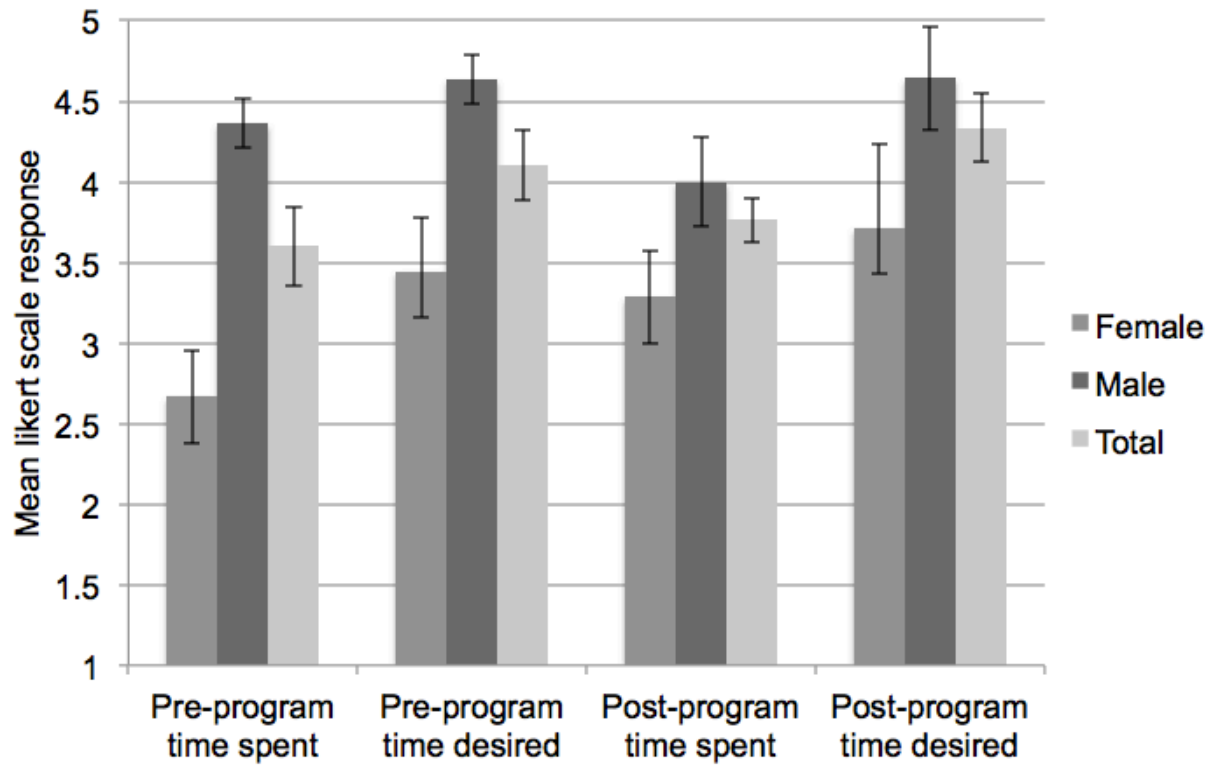
Engagement

Figure 3 shows the amount of time participants spend in the sea for fun (time spent), and the amount of time they would like to spend in the sea for fun (desired time spent), pre and post-program. In the pre-program survey, both

male (n=11) and female (n=9) participants desired to spend more time in the sea than they currently did, however, time spent was not significantly different to time desired. Overall, participants desired to spend a statistically significantly higher amount of time in the sea than they currently spend ($p < 0.001$, $a = 0.025$, $V = 0$, $n = 20$). The difference between the amount of time males and females spent was also significant ($p < 0.001$, $a = 0.025$, $W = 7$), as was the amount of time males and females desired to spend ($p < 0.007$, $a = 0.025$, $W = 15.5$). Males scored significantly higher than females in both these indices.

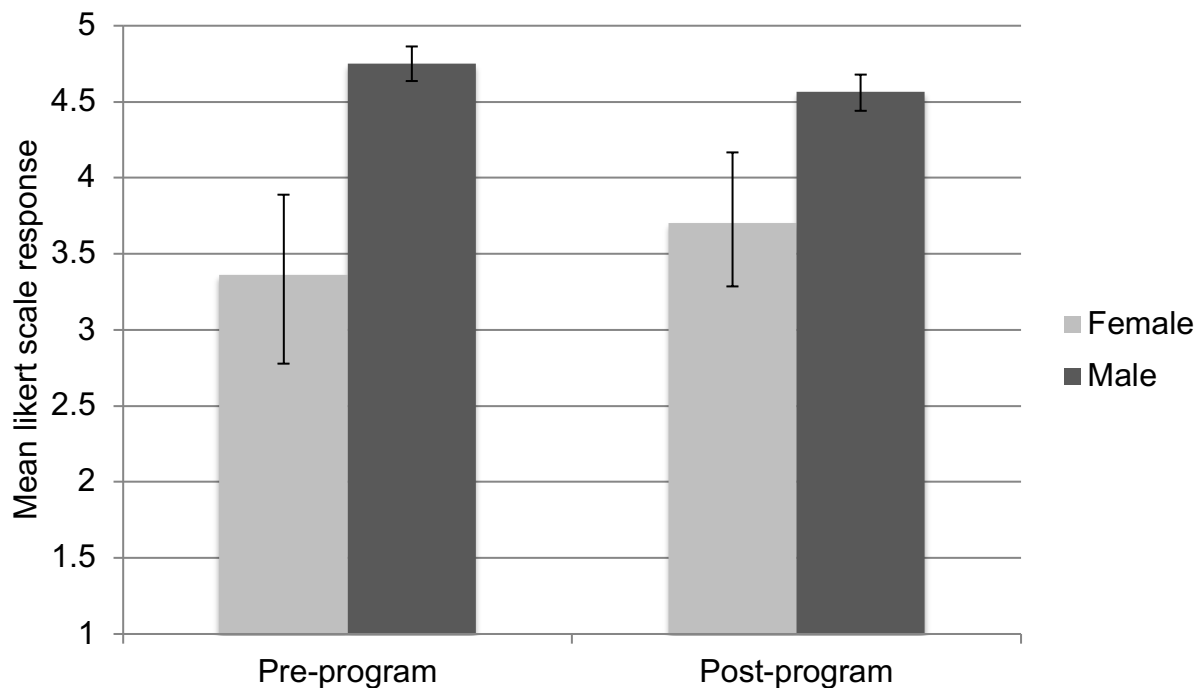
Results were similar post-program. Significant differences existed between male time spent and time desired (n=14, $p < 0.009$, $a = 0.017$, $V = 0$), overall time spent and time desired (n=21, $p < 0.001$, $a = 0.017$, $V = 1$), male time spent and female time spent ($p < 0.02$, $a = 0.017$, $W = 75.5$) and male time desired and female time desired ($p < 0.007$, $a = 0.017$, $W = 84$). For the total sample, time spent increased non-significantly ($p = 0.85$, $a = 0.017$, $W = 217$) and time desired increased significantly when compared with pre-program time spent and time desired ($p < 0.001$, $a = 0.017$, $W = 20$), showing an increased interest in swimming in the sea more frequently post-program. For males time spent and time desired did not change significantly from pre to post-program. For females time desired increased insignificantly and time spent increased significantly ($p < 0.002$, $a = 0.017$, $W = 1$).

Figure 3: Graph to show the mean amount of time female, male and combined (total) students spent in the sea and desired to spend in the sea for fun, pre-program and post-program. The maximum possible score of 5 represents 'every day,' and minimum possible score, 1, represents 'very rarely/never.' The mean possible score of 3 represents 'once a month.' The bars represent the standard error.



Concurrently, significant differences existed between Likert-coded category 'engagement' and gender, both pre-program ($p < 0.001$, $a = 0.01$, $W = 0$) and post-program ($p < 0.008$, $a = 0.01$, $W = 13.5$), demonstrating a gender disparity with males engaged in the ocean significantly more than females. This is visualised in Figure 4. Age did not significantly affect engagement pre or post-program.

Figure 4: Graph to show mean male and female scores in the category 'engagement.' The scores represent the mean Likert-scale response to four questions concerning marine engagement, and are averaged across male and female participants, pre and post-program. On the scale, a score of 1 represents low engagement and a score of 5 represents high engagement. A significant difference exists between male and female engagement both pre ($p < 0.001$, $a = 0.01$, $W = 0$) and post-program ($p < 0.008$, $a = 0.001$, $W = 13.5$). Error bars represent bootstrapped 95% confidence intervals.

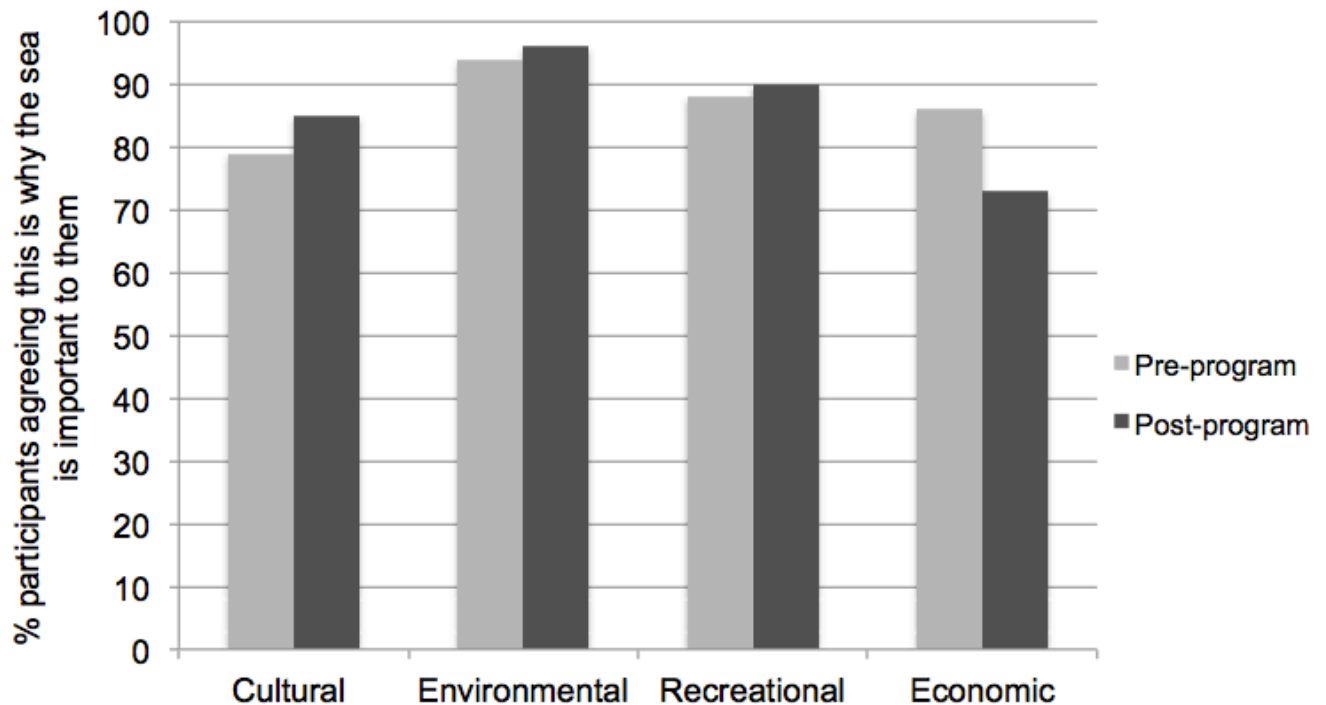


Participants got the majority of their information about the sea from the Internet (29 and 24%), television (27 and 21%), and family and friends (29 and 18%) pre and post-program, respectively. Information received from school or teachers doubled from 8% pre-program to 19% post-program, and two participants wrote "marine education program" in 'other.'

The response rate for collated cultural, environmental, recreational and economic reasons the sea is for important to participants is shown in Figure 5 and was high pre and post-program, ranging from 73-96%. Environmental

reasons were most agreed with, and there was a slight increase from 94-96% pre to post-program. The second-most agreed with category, recreational, increased from 88-90%, whilst economic decreased 13% and cultural increased 6%.

Figure 5: Graph to show the reasons the sea is important to participants, pre and post-program. Questions representing each category have been summarised using the four categories and scores have been totalled. Table 2 shows reasons included in each category. The vertical axis represents the % of participants who responded 'yes' to questions in each category, out of the total possible 100%. Environmental reasons dominated and increased marginally from pre to post-program.



Awareness

Mean marine environmental awareness increased by 9% from 3.61 (out of a possible 5) pre-program (range 1-5, n=20) to 4.03 post-program (range 1.75-5, n=21), illustrating a mean shift from high to very high awareness. Mean female awareness increased from 3.14 to 3.34 (n=9&7) and mean male awareness from 4.04 to 4.40 (n=11&14) pre to post-program. Females

consistently scored lower than males. Awareness was not significantly different dependent upon age or gender. The mean score from responses on a scale of 0 (not important) to 10 (extremely important) for question 17: 'How important do you think environmental conservation in the Maldives is?' decreased by 7% from 8.6 pre-program to 7.9 post-program.

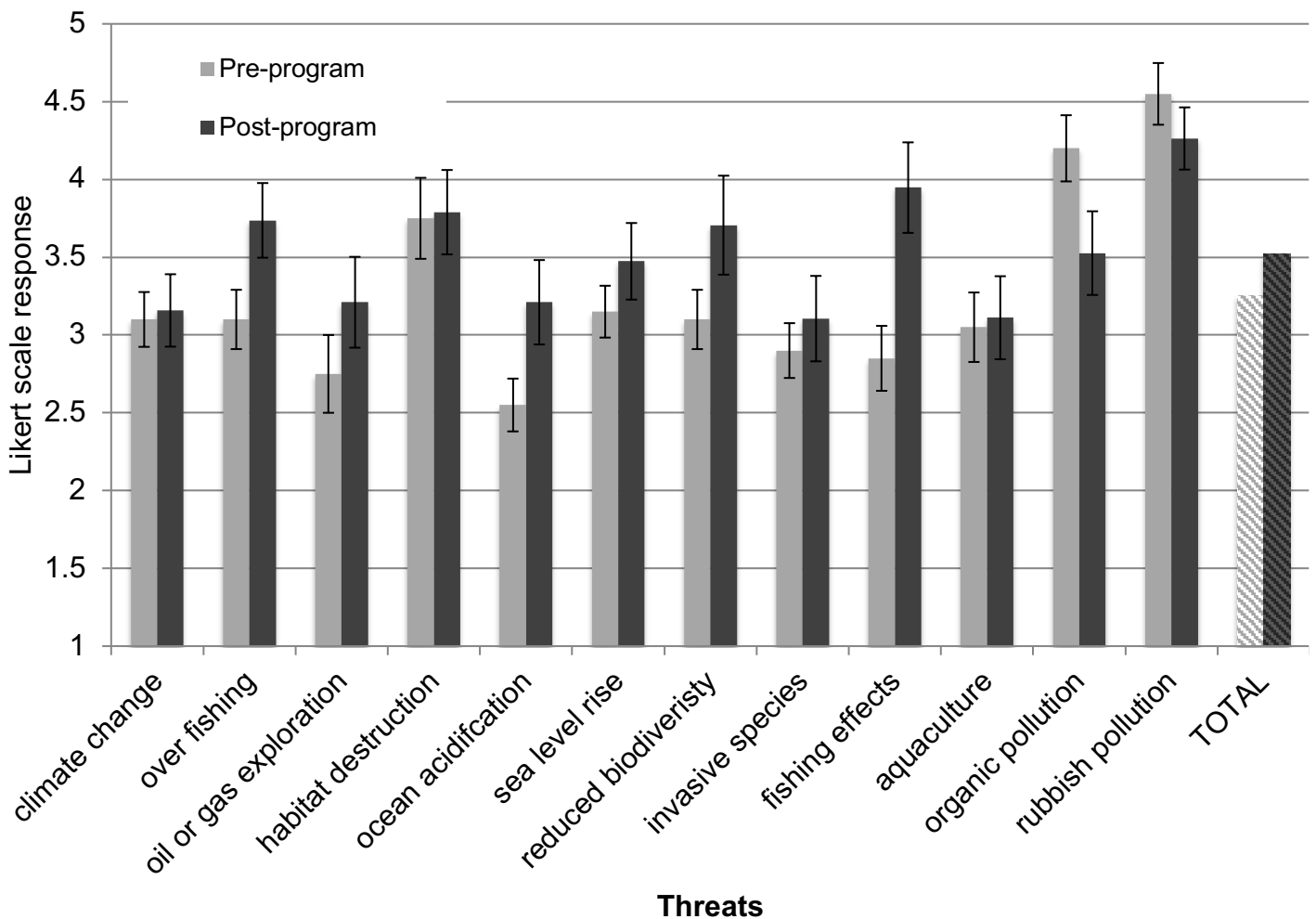
Tables 5 and 6 illustrate participant's key wishes when asked 'if you had one wish for the future of the sea in the Maldives what would it be?' Recurrent themes in pre-program wishes, visualised in Figure 6, include 'scuba diving', 'healthy' and 'ocean'. Key themes could not be interpreted from the post-program wordcloud (Figure 7). Dominant pre-program wishes included to go scuba diving (30%), explore more of the ocean (15%), and that ocean health would improve (15%). The only environmentally unfriendly wishes were two female respondents wishing "all sharks in the world will become extinct." The most prevalent post-program wishes were to explore more of the ocean (35%) and work in an ocean-related field (18%). The remaining statements were all environmentally friendly or unrelated.

Table 5: Frequent wishes in the pre-program survey when participants were asked: if you had one wish for the future of the sea in the Maldives what would it be? (Q18)

Themes	Number of mentions
To go scuba diving	6
The ocean would be healthier	3
To explore more of the ocean	3
People would be more environmentally friendly	2
To protect the ocean/reduce threats	2
Sharks would become globally extinct	2
Work in an ocean-related field	2

Figure 8 demonstrates responses to Q9. Mean participant knowledge increased for 83% of topics pre to post-program. Overall mean knowledge increased from 65% to 70% pre to post-program, and knowledge increased most for the topics 'overfishing' (13%), 'reduced biodiversity' (12%), 'effects of fishing' (22%), and 'ocean acidification' (13%). These topics were all covered in depth in the MEP.

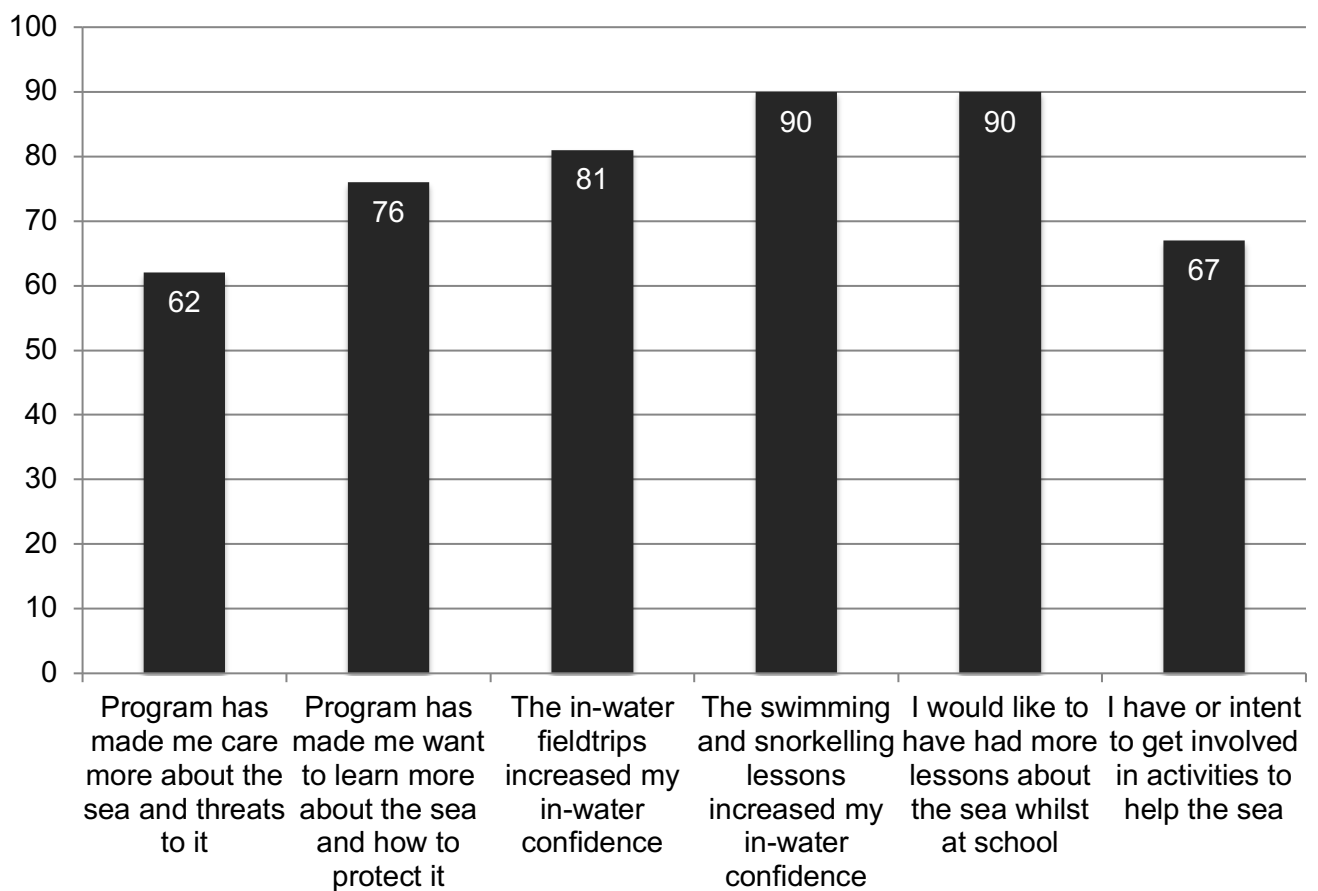
Figure 8: Graph showing mean pre and post-program self-perceived knowledge for each of the threats listed on the x-axis. The Likert scale response is the mean coded response selection for each threat. The minimum score of 1 represents the student knows 'nothing' about the threat, and the maximum score of 5 represents the students knows 'very much' about the threat. Bars show the standard error. Knowledge increased for 83% of threats from pre to post-program.



Effectiveness

The mean Likert-score for MEP effectiveness was 21 (very effective, n=21) out of 25. The female mean score was 19 (quite effective, n=7) and the male mean score was 23 (very effective, n=14), representing a 16% difference between genders. Figure 9 exhibits the proportion of students that agreed with statements designed to assess effectiveness.

Figure 9: Graph to show the proportion of students who selected 'quite a lot' or 'very much so' in response to the questions that are displayed as statements below. The percentage of students who selected these responses out of the total number of students (n=21) is shown at the end of each bar. The higher the percentage, the more effective the program was for achieving that statement.



Since taking part in the MEP, 24% of students had gotten involved in activities to help the sea or environment, and 43% intend to. Two students commented they “didn’t get a chance.” 10 percent of participants intended to change their environmental behaviour because of the program, whilst 29% had changed their behaviour. Table 7 and Figure 10 show the ways that participant’s environmental behaviour changed. 10 percent of participants reduced ocean littering and 10% stopped touching or treading on coral. 57 percent shared knowledge from the MEP with family members or friends. Table 8 shows that most students shared knowledge about manta rays. Table 9 shows the reasons students shared knowledge are because ‘it is important to share information’ and the information ‘is cool or exciting.’

Table 7: Actions that participants have taken to improve their environmental behaviour because of the marine education program

Themes	Number of mentions
Not littering in the ocean	2
Not physically disturbing coral	2
Being aware and sharing information	1

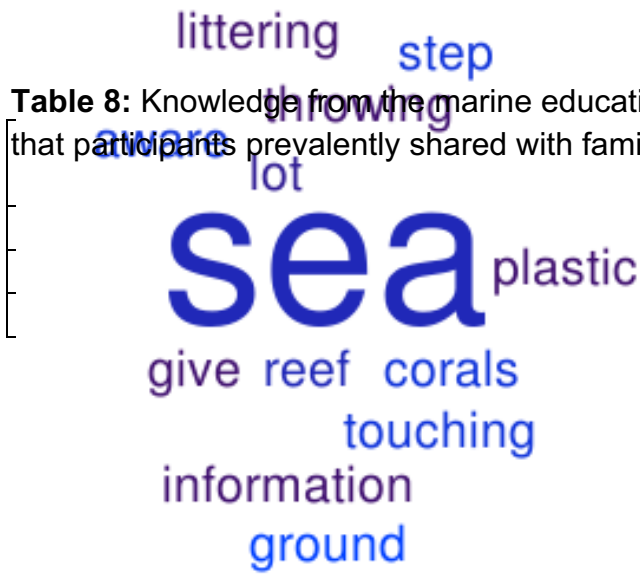


Table 8: Knowledge from the marine education program that participants prevalently shared with family or friends

	Number of mentions
Its important to share information	2
Because the information is cool/exciting	2

Figure 10: Visual representation of actions respondents have taken to improve their environmental behaviour following the program (Q27). The larger the word, the more frequently it was mentioned.

Table 9: Prevalent reasons respondents shared knowledge they had gained from the marine education program with family or friends

The amount of participants that wanted to work in marine conservation decreased from 65% (n=20) pre-program to 48% (n=21) post-program, although the amount of students who wanted a job in tourism increased from 40% to 57%. Two male students commented that they wanted to work in marine conservation in the future because “everything we have learnt in the program is awesome” (Pers. Obs.). Responses to Q29 (n=11), which

requested feedback on the MEP, were overwhelmingly positive (91%), with only one negative comment: “please end this program” (9%), visualised in Figure 11 and Table 10. Four students wanted the program to continue, and a further four asserted the program was good or exciting. One male student commented, “fieldtrips are amazing, I didn’t find anything to improve, all are

Statements	Number of mentions
I don’t want this program to end	4
The program is very good/exciting	4
Give more classes to other schools	1
The fieldtrips are amazing	1
Please end this program	1

perfect”
and
another
requested
[the

facilitators] “give more classes to other schools.” Correlation tests revealed no significant relationships between any categories pre- or post-program.

Table 10: The statements mentioned with the highest frequency when participants were asked to give feedback on the marine education program

Figure 11: Visual representation of respondents feedback regarding the marine environmental education program. The larger the word, the more frequently it was mentioned. Table 10 shows key statements in detail.



Discussion

Exploring the effectiveness

The marine environmental education program (MEP) increased student's marine environmental engagement, awareness and knowledge, in-water confidence and academic interest in the sea, and the amount of time students spent and desired to spend in the sea. The MEP's effectiveness is further evidenced by a mean effectiveness score of 21/25. Effectiveness could have been influenced by the inclusion of fieldtrips and practical's, or student's interest in the subject field. Hamilton-Ekeke (2007) compared fieldtrip and theory-based methods of environmental education (EE) teaching and found a significant difference between pre- and post-test results for students engaged in fieldtrips, and no considerable difference for those involved in theory-classes. The MEP used an integrated teaching approach whereby theory classes were complemented by practicals and fieldtrips, which stimulate further learning and encourage students to work collaboratively and actively consider their environment (Braund and Reiss 2006).

Students predominantly shared their knowledge about manta rays with others, most likely after the fieldtrip to swim with manta rays, and statements evidence that this was because it is "important" and "exciting." One student commented "the fieldtrips are amazing" and four did not want the MEP to end. Additionally, students desired to spend significantly more time in the sea after the program, evidencing an increased interest in marine participation. It is encouraging that studies have shown outdoor fieldtrips are strong predictors

of proenvironmental behaviour change, as the MEP provided >30 hours of nature-based fieldtrips (Neiman and Ades 2014). Attendance was optional yet relatively high throughout the MEP, which demonstrates high interest levels and the MEP and researchers success in engaging students, perhaps due to integrated teaching methods (Short 2009). 90 percent of students would like to have had more lessons about the sea and threats to the sea whilst they were at school. These assertions indicate students were interested in the subject matter, and interest in a subject motivates enhanced comprehension of the subject (Schiefele 1991).

Gender disparity and categorical causation

Females scored lower than males in all categories, were significantly less engaged in the marine environment than males, and spent significantly less time in the sea than males. The Maldives has a 'major disparity between men and women' for all three indicators of the Gender Inequality Index (USAID 2015). Increasing urbanisation, income disparity and fundamentalist Islamist discourses are exacerbating gender stereotypes and conditions for woman in the Maldives (Fulu 2014). Gender inequality in the Muslim world is not my area of expertise, and I therefore present potential discourses for females' low engagement but acknowledge I may interpret Islamic principles erroneously (Piela 2010). I could not source any literature on marine participation in the Maldives, and following the results of this study strongly recommend research be conducted into gender and marine participation in the Maldives.

Lower engagement scores could have been influenced by fear of the sea, religious and cultural taboos, or cultural norms. Two females wished for “all the sharks in the world to go extinct” in the pre-program survey. Upon researcher-initiated discussion on sharks, it emerged many students were afraid to go in the sea because of shark attacks portrayed in the media, especially females (Pers. Obs.). Despite this, all female participants partook in the swimming lesson and most of the in-water fieldtrips, and normally did not outwardly exhibit signs of panic (Pers. Obs.).

A Maldivian recreation manager at Four Seasons, who taught female participants to snorkel, asserted afterwards “not many girls, because of religious and cultural taboos, get the opportunity to swim. The majority of women can’t swim” (Pers. Comm. Nooman 2017). In the Maldives everyone is required by law to be Muslim (Fulu 2007). Influenced by Islam, the women’s role is seen to be primarily domestic, and a culture of protectiveness of women exists whereby females are encouraged to stay at home and males encouraged to be outgoing (UNDP 2010). This could explain the reduced engagement and increased fear of the ocean that females verbally exhibited; for many it may be ‘unknown territory.’

Although woman must wear full dress to swim, they are not prohibited from swimming, and the researchers observed positive community attitudes towards girls swimming during the MEP (Pers. Obs.). The historical role of women as household managers and men as fishermen may have been adopted as a ‘cultural norm’ and passed down through communities and

generations (Fulu 2007). Under this norm, girls in the community may simply “not even think about swimming”, as it has become culturally normative for females not to swim, so there is no facilitation for them to learn (Pers. Comm. Thol’Hath, Manta Trust 2017). It is likely that interweaving cultural norms, religious principles and fear of the sea have all influenced female engagement scores in this study.

Previous studies have shown EE programs to have an equal influence on males and females (Lieflander and Bogner 2014), that females have more proenvironmental attitudes and intentions than males (De Leeuw *et al.* 2015) and females are more environmentally concerned than males (Liu *et al.* 2014). These findings do not support this studies predominant gender disparity and therefore reduced female environmental engagement could be a key predictor of reduced awareness, knowledge and effectiveness observed in the study. However, the study uncovered no relationships between environmental engagement, awareness or knowledge. Johnson and Činčera (2015) reveal that an EE program in the Czech Republic improved students’ environmental attitudes, which stimulated increased proenvironmental behaviour. Levine and Strube (2011) revealed that increased environmental knowledge predicted increased awareness and proenvironmental behaviour. Although no relationships were found in this study, increased ocean use is linked to increased awareness of environmental issues, interest in the environment and desire to participate in marine conservation activities (Wiener *et al.* 2016). This indicates engagement could impact awareness or knowledge, and therefore males’ higher engagement could explain their

higher awareness, knowledge and effectiveness results. If this is the case, marine participation should be increased to improve awareness of environmental issues and achieve effective environmental management in the Maldives. However, further research and a larger sample size are needed to decipher potential relationships (Koricheva *et al.* 2013).

Implications

The effectiveness of the MEP has exciting environmental implications. All of the students were Maldivian, and there is currently a low interest in the marine conservation occupation amongst Maldivians, who generally prefer to work in alternative departments in luxury resorts (Pers. Comm. Sawers, Manta Trust 2017). It is important to involve local people in conservation work to improve the success chances of conservation projects and ensure foreign-run initiatives are communicated effectively to local communities (Elbroch *et al.* 2011). 76 percent of students wanted to learn more about the sea following the program, and two males directly attributed their newfound desire to work in marine conservation to the MEP. This suggests MEP's could encourage young Maldivians to study or work in marine conservation.

The studies proenvironmental results evidence how an MEP could, on a small-scale, fill the post-primary EE deficiency in schools that do not offer Fisheries science. Mean scores increased for every category after the program, and for knowledge this was statistically significant. Environmental behaviour, actions and intentions were also positively impacted, and currently, participants are requesting the island council's help to organise an island-

scale beach cleanup (Pers. Comm. Thol'Hath 2017). These results illustrate that an MEP, which promotes EE, could be used strategically to improve community-based environmental management (Smith *et al.* 2006). Until the government incorporates effective EE into the secondary school curriculum or instigates fisheries science across all Maldivian schools, NGO and resort-funded and based EE initiatives may be the best way to fill this EE gap effectively (Smith *et al.* 2006). The successfulness of the MEP suggests that similar programs in other schools could provide effective EE, fulfil student's desires to learn and engage more with the marine environment, and widen students' knowledge base (Shiuna and Sodiq 2013). The findings of this study are limited by a small sample size and specific to its particular context; however, useful recommendations could be drawn from this study for other Maldivian secondary schools (Shareef 2010). 67 percent of Maldivian school students are enrolled in 'rural' island schools, which are relatively homogenous in size and syllabus across the Maldives (Ministry of Education 2014). Results of this study could therefore be representative of some of the wider rural student population.

Conclusion

The MEP was an effective initiative that's success has encouraged MMRP to expand the MEP into more schools and two administrative atolls in the Maldives during 2018 (Pers. Comm. Sawers, Manta Trust 2017). Research should be conducted during these programs to further understand gender discourses and continually improve effectiveness. Additionally, it would be useful to assess whether students have maintained heightened environmental

engagement, awareness or knowledge a year after the program, to investigate the long-term value of MEP's and adjust future MEP content accordingly (Farmer *et al.* 2007). The researchers recommend that government, NGO, and community learn-to-swim initiatives are facilitated and encouraged across the Maldives to address gender inequalities and potentially increase environmental awareness and management (Wiener *et al.* 2016). EE is a key tool for environmental management that has not yet been employed strategically in the Maldives to empower young people and address environmental issues (Smith *et al.* 2006). The expansion of the MEP may begin to mitigate this shortfall. However, implementation of nationwide, effective environmental education is crucial to improve marine environmental participation and protection, and sustain marine biodiversity in the Maldives (Shareef 2016).

Word count: 4,999

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Web resources:

1. <http://www.mantatrust.org/about-us/the-manta-mission/>
2. <http://www.guesthousesofmaldives.com/location/baa/kendhoo/>
3. [http://www.atollsofmaldives.gov.mv/atolls/Maalhosmadulu-Dhekunuburi-\(Baa-Atoll\)/Kendhoo-%28I%29/533](http://www.atollsofmaldives.gov.mv/atolls/Maalhosmadulu-Dhekunuburi-(Baa-Atoll)/Kendhoo-%28I%29/533)

Appendix A: An example of the handout component of the course materials:

Reef Fish and Turtles Hand-out

What this handout covers:

1. Ecology of turtles
2. Threats to turtles
3. Classification of reef fish and their place in the food chain
4. Threats to reef fish
5. Importance of sharks
6. Threats to sharks
7. What you can do to help turtles, reef fish and sharks

About Turtles

Sea turtles are marine reptiles. There are 7 species of turtle in the world, which live in almost every ocean basin throughout the world. Green turtles and Hawksbill turtles are often found in the Maldives. Turtles migrate long distances to feed, sometimes crossing oceans. Sea turtles eat many different things, including anemones, sea grass, jellyfish, lobster and sponges.



Green Turtle



Hawksbill Turtle

Mating

Male turtles compete with other males for females to mate with, and the mating process occurs in tropical coastal areas. The strongest male will be allowed to mate with the female. Females can mate with many males and store males sperm inside them for many months until they are ready to lay eggs. As the eggs will represent many male turtles sperm, genetic



Males compete for a female to mate with

diversity in the population is maintained, which makes it healthier and more resilient to threats.

Nesting

Turtles nest on the same beach they were born on! Sometimes this is a long way away and turtles find their way back using the earth's magnetic field. When nesting, a female turtle hauls herself up onto the beach in the moonlight and uses her flippers to dig a hole where she lays her eggs – about 100 at a time! She then buries the eggs using the sand she dug up and camouflages the nest by throwing dry sand behind her, to hide it from predators, and returns to sea.



Hatching

The eggs incubate in the nest for about 60 days. Then, usually at night, the turtles hatch and push their way out of the nest. They follow the moonlight to the sea, and do all of this in a big group to reduce vulnerability to predation. Only 1 in 1000 hatchlings will usually survive all the way to adulthood! Turtle hatchling survival rate is reduced by human threats.

Threats to Turtles

Entanglement in ghost fishing nets

Olive Ridley turtles, which live further out at sea, are common victims of ghost fishing nets in the Maldives. These are trapped in harmful fishing gear, usually drifting 'ghost nets' that have been discarded by fishing boats and drift into shallow waters, trapping any animals in their path.



The turtles approach the nets looking for food or shelter and become entangled in the nets, which can be huge, and then either drown if they cannot reach the surface to breathe or become too exhausted, or cause themselves serious injuries like cuts to their flippers. They may also starve if they are trapped and therefore cannot hunt for food. At Four Seasons Landaa Giraavaru, marine biologists help to rehabilitate injured turtles that have been

rescued from ghost fishing nets. Often these turtles have had one or more flippers amputated by their struggle in the fishing gear. Sometimes, once they are healthy again, they can be returned to sea.

Eating litter

Juvenile (young) sea turtles often go where ocean currents push a lot of food together, like seaweed, to feed. The sea is full of tiny and big pieces of human litter, which also concentrates in these areas. The young turtles can mistake litter



for food and eat it, this can be toxic to the turtles due to the chemicals in the litter. Some turtles eat jellyfish, and often mistake drifting plastic bags for jellyfish and eat them. If they eat a lot of plastic, they can starve because their stomach is full of plastic so they stop eating the food they need to survive.

Harvest for meat and eggs

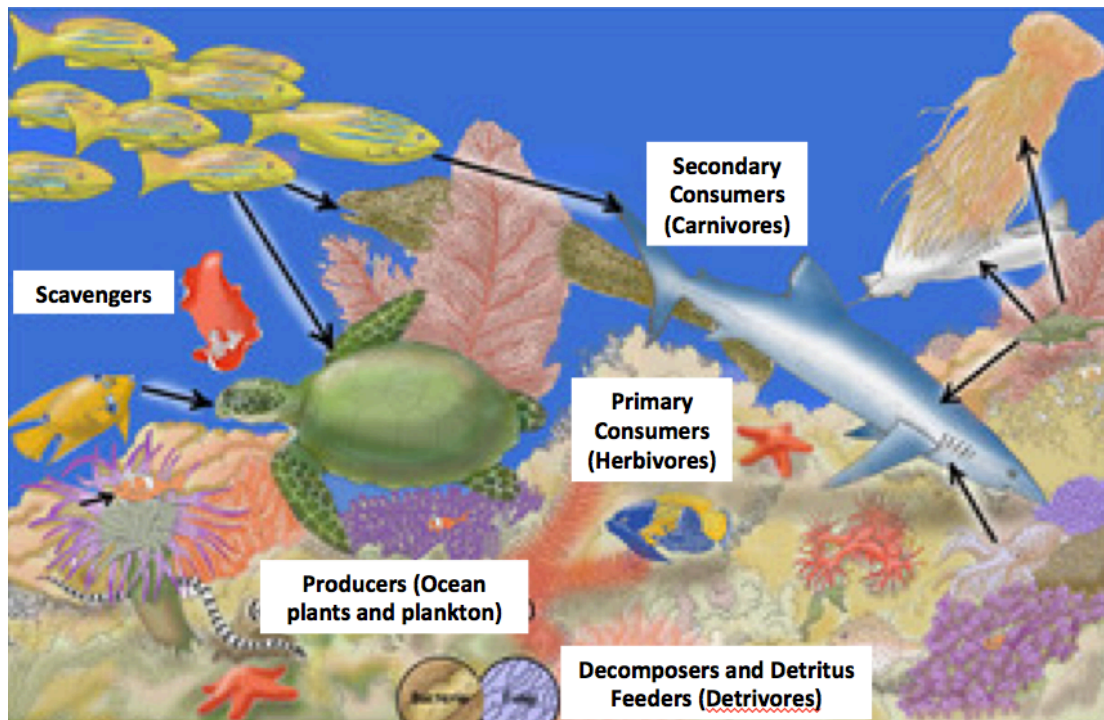
Eggs are taken by poachers from turtle nests on the beach, to sell or eat. This is bad because it reduces the amount of turtles that hatch and have a chance to survive to adulthood. Therefore, it can endanger turtle populations, which are already very vulnerable.



Turtles are killed for their meat or their beautiful shells (carapace), especially the hawksbill turtle, which is used for decoration or sold.

About Reef Fish

Reef fish can be grouped depending on what they eat. This determines their place in the food chain, or their trophic level (a level in a food chain). Some fish change what they eat as they mature, and some will feed outside of their main prey group. The coral reef food web is extremely complex, and it would take a really long time to explain all the links and symbiotic relationships that keep it running smoothly. Therefore, reef fish can be split into three groups or trophic levels. These are detritivores, herbivores and carnivores.



Detrivores and Decomposers

Detrivores and decomposers complete the cycling of energy through the food web. They eat and break down dead organic material and return nutrients to the sediment or seafloor. These nutrients are used by primary producers (e.g. algae/seagrass) to create energy, which can then be used by other organisms in the food web. This completes the cycling of energy through the food web.

Examples of detrivores:

- Sea cucumbers
 - Sea cucumbers feed on tiny particles like algae, tiny animals or waste materials (detritus). They gather this detritus with their many tube-feet, which look like tentacles surrounding their mouths. The cucumbers break down this dead organic matter into even tinier pieces and recycle them back into the food chain.
- Shrimp
- Brittle stars



- Brittle stars are echinoderms like starfish and sea cucumbers. They are closely related to starfish, but are better at moving around. They feed on detritus on the seafloor, recycling it into the food chain. Fun fact: Brittle stars arms break off very easily, which means they can escape if an arm is caught by a predator. They can then regrow the arm!

Herbivores:

Herbivores are the primary consumers on a reef, and mainly feed on plants. Herbivorous reef fish mostly eat algae, which are photosynthetic plants. Herbivorous reef fish often graze on/eat algae that is growing over dead coral or rocks at the bottom of a reef (benthic algae). This is important because it helps the coral to stay healthy as it is not overgrown by algae. Parrotfish, damselfish and surgeonfish are all herbivores, although they feed on other organisms sometimes.

Parrotfish:

Parrotfish are herbivores that are common on the reef and named for their bright colours and parrot-like beaks. They graze on algae that is growing on dead coral by using their strong crushing jaws and beaks to break off chunks of coral. They crush the coral and digest the algae that is coating it, and then poop out the coral as fine sand. Fun fact: Parrotfish poop provides the fine sand that helps to build up islands inside atolls, including those in the Maldives!

**Carnivores:**

Carnivorous reef fish prey on other fish and animals. They are often very successful hunters, with adaptations to catch their prey. Carnivores are important as they keep the entire ecosystem in balance by removing sick or diseased fish and this contributes to good biological diversity. The largest carnivores in a coral reef ecosystem are piscivores. These are fish that prey on other fishes. They include:

- Barracuda
- Sharks
- Groupers

- Trumpetfish
- Large snappers

Threats to reef fish

Fishing for food

- Mainly for tourist resorts in the Maldives
- Can unbalance the food web

Habitat changes/ Climate Change

- Decline of coral reefs means that fish that eat coral (corallivores) may disappear from some areas
- When coral reefs become less healthy, sharks disappear from that reef, indicating the ecosystem is in bad health
- Other habitat changes can change the availability of prey for reef fish, e.g. pollution/dredging

<http://www.coral-reef-info.com/coral-reef-food-web.html>

The top predator in marine ecosystems: sharks

Sharks are apex predators (top predators) in all marine ecosystems, including coral reefs. Sharks play an important role in the ecosystem by maintaining the species below them in the food chain. They are useful indicators of the health of an ecosystem. Sharks remove the weak or sick fish and animals from the ecosystem. By doing this they help to stop disease spreading and keep a healthy level of species diversity (many different species in the ecosystem). This keeps the whole ecosystem in balance.

If the number of sharks in a coral reef ecosystem declines, this can lead to the decline of the coral reef and other species in the ecosystem. For example, other large carnivores like groupers will increase in numbers when sharks decrease and eat more herbivores (like parrotfish). This means there are less herbivores, which means the amount of algae expands as herbivores are not eating it. This means more algae grows on the coral, and the coral will decline. The ecosystem may then shift from one that is dominated by coral to one dominated by algae. So losing sharks has major knock-on effects on whole ecosystems.

Reef sharks in the Maldives

The main shark species that can be found in reef ecosystems in the Maldives are:

- Black tip reef sharks
- White tip reef sharks
- Grey reef sharks
- Nurse sharks

These sharks are very important for keeping the coral reef ecosystems of the Maldives healthy. They are usually quite shy and will not come that close to swimmers or snorkelers. They are not aggressive towards humans, and you should not worry about sharks in the water, as they will not harm you.

There are also tiger sharks, thresher sharks and whale sharks in the Maldives. However, these are found on reefs and are mainly open ocean dwellers.

Threats to sharks:

Targeted commercial fishing

- In many parts of the world, huge numbers of sharks are fished for their fins. In China, the fins of sharks are used in shark fin soup. This is a delicacy that is eaten on special occasions, like weddings or at feasts. Eating shark fin soup is a symbol of wealth. It is estimated that 100 million sharks are killed every year, just for their fins for this soup! This means that sharks are overfished. In the Maldives, sharks used to be fished for the oil in their livers, which was used to power boats. Shark fishing was banned in the Maldives in 2010, which was an amazing step to protect sharks and the ecosystems that they help to maintain!



Bycatch

- Sharks are often caught in fishing nets or lines that have been laid out to catch other types of fish. This is called bycatch. By the time the nets are dragged onto the boat, the sharks are usually already

dead. An estimated 50 million sharks are caught as bycatch each year, and this is causing shark population declines. In the Maldives, this is not a big problem, but any sharks caught accidentally by fishermen should be released back into the ocean, and fishers should use the right nets and lines that are the least likely to cause harm to sharks.

Recreational fishing

- Sharks are sometimes fished for fun by locals or tourists in parts of the world. Sometimes, sharks are killed so the fishers will display or sell their teeth or jaws as trophies of their catch. This is a threat to sharks and the ecosystems they maintain and should not be done.

Habitat loss, pollution or environmental degradation

- Can negatively affect sharks prey or ecosystem
- Plastic and chemical pollution is harmful to sharks, and activities like dredging can cause a decline in shark habitat and juvenile (baby) shark numbers.

<http://www.sharksavers.org/en/education/sharks-are-in-trouble/other-threats-facing-sharks/>

What can you do to help turtles, reef fish and sharks?

- If you see a **nesting** sea turtle, do not **disturb it** or shine bright lights
- Put a **nesting sign** up to stop people from accidentally destroying turtle nests
- **Raise money or awareness** for your local sea turtle conservation charity
- Organise **beach cleanup's** to remove litter
- Spread the word in your community **not to:**
 - Discard fishing line
 - Take sea turtle eggs
 - Fish for sharks or turtles
 - Disturb nesting sea turtles
 - Litter



Appendix B: The pre-program survey**Baa Atoll Marine Education Program for local students - 2017****Kendhoo School****Initial Assessment Questionnaire**

My name is Flossy Barraud and I am studying for a Masters degree in Marine Environmental Management at the University of York in the UK. For my degree I would like to have your answers to a questionnaire about the marine biology program that you are going to do.

My questionnaire wants to find out:

1. How much you use and value the sea
2. How much you know about the sea and things that threaten it in the Maldives
3. What you have most enjoyed about your marine program, what you have learnt from it, and if your attitude towards the sea has changed during the program

You don't have to do my questionnaire unless you want to, and if you do, nobody will know that what you say was said by you. If you do my questionnaire then in six weeks' time I will ask if you would like to do another questionnaire for me that will ask you some similar but different questions. If you start to answer my questionnaire but don't want to finish it or don't feel able to answer some of the questions then that is fine, so just stop or leave a blank space. The survey will take approximately 15 minutes to complete. Thank you for participating, and if you have any questions please ask.

For questions 1 to 4 underline which answer from those provided you most agree with

1. How much time do you spend in the sea for fun?

- d. Every day
- e. Once a week
- f. Once a month
- g. A few times a year
- h. Very rarely/ never

2. Do you enjoy being in the sea?

- a. Not at all
- b. Very little
- c. Moderately
- d. Quite enjoy
- e. Enjoy very much

3. How much time would you like to spend in the sea for fun?

- a. Every day
- b. Once a week

- c. Once a month
- d. A few times a year
- e. Very rarely/ never

4. How important is the sea to you?

- a. Not at all
- b. Very little
- c. Moderately
- d. Quite important
- e. Very important

5. If the sea is important for you then underline yes or no for all the reasons listed below that could explain why:

My family are fishers	YES	NO
I like to draw the sea and things that live in it	YES	NO
I like to learn about the sea and things that live in it	YES	NO
The sea gives me a good feeling in my heart	YES	NO
My family has loved or valued the sea for a long time	YES	NO
I like animals that live in the sea	YES	NO
I want the ocean to be healthy	YES	NO
I think the ocean should stay healthy for people in the future	YES	NO
I think a healthy ocean can provide good things for humans	YES	NO
I think we have a responsibility to care for the oceans	YES	NO
I like fishing	YES	NO
I like watching birds or other animals	YES	NO
I like going on boats	YES	NO
I like going to the beach or shoreline	YES	NO
I like swimming in the sea	YES	NO
I like snorkelling or diving in the sea	YES	NO
The sea provides me/my family with a lot of our money	YES	NO
The sea provides me/my family with a little bit of our money	YES	NO
I collect some food from the ocean	YES	NO
The sea is important for bringing money to my island	YES	NO

6. From where do you get information about the sea?

(Please underline ALL answers that apply to you)

- a. Television
- b. School/ teachers
- c. Radio
- d. Internet
- e. Magazine/ newspaper
- f. Family/ friends
- g. Other _____

7. How much do you think you know about the sea?

(Please underline the answer that applies to you)

- a. Nothing
- b. A little
- c. A medium amount
- d. Quite a lot
- e. A lot

8. Do you think the sea in the Maldives is under threat?

(Please underline the answer that applies to you)

- a. Not at all
- b. Only a little threatened
- c. Somewhat threatened
- d. Yes, it is quite threatened
- e. Yes, it is very threatened
- f. Don't know

9. How much do you think you know about the threats to the sea that are listed below? (Please underline one option for each topic)

- a. Climate change
 - i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- b. Over fishing
 - i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- c. The idea of exploring the sea to find oil or gas
 - i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- d. Damage to marine habitats (ecosystems like mangroves or coral reefs) by humans
 - i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- e. Ocean acidification
 - i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- f. Sea level rise
 - i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much

- g. Reduction in biodiversity (the number of different animal or plant species in the ocean)
 i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- h. Invasive animals or plants (animals or plants from another place or ecosystem)
 i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- i. The effects of fishing on the sea
 i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- j. Aquaculture (farming fish for food)
 i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- k. Pollution from human waste or farming
 i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- l. Pollution from plastic or litter
 i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much

10. What do you think are the top FIVE threats to the sea in the Maldives?

(Circle them)

a. Sea Level Rising	b. Climate Change	c. Ocean Acidification
d. Aquaculture (farming fish for food)	e. Tourism	f. Over fishing
g. Invasive animals or plants	h. Pollution from plastic or litter	i. Reduction in biodiversity (amount of different animal species in the ocean)
j. Pollution from human waste or farmers	k. Fishing for business, to sell to shops or people	l. Habitats being destroyed or changed by humans
m. Fishing for fun	n. Exploring for oil or gas to use	o. Salty seawater mixing with freshwater on the land

11. Do you think threats to the Maldives will increase or decrease in the next 100 years? *(Please underline the answer that applies to you)*

- a. Decrease a lot
 b. Decrease a little

- c. Stay the same
- d. Increase a little
- e. Increase a lot
- f. Don't know

12. Do you think that it is important to work to decrease threats to the sea?

(Please underline the answer that applies to you)

- a. Not at all important
- b. A little important
- c. Somewhat important
- d. Quite important
- e. Very important
- f. Don't know

13. When an area of the ocean becomes a marine protected area (MPA), people who use the area may have to stop doing things like fishing, collecting or dredging for sand or boat channels in that place.

Do you think this is OK? *(Please underline the answer that applies to you)*

- a. Definitely NO
- b. Probably NO
- c. Maybe/sometimes
- d. Probably YES
- e. Definitely YES
- f. Don't know

14. How do you feel about tourism in the Maldives? *(Underline any you agree with)*

- a. It does not help the local people as much as it should
- b. It is really good for industry, nature and local people and helps to keep these things healthy for the future
- c. Tourism should be run more by local people and not big businesses, so that there are more benefits for local people
- d. We should focus on other industries, like fishing or business, more than tourism
- e. Tourism is not good for nature and wildlife in the Maldives
- f. Tourism does not help local communities to keep developing
- g. Tourism is the best way to help the Maldives develop and get more money which can be used to make the Maldives better
- h. Tourism gives people good jobs and money
- i. Tourism helps to keep the ocean and land healthy and make sure the animals and plants do not die
- j. In the future, I would like to get a job in tourism

15. What do you think environmental conservation means? *(Underline any of the sentences that you think explain this)*

- a. Helping to keep the land and sea healthy by stopping humans using the land or sea in any way

- b. Using the land and sea in a way that has equal benefits for humans and nature, and keeps the land and sea healthy for people in the future
- c. Protecting animals and plants for people to use now and in the future
- d. Protecting and guarding nature so that it stays healthy

16. Would you like to become a marine biologist or marine conservationist for your job? (*Underline the answer you agree with*)

- a. No
- b. Yes
- c. Don't know

17. On a scale from 0 (not important at all) to 10 (extremely important), how important do you think environmental conservation in the Maldives is? (*Underline the number that you agree with*)

0	1	2	3	4	5	6	7	8	9	10
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18. If you had one wish for the future of the sea in the Maldives what would it be?

Age: _____

Gender: _____

Thank you for your participation!

Appendix C: The post-program survey**Baa Atoll Marine Education Program 2017, Kendhoo School: Midway Questionnaire**

My name is Flossy Barraud and I am studying for a Masters degree in Marine Environmental Management at the University of York in the UK. For my degree I would like to have your answers to a questionnaire about the marine biology program that you are in the middle of. This survey will be similar to the last survey you completed, with a few extra questions, which I have asked understand how effective the program was and how useful it was for you. You don't have to do my questionnaire unless you want to, and if you do, nobody will know that what you say was said by you. This survey should take approximately 15 minutes to complete. Thank you for participating, and if you have any questions then please ask. If you would like to know more, email me at fvb501@york.ac.uk.

For questions 1 to 4 circle which answer from those provided you most agree with:

1. How much time do you spend in the sea for fun?

- a. Very rarely/never
- b. A few times a year
- c. Once a month
- d. Once a week
- e. Every day

2. Do you enjoy being in the sea?

- a) Not at all
- b) Very little
- c) Moderately
- d) Quite enjoy
- e) Enjoy very much

3. How much time would you like to spend in the sea for fun?

- a) Very rarely/never
- b) A few times a year
- c) Once a month
- d) Once a week
- e) Every day

4. How important is the sea to you?

- f. Not at all important
- g. Very little
- h. Moderately
- i. Quite important
- j. Very important

5. If the sea is important for you then circle yes or no for all the reasons listed below that could explain why

My family are fishers	YES	NO
I like to draw the sea and things that live in it	YES	NO
I like to learn about the sea and things that live in it	YES	NO

The sea gives me a good feeling in my heart	YES	NO
My family has loved or valued the sea for a long time	YES	NO
I like animals that live in the sea	YES	NO
I want the ocean to be healthy	YES	NO
I think the ocean should stay healthy for people in the future	YES	NO
I think a healthy ocean can provide good things for humans	YES	NO
I think we have a responsibility to care for the oceans	YES	NO
I like fishing	YES	NO
I like watching birds or other animals	YES	NO
I like going on boats	YES	NO
I like going to the beach or shoreline	YES	NO
I like swimming in the sea	YES	NO
I like snorkelling or diving in the sea	YES	NO
The sea provides me/my family with a lot of our money	YES	NO
The sea provides me/my family with a little bit of our money	YES	NO
I collect some food from the ocean	YES	NO
The sea is important for bringing money to my island	YES	NO

6. From where do you get information about the sea?

(Please circle ALL answers that apply to you)

- h. Television
- i. School/ teachers
- j. Radio
- k. Internet
- l. Magazine/ newspaper
- m. Family/ friends
- n. Other _____

7. How much do you think you know about the sea?

(Please circle the answer you most agree with)

- c. Nothing
- d. A little
- e. A medium amount
- f. Quite a lot
- g. A lot

8. Do you think the sea in the Maldives is under threat?

(Please circle the answer you most agree with)

- a. Not at all
- b. Only a little threatened
- c. Somewhat threatened
- d. Yes, it is quite threatened
- e. Yes, it is very threatened
- f. Don't know

9. How much do you think you know about the threats to the sea that are listed below? *(Please circle how much you think you know about each threat)*

- m. Climate change
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- n. Over fishing
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- o. Companies exploring the sea for oil or gas that they can use
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- p. Habitats being destroyed or changed by humans
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- q. Ocean acidification
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- r. Sea level rise
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- s. Reduction in biodiversity (the amount of different animals or plants in the ocean)
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- t. Invasive animals or plants
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- u. Fishing
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- v. Aquaculture (farming fish for food)
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- w. Pollution from human waste or farming
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much
- x. Pollution from plastic or litter
i. Nothing ii. Not much iii. A medium amount iv. Quite a lot v. Very much

10. What do you think are the top FIVE threats to the sea in the Maldives?
(Circle them)

a. Sea Level Rising	b. Climate Change	c. Ocean Acidification
d. Aquaculture (farming fish for food)	e. Tourism	f. Over fishing
g. Invasive animals or plants	h. Pollution from plastic or litter	i. Reduction in biodiversity (amount of different animals in the ocean)
j. Pollution from human waste or farmers	k. Fishing for business, to sell to shops or people	l. Habitats being destroyed or changed by humans
m. Fishing for fun	n. Exploring for oil or gas to use	o. Salty seawater mixing with freshwater on the land

11. If you think the sea in Maldives is threatened, do you think threats to the Maldives will increase or decrease in the next 100 years? (Please circle the answer you most agree with)

- a. Decrease a lot
- b. Decrease a little
- c. Stay the same
- d. Increase a little
- e. Increase a lot
- f. Don't know

12. Do you think that it is important to work to decrease threats to the sea? (Please circle the answer you most agree with)

- a. Not at all important
- b. A little important
- c. Somewhat important
- d. Quite important
- e. Very important
- f. Don't know

13. When an area of the ocean becomes a marine protected area (MPA), people who are using the area may have to stop using it for things like fishing, collecting or dredging for sand or boat channels.

Do you think this is OK? (Please circle the answer you most agree with)

- g. Definitely NO
- h. Probably NO
- i. Maybe/ sometimes
- j. Probably YES
- k. Definitely YES
- l. Don't know

14. How do you feel about tourism in the Maldives? (Circle any you agree with)

- k. It does not help the local people as much as it should
- l. It is really good for industry, nature and local people and helps to keep these things healthy for the future
- m. Tourism should be run more by local people and not big businesses, so that there are more benefits for local people
- n. We should focus on other industries, like fishing or business, more than tourism
- o. Tourism is not good for nature and wildlife in the Maldives
- p. Tourism does not help local communities to keep developing
- q. Tourism is the best way to help the Maldives develop and get more money which can be used to make the Maldives better
- r. Tourism gives people good jobs and money
- s. Tourism helps to keep the ocean and land healthy and make sure the animals and plants do not die
- t. In the future, I would like to get a job in tourism

15. What do you think environmental conservation means? (Circle any of the sentences that you agree with)

- e. Helping to keep the land and sea healthy by stopping humans using the land or sea in any way

- f. Using the land and sea in a way that has equal benefits for humans and nature, and keeps the land and sea healthy for people in the future
- g. Protecting animals and plants for people to use now and in the future
- h. Protecting and guarding nature so that it stays healthy

16. Would you like to become a marine biologist or marine conservationist for your job? *(Circle the answer you agree with)*

- a. No
- b. Yes
- c. Not sure

If yes, please explain why:

17. On a scale from 0 (not important at all) to 10 (extremely important), how important do you think environmental conservation in the Maldives is? *(Circle the number that you agree with)*

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

18. If you had one wish for the future of the sea in the Maldives what would it be? *(Please write your wish):*

19. Has taking part in this program made you want to learn more about the sea, or help to protect the sea in the future? *(Please circle the answer you most agree with):*

- a. Definitely NO
- b. Probably NO
- c. A medium amount
- d. Probably YES
- e. Definitely YES

20. Has taking part in the program made you care more about the sea and environmental issues? *(Please circle the answer you most agree with):*

- a. No
- b. Not really
- c. A medium amount
- d. Yes, a little more
- e. Yes, a lot more

21. Since taking part in the program, have you made an effort to get involved in any activities to help the sea or environment? *(Please circle the answer you most agree with)*

- a. No
- b. No, but I intend to:

*Please explain what you **intend to** get involved in:*

c. Yes

*If yes, please explain what you **have already gotten involved in**:*

22. Which theory lesson and fieldtrip did you enjoy the most and enjoy the least? (Tick **one for theory and **one for fieldwork** which you have enjoyed the most, and put a cross (X) next to **one for theory** and **one for fieldwork** you have enjoyed the least)**

Theory	Fieldtrip
Marine ecosystems	Marine ecosystems (trip to Landaa Giraavaru Marine Centre)
Corals	Corals (coral reef snorkelling)
Reef fish and turtles	Reef fish and turtles (identifying turtles and fish)
Biosphere reserves	Biosphere reserve (snorkelling with manta rays)
Waste	Waste (trip to waste management centre)

23. Which theory lesson and fieldtrip do you think you learnt the most from and learnt the least from? (Circle **one for theory and **one for fieldwork** which you have learnt the most from, and put a cross (X) next to **one for theory** and **one for fieldwork** you have learnt the least from)**

Theory	Fieldtrip
Marine ecosystems	Marine ecosystems (trip to Landaa Giraavaru Marine Centre)
Corals	Corals (coral reef snorkelling)
Reef fish and turtles	Reef fish and turtles (identifying turtles and fish)
Biosphere reserves	Biosphere reserve (snorkelling with manta rays)
Waste	Waste (trip to waste management centre)

24. Did the swimming and snorkelling lesson make you feel more confident in the sea? (Please circle the answer you most agree with)

- Not at all
- Only a little
- A medium amount
- Quite a lot
- Very much so

25. Did the fieldtrips make you feel more confident in the sea? (Please circle the answer you most agree with)

- Not at all
- Only a little
- A medium amount
- Quite a lot
- Very much so

26. Would you like to have had more lessons about the sea and threats to the sea whilst you were at school? (Please circle the answer you most agree with)

- No
- Not really
- Maybe/sometimes
- Yes a little more
- Yes a lot more

27. Has taking part in the program made you change your environmental behaviour in any way? (For example using less plastic, recycling your waste or composting, being more respectful of wildlife) *(Please circle the answer you most agree with)*

- a. No
- b. No, but I intend to

Please explain what you intend to change:

-
- c. Yes

If yes, please explain how your environmental behaviour has changed:

28. Have you passed any of your knowledge/information learnt from the marine biology program onto others, like family members or friends? *(Please circle the answer you most agree with):*

- a. No
- b. Yes

If you answered YES to question 28, please answer the 3 questions below:

28a. What knowledge/information did you pass onto others?

28b: Why did you want to tell others about what you learnt?

28c: Do you think you have affected your family or friends' environmental behaviour, knowledge or attitude in any way? Describe how.

29. Do you have any other comments about the marine education program?

*Please write anything you thought was **good or bad** about it and anything that could **improve** it in the future:*

Age: *(please circle your age):* **13** **14** **15** **16**

Gender *(please circle your gender):* **Male** **Female**