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Strategies for Environmental Education for Youths and Adults, Chumbe Island Coral Park, Zanzibar

Samantha Pfeffer
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Strategies for Environmental Education for Youths and Adults, Chumbe Island Coral Park, Zanzibar

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School for International Training – Zanzibar: Coastal Ecology and Natural Resources
Management, Fall 2017

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All pictures present in this paper were taken by Samantha Pfeffer during the study period.

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Abstract

Chumbe Island Coral Park (CHICOP) is a privately-owned business that strives to follow the best principles of ecotourism, conservation, and environmental education. Their environmental education initiative is award-winning and has affected thousands of students and community members in Zanzibar. This study looked at the environmental education techniques that CHICOP already has in place by observing two pre-visits, three island-visits and one-post visit, and determined where there was a need for enhanced and new techniques for teaching about the environment. Evidence of climate change on Chumbe Island was also recorded to aid in the educational tools and to create a database of climate change evidence on Chumbe. After compiling the observations of each of the visits, twenty new environmental educational tools and activities were created, under eleven category types. It is hoped that these tools and activities will enhance environmental education based on Chumbe's needs.

Introduction

Chumbe Island Coral Park (CHICOP) is an extremely successful venture that has made impressive strides in ecotourism, conservation, and Environmental Education (EE) since its inception in the early 1990s (CHICOP, 2017; *Chumbe Island Coral Park*). The island houses a Coral Reef Sanctuary (CRS), a Closed Forest Reserve (CLF), historical monuments, seven eco-lodges, and a fully functional visitor and education center (CHICOP, 2017; *Chumbe Island Coral Park*). All the funds that result from CHICOP's ecotourism program go towards funding Chumbe's conservation efforts and their award-winning education program (CHICOP, 2017). CHICOP has been incredibly successful in its implementation of an environmental education initiative that, since its inception, has benefited thousands of Zanzibari students and teachers as well as hundreds of community members and college students (CHICOP, 2017; *Chumbe Island Coral Park*).

The purpose of this study was to evaluate the environmental education programming that is already in place in the CHICOP curriculum and to develop new methods, tools, and activities to increase environmental knowledge and environmental education. CHICOP has asked for help in developing new strategies and enhancing their already existing strategies for environmental

education. The methods they already have in place are excellent, but they need some new and fresh ideas. The question that was addressed in this study was, what are the most effective ways of teaching environmental issues and climate change to primary and secondary school children, as well as adult students, teachers, and community members from different backgrounds? After observing the educational methods already in place for pre-visits, island-visits, and post-visits, new methods, tools, and activities were developed and implemented to enhance what is already in place.

Background

This study covers a range of subjects, including climate change, coral reefs, coastal forests, and environmental education. To obtain the required information work was done with CHICOP to observe their environmental education programming to create new educational tools and activities.

Framing Ecological Concepts

Climate change is a problem that the entire world is facing (Viles and Spencer, 1995). Many people confuse climate change with weather. Weather is comprised of the changes that can be seen on a day to day basis while climate change takes years to become apparent and is a change in the Earth's overall climate (Stillman and Green, 2017). These changes can be in average rainfall levels or in average temperatures (Stillman and Green, 2017). Climate change is something that can be extremely impactful to small islands communities, like Zanzibar (Mustelin, et al., 2009). There has been evidence of receding shorelines, increasing inundations, and saltwater intrusion across Zanzibar and its surrounding islands (Mustelin, et al., 2009). This is increasingly problematic because, not only are small tropical islands highly affected, but islands within developing countries are especially influenced (Mustelin, et al., 2009). While

developing countries are not necessarily the primary sources attributed to climate change, they are some of the countries that are hit the hardest because they rely on economic sectors that are sensitive to climate change effects, such as forestry, fishing, agriculture, and tourism (Mustelin, et al., 2009). Islands like Zanzibar are highly affected due to their limited size and geographic range in the tropics (Mustelin, et al., 2009).

Climate change is caused by a multitude of factors, both ecological and anthropogenic. A volcanic eruption can result in a change in the Earth's climate, but a large portion of climate change is attributed to anthropogenic causes (Stillman and Green, 2017). Any human activity that emits gases, such as Chlorofluorocarbons (CFCs), into the atmosphere, is part of the cause of climate change (Stillman and Green, 2017). One of the biggest gas emissions on Zanzibar is the burning of various materials (Kloiber, 2013). Coal, oil, and gas are burned for cooking purposes and to heat or cool homes in some circumstances, but one of the biggest burnings occurs from material waste (Kloiber, 2013; Stillman and Green, 2017). Zanzibar has a very poor trash disposal system and most of the garbage it produces ends up burned, if it is not left on the side of the road (Kloiber, 2013).

One of the biggest results of climate change is coral bleaching. Coral bleaching is when sea temperatures rise, causing the zooxanthellae to be expelled from the coral it lives in (Viles and Spencer, 1995). Zooxanthellae is a type of algae that has a symbiotic relationship with coral where the zooxanthellae photosynthesize and share some of the food they produce with the coral polyp, while the coral provides a home for the zooxanthellae (Viles and Spencer, 1995). This is also how most corals develop their beautiful colors (Viles and Spencer, 1995). When sea temperatures increase, it puts stress on the zooxanthellae and causes them to eject from their home within the coral (Viles and Spencer, 1995). This loss of the zooxanthellae is

what causes the lack of color in coral and why the effect is called coral 'bleaching' (Viles and Spencer, 1995). The coral can survive without the zooxanthellae because they are able to photosynthesise on their own, but not to the magnitude that the zooxanthellae can, resulting in coral starvation, weakness and susceptibility to diseases, and eventual death (Viles and Spencer, 1995). This also lowers available nutrients to the coral, reduces reproduction potential, reduces growth, and reduces coral's carbon fixation ability (Viles and Spencer, 1995).

While climate change is an increasing problem for coral reefs, there are also a plethora of other problems that befall reefs. Unsustainable tourism is a huge problem, especially in Zanzibar where tourism is such an integral aspect of the economy and culture (Viles and Spencer, 1995). Tourists can cause direct harm to the reef if they kick it with their flippers or break part of it to take as a souvenir, but they can also produce high levels of pollution in the form of chemicals in sunscreen and other body lotions as well as physical trash items like plasticware and straws (Viles and Spencer, 1995). Agricultural runoff and chemical runoff can also be washed into the ocean where they reach coral reefs (Viles and Spencer, 1995). In addition, unsustainable fishing is a significant problem for coral reefs, especially in Zanzibar where fishing is such a large industry (Mustelin, et al., 2009; Viles and Spencer, 1995). Overfishing of reefs, as well as over-harvesting of mollusks and echinoderms, can cause imbalances in the ecosystems and food chains, and deplete the fish that are necessary to continue fishing (Viles and Spencer, 1995). If all the fish are fished from the reef, there will be no fish left for future generations. While there are a plethora of human-caused problems that befall coral reefs, there are also ecological problems. One problem concerns *Acanthaster planci*, or the Crown-of-Thorns-Starfish, which can eat ten square meters of coral in a year (Viles and Spencer, 1995).

When there is a fleet of the Crown-of-Thorns-Starfish, the effects can be disastrous (Viles and Spencer, 1995).

Framing Social Concepts

The reliability, usefulness, and importance of environmental education has been debated for years. The Environmental Protection Agency (EPA) defines “environmental education” as “a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment” (*What is Environmental Education*, 2017). Eheazu and Ezeala discuss three different ways to view environmental education; education *about* the environment, *from* the environment and *for* the environment (Eheazu and Ezeala, 2017).

Education *about* the environment consists of the knowledge and understanding of environmental ideas and processes, education *from* the environment deals with actually being in the environment and using the environment as a tool for gaining knowledge about its resources and related issues, while education *for* the environment is education that allows individuals to develop the knowledge they have about the surrounding environment and use it to make educated and ethical decisions about its use and management (Eheazu and Ezeala, 2017).

With environmental education, there are many ways it can be taught and many different groups of people that it can be taught to; the different audiences and groups that receive environmental education determine the methods that should be applied to teach about the environment. For example, for most adults, when they receive environmental education, they are not usually in a traditional classroom settings so they need different learning methods (Eheazu and Ezeala, 2017; Manase, 2016). Most adult environmental education involves education *from* the environment because it is important to and for adults to learn about environmental issues that directly relate to their lives and livelihoods (Eheazu and Ezeala, 2017; Okur-Berberoglu, 2017).

In communities where adults rely on natural resources for their income, typically in less affluent communities, education is aimed at conservation in ways that allow community members to better manage the resources they are already using (Eheazu and Ezeala, 2017; Manase, 2016; Okur-Berberoglu, 2017). Adult community members are also more likely to show interest and support for environmental education issues when it relates to their livelihoods (Manase, 2016).

Another aspect of education is experiential education. Experiential education deals with learning by doing (Bozdemir et al., 2014; Kolb, 2014; Mainemelis et al., 2002). Students go outside and learn about the environment by planting trees, walking through the woods, and seeing, touching, and smelling what they are learning about (Bozdemir et al., 2014; Okur-Berberoglu, 2017). Kolb developed an Experiential Learning Theory where knowledge is created through real life experiences (Kolb, 2014; Mainemelis et al., 2002). While this method of education is extremely helpful in educating adults about the environment, it can be useful for students of all ages (Kolb, 2014). Young students can also benefit from experiential learning in that it helps them connect what they learn in the classroom to what is in their environment (Kolb, 2014; Kwan et al., 2017). A lot of younger students cannot find a connection between the lectures they receive in school with the environment around them, but experiential education allows them to find the bridge between book-knowledge and real life (Kwan et al., 2017). A prime example of successful experiential environmental education is the program implemented by the Chumbe Island Coral Park (CHICOP).

CHICOP has made significant progress in its implementation of a very successful Environmental Education program in which they have worked with over 6.5 thousand students, 1.2 thousand teachers, and 750 community members between 1996 and present (CHICOP, 2017). CHICOP's educational program involves a three-step process in which each group has

three distinct sessions (CHICOP, 2017). The first step, the pre-visit, is an in-classroom visit where the CHICOP staff visit schools on Unguja to give a preliminary lesson on conservation, ecology, and about the history and management of Chumbe Island (CHICOP, 2017; *Chumbe Island Coral Park*). A few weeks after that initial visit, the group then visits Chumbe Island, for the island-visit, to have a full-day excursion where the students learn about the ecology of the island, sustainable management, and ecotourism (CHICOP, 2017; *Chumbe Island Coral Park*). This is achieved through snorkeling in the Coral Reef Sanctuary, a forest walk in the Closed Forest Reserve, visits to the historical lighthouse and eco-bungalows, and classroom lectures (CHICOP, 2017; *Chumbe Island Coral Park*). A few weeks after the Chumbe visit, the CHICOP staff then return to Unguja for a second in-classroom visit, the post-visit, for some “wrap-up” activities and lessons (CHICOP, 2017; *Chumbe Island Coral Park*). CHICOP also engages in other school-based and classroom activities as well as their annual “Chumbe Challenge Award” competition (CHICOP, 2017).

How Does Chumbe Organize Their Activities?

Chumbe’s environmental education programming usually follows a three-step process involving a pre-visit, an island-visit, and a post-visit (CHICOP, 2017). These visits are usually about a month apart, but some groups do have a shorter amount of time between visits (CHICOP, 2017). There are also groups that only have island-visits, with the pre- and post-visits excluded (CHICOP, 2017). Pre-visits are held with groups that are going to visit Chumbe Island for an island-visit (CHICOP, 2017). Pre-visits usually include a preliminary survey of ecological and conservation questions meant to gauge how much environmental education each student has had (CHICOP, 2017). After the survey, the students are given a lesson on general ecology surrounding Zanzibar and Chumbe Island and a brief history of how CHICOP was founded and

how it runs (CHICOP, 2017). The lesson is concluded with a discussion of what the group should expect from their trip to Chumbe Island, as well as how they should prepare (CHICOP, 2017).

The biggest educational visit that Chume provides is the island-visit. There are two different groups that usually visit Chumbe for the environmental education island-visit: groups that have had a pre-visit prior to the island-visit and groups that have not received a pre-visit and will not receive a post-visit (CHICOP, 2017). These groups are primarily community groups and groups of college level students (CHICOP, 2017). While on Chumbe, groups experience multiple activities including snorkeling in the Coral Reef Sanctuary (CRS), an intertidal-zone walk, walking through the Closed Forest Reserve (CFR), learning about sustainable eco-tourism inside one of Chumbe's eco-bungalows, learning in the classroom, and walking up the steps of the historical lighthouse (CHICOP, 2017). Because many of the students who visit Chumbe either do not know how to swim or are not strong swimmers, all students are given a lesson in first how to use their mask and snorkel, and, then, when they are in the water, they take turns lying on the innertube so that they can still see the reef using their mask, even if they cannot swim (CHICOP, 2017; Figure 1). The walk through the Closed Forest Reserve usually includes a lesson at the Mangrove Pool, the compost pile, through the forest, along the rocky eastern shore, and sometimes a lesson at the lighthouse (CHICOP, 2017; Figure 2). For each of these activities, the lessons are tailored to each group that visits the island. The overall lessons are the same, but they have different specific undertones.



Figure 1. Students from the College of Health Sciences learning about how to use a mask and snorkel before snorkeling (a). One of the students from the College of Health Sciences using an innertube to assist with snorkeling (b).



Figure 2. Students from the College of Health Sciences standing around the Mangrove Pool during the forest walk (a). Students from the College of Health Science learning about how Chumbe processes their compost while on their forest walk (b). The men from the veterans group learning about the importance of the forest and its ecological significance while on their forest walk (c). Students from the College of Health Sciences learning about the geological history of Chumbe and Zanzibar Islands on the eastern shores of Chumbe Island (d).

Study Area

Unguja Island is one of two islands that make up the Zanzibar Archipelago, located about 25-50 km from mainland Tanzania (Figure 3). Chumbe is an island about 6 km from Unguja (*Chumbe Island Coral Park*; Figure 3). In 1991, Chumbe was developed into Chumbe Island Coral Park Inc. (CHICOP) to promote the sustainable management and conservation of the natural resources on the island (*Chumbe Island Coral Park*). It then became the first privately owned Marine Protected Area (MPA) in Zanzibar (*Chumbe Island Coral Park*). CHICOP is a non-commercial, privately owned and operated organization that houses a fully protected Coral Reef Sanctuary (CRS) and Closed Forest Reserve (CFR), as well as a Visitor and Education Center, seven eco-lodges, and historical monuments (CHICOP, 2017; *Chumbe Island Coral Park*; Figures 3 and 4). While they are a not-for-profit organization, they strive to follow best commercial principles to obtain the highest revenue to support their ecotourism, education, and conservation programs (CHICOP, 2017; *Chumbe Island Coral Park*): “The overall aim of CHICOP is to create a model of financially and ecologically sustainable park management, where ecotourism supports conservation, research and comprehensive Environmental Education programs for local schools and other benefits for local people” (*Chumbe Island Coral Park*).

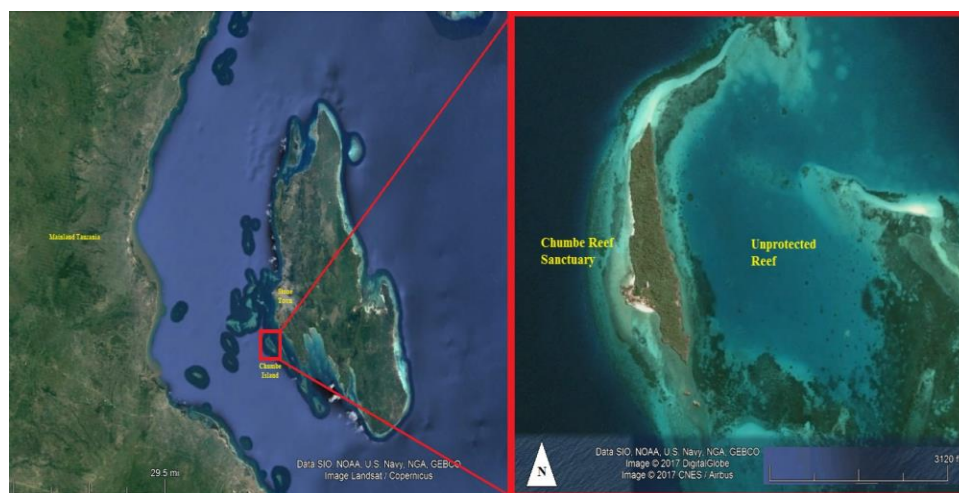


Figure 3. Unguja Island in relation to mainland Tanzania, with Chumbe Island highlighted (left) and Chumbe Island showing the Chumbe Reef Sanctuary and the location of the unprotected reef highlighted in red (right).

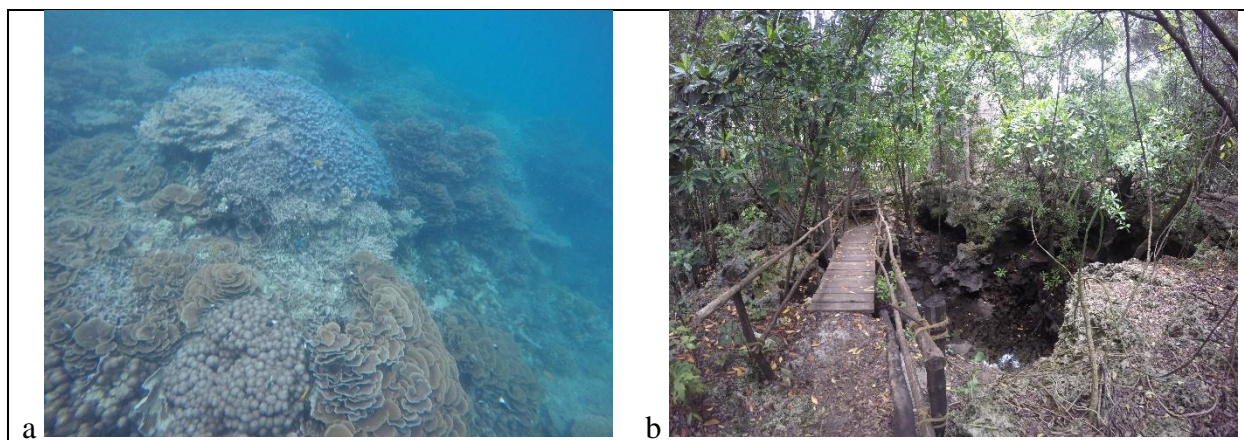


Figure 4. The Coral Reef Sanctuary (CRS) (a) and the Mangrove Pool on the Closed Forest Reserve (CFR) (b).

CHICOP works with multiple types of communities, including students, teachers, and other members of the various communities of Unguja (CHICOP, 2017). The students and community members who work with CHICOP reside in six target-villages: Mazizni, Chukwani, Buyu, Nyamanzi, Kombeni, and Dimani, as well as non-target villages, which include the rest of the villages and communities across Unguja (CHICOP, 2017). Due to the diverse tropical ecosystems located throughout Unguja, including scrub forests, coral rag forests, and urban centers, the different environmental education programs that CHICOP provides are tailored to the locations of the various schools and communities' locations (CHICOP, 2017).

Chumbe Island was chosen for this study site because of the unique qualities of Chumbe Island and CHICOP. There are very few organizations with outstanding environmental education programs, like CHICOP. CHICOP's environmental education efforts are excellent, but they requested enhancements to their existing techniques. CHICOP needed fresh ideas. Due to CHICOP's request for assistance as well as the unique and amazing quality of CHICOP's environmental education efforts, Chumbe Island was the optimal location for this study.

Methodology

To conduct this study two phases of research were conducted. The first phase of the study involved participant observation. “Participant observation” concerns immersing oneself in the various aspects of a culture to collect data (Bernard, 2013). Participant observation can involve two main forms of participant observation, the participating observer and the observing participant (Bernard, 2013). The participating observer is an outsider immersing themselves in the community to collect data while also participating in certain aspects of the community, while the observing participant is an outsider to the community who solely observes the community to collect data without participating in any aspects of the community (Bernard, 2013). For the purpose of this study both forms of participant observation were completed.

To obtain background information of the school systems and education in Zanzibar, I observed multiple pre-, post-, and island-visits to classrooms on Unguja and to Chumbe Island through CHICOP. While in the classroom, the observing participant method was employed. Statistical data was collected on the students’ ages and gender as well as observational data on attitudes, levels of interest, relationships between the students and the teachers, relationships between the students and the CHICOP staff, and general notes about the activities performed throughout the lesson. It was also noted what the classroom environment was like and what supplies, if any, were available and used.

While on Chumbe Island, I observed the already existing Environmental Education (EE) programming. The same statistical data that was collected in the classrooms on Unguja was also collected on Chumbe. In addition to the statistical data, information on the general schedule and timings for the various activities were noted. Due to the nature of the Chumbe Island visits, the participating observer method was more prevalent. While the students were snorkeling in the

Coral Reef Sanctuary, I assisted in pulling the innertube that the students used and I pointed out different fish and corals that they students might find interesting. I also took part in the classroom lessons that were taught, went on the forest walks and lighthouse climbs, ate lunch with the group, and spent the day getting to know some of the students that were there for each visit.

While getting to know some of the students during the Chumbe Island visits, I conducted unstructured interviews in the form of conversations. Information from these conversations and unstructured interviews was collected to aid in the evaluation of environmental education in Zanzibar and on Chumbe. No translator was used for these conversations as they were mostly in English and no direct quotes were recorded, only ideas and general comments about the environment, education, and Chumbe as a whole.

Another aspect of collecting data while on Chumbe Island involved taking pictures and videos of evidence of climate change while on the island. These pictures and videos were mainly taken to add to a digital archive of climate change evidence on Chumbe, but also to aid in the creation of environmental educational tools developed during phase two of this study. While snorkeling in the Chumbe Reef Sanctuary, videos and pictures were taken of bleached corals and, while on land, pictures were taken of the geological evidence of climate change, such as the undercutting of cliffs and shorelines.

Phase two of this study was to develop new environmental education methods. After observing CHICOP's methods for environmental education, both in the classroom for pre- and post- visits as well as on Chumbe Island, I developed new environmental educational tools and activities to aid in the education process. To create the best tools possible, the pictures and videos taken on the Coral Reef Sanctuary as well as on Chumbe Island in the Closed Forest

Reserve and surrounding areas were used as real-life examples of the environment in Zanzibar and of climate change. To incorporate climate change into the educational tools, pictures and videos were taken of coral bleaching as well as evidence of eroding shorelines. Some of the educational tools created have hard copy materials that were presented to CHICOP, and all the tools created have digital copies or records to make the activities replicable, portable, and subject to change if necessary. All materials and tools created were presented to CHICOP at the end of the study period and the digital record can be found in the SIT office and the CHICOP office.

Results

There were three categories of results that were discovered through the course of this study. Evidence of climate change was observed while on Chumbe Island, observations of pre-, post-, and island-visits were observed to evaluate CHICOP's environmental education programming, and new educational materials were created as a result of the observations made during the various visits.

Environmental Observations

While on Chumbe Island during the island-visit, observations were made of evidence of climate change on Chumbe Island. Numerous pictures and videos were taken while on island, both in the Coral Reef Sanctuary and on land, of distinguishing features related to climate change. High levels of erosion, an indicator climate change, were documented in multiple instances of undercutting which were present around the entire island (Figure 5). There was also extensive coral bleaching along areas of the Coral Reef Sanctuary that were observed while snorkeling (Figure 6). All the pictures and videos taken during this study are now in a digital file that can be found in the SIT office or the office of CHICOP.



Figure 5. Examples of erosion in the form of undercutting present on Chumbe Island.



Figure 6. Examples of bleached corals found in the Coral Reef Sanctuary (CRS) at Chumbe Island.

Demographics

During phase 1 of the study, six visits were made to different classrooms with the help of CHICOP; two were pre-visits, three were island-visits, and one was a post-visit. Of these visits, four different groups of people were observed: a group of primary school teachers, a group of students from the College of Health Sciences attached to the State University of Zanzibar (SUZA), a group of veterans, and a group of primary/ secondary school students. The college students from SUZA and the primary/ secondary school student groups were both made up of students who were part of an environmental group. Of the teachers who were observed, some of them were in training to be teachers and some had already had some classroom experience. While age was relatively equal when looked at as total people observed, men and women observed within the individual visits were disproportionate (Table 1).

During each visit, observations were made on the behaviors exhibited to better understand which activities and tools would be the most helpful and beneficial to Chumbe (Table 2). Even though there were some groups who were distracted during some of the lessons, everyone seemed to be interested in what they were being taught and asked questions when they did not understand a topic (Table 2). These observations of the different students' behaviors were then used to develop new activities. Certain activities were created after observing already existing activities, such as the Scavenger Hunt, and others were created after learning the topics that were emphasized, such as the Coral Reef Board Game (Appendix A).

Table 1. Age and gender demographics for each of the visits that were observed.

<i>Group Type</i>	<i>Visit Type</i>	<i>Age Range (years)</i>	<i>Men Present</i>	<i>Women Present</i>	<i>Total Present</i>
<i>Primary School Teachers</i>	Pre-	25-40	3	9	12
	Island-		5	6	11
<i>College of Health Sciences Sudent</i>	Pre-	19-25	4	8	12
	Island-		7	8	15
<i>Veterans Group</i>	Island-	< 25	15	0	15
<i>Primary/ Secondary School Students</i>	Post-	> 18	3	7	10

Table 2. Demographics for the attendees of each visit.

<i>Group Type</i>	<i>Visit Type</i>	<i>Took Notes</i>	<i>Listened/ Paying attention</i>	<i>Distracted from lessons*</i>	<i>Language?</i>
<i>Primary School Teachers</i>	Pre-	Yes	Yes	No	English
	Island-	Yes	Yes	No	English
<i>College of Health Sciences Students</i>	Pre-	Yes	Yes	Yes	English
	Island-	Yes	Yes	Yes	English
<i>Veterans Group</i>	Island-	No	Yes	Yes	Swahili
<i>Primary/Secondary School Students</i>	Post-	Yes	Yes	No	English

Materials Created

During phase 2 of this study, new replicable educational tools were created. After observations of the six educational visits that were made with CHICOP, twenty new tools and activities were created under eleven ‘categories’ (Appendix A and B). Each of the activities or tools has a digital copy so that it can be reprinted or duplicated to ensure the tools’ and activities’ longevity. Most of the activities are appropriate for all ages and can be used at any of the visits (Appendix A and B). Only a few of the activities require a specific age group or location (Appendix A and B). Two of the activities created, the Tragedy of the Commons Game and the Stakeholders Activity, require no materials and are aimed towards older students, whether that be secondary school students or adult communities (Appendix B). These activities are meant to be ways for the group using them to begin an educated discussion about environmental issues that are relevant to their lives. These are the only two activities that are aimed towards older students, but any of the other tools created can be used for older students as well. In addition to these activities, four songs and six videos were created (Appendix B). The poem, *What is Coral?*, and the song, *C.O.R.A.L.*, are completely original creations developed to introduce elements of coral reef ecology, while the other two songs, *Little Polyp*, *Little Coral* and *You’ve Got the Whole Future in Your Hands*, have original lyrics but are to the tunes of two songs recognizable to students (Appendix B4). In addition to these items, six short videos were created, each featuring pictures and videos of the Coral Reef Sanctuary, the Closed Forest Reserve, as well as other areas of Chumbe Island in short bursts meant to grab the viewer’s attention and show glimpses of Chumbe Island and the effects of climate change (Appendix B3).

There are also seven activities that include materials created during this study period, including the Coral Reef Board Game, the Scavenger Hunt, the Animal Card Activity, two

picture books, the Electronic-Interactive Ecosystem Poster, the 3D Garbage Reef, and the “What Did You Learn from Chumbe?” Poster (Appendix A). These activities can be used for all ages but were created with younger students in mind (Appendix A). The picture books are aimed at primary school children, as they portray ecological issues using exaggerated cartoon animals and pictures (Appendix A5). The other activities all have accompanying physical and digital materials to aid in the educational process (Appendix A). One of the activities, the Electronic-Interactive Ecosystem Poster, is completely electronic, but still includes materials with which the students can interact (Appendix A7).

Discussion

Climate change is a growing problem all over the world, with obvious impacts in Zanzibar and on Chumbe Island. The focus of this study was not climate change, but a portion of the study time was dedicated to observing climate change effects and its multiple records (Figures 5 and 6). Erosion in the form of undercutting was seen around the entire island as well as extensive coral bleaching in the Coral Reef Sanctuary (Figures 5 and 6). It was already known that climate change was an influence, but the direct evidence that can be found on Chumbe is a good indicator that more climate education is necessary. Climate change is affecting people, but in a lot of places it is not emphasized in classrooms. It is extremely important to educate about climate change and other environmental issues to prevent and mitigate the problems that befall the environment. The activities created during this study are meant to be tools to aid in the education that Chumbe already has and to be ways to better engage students on these topics.

The Coral Reef Board Game was created with the intention of broadening students’ knowledge of coral reef ecology and the many harms that befall reefs (Appendix A1). Due to the

high importance of coral reefs to both Chumbe Island and Zanzibar, and the amount of time that is spent during the pre-, post-, and island-visits teaching about coral reefs, this game is meant to be a fun way to learn about coral reefs as a supplemental tool to lectures. This game uses cards, which describe ecological, economic, and social benefits from the reef (Appendix A1). These cards allow the player go forward on the board, and therefor closer to winning (Appendix A1). Cards describing the multiple harms that befall coral reefs and coral, both anthropogenic and ecological, push the player further back on the board and take them further away from winning (Appendix A1). The goal of this was to show that all the harms that befall reefs are negative and should be avoided. As most of the negative actions toward reefs are performed by humans and are things that can be adjusted for the better, the hope is that this game would create negative thoughts about some of the actions performed against the reefs, such as destructive fishing practices, unsustainable tourism, and pollution (Appendix A1). By putting the information in a game format, it inspires more enjoyment out of learning and therefore higher motivation to learn about coral reefs. In another study, Pinder found that using games as an instructional tool was a reliable way to increase students' academic knowledge and their motivation to learn (Pinder, 2013).

The goal of the Scavenger Hunt Activity was to increase involvement with the already existing forest walk through the Closed Forest Reserve on Chumbe during the island-visit (Appendix A2). The forest walk involves a walk through the forest with different stops along the way where the Chumbe Educator gives a short lecture on the ecological and social importance of the area (Figure 2). I went on multiple forest walks when I was on Chumbe to observe the island-visits and I noticed that during the walk, multiple students were distracted from the lessons. Some of them were turned away on their phones and some had small side conversations

amongst themselves (Table 2). The goal of this activity is to increase interest in the forest walk and encourage more students to be engaged. The Scavenger Hunt cards would be hidden at key points along the walk but the students would not know where (Appendix A2). By placing cards along the forest walk, students would have to stay focused in order to find the cards and solve the riddle. An ISP done in Spring 2011 focused on the forest trail located on Chumbe and they found that a more involved forest walk was necessary (Kranz and Brady, 2011). Since this ISP in 2011, the forest walk is more elaborate than what they described; however, there is always room for improvement and innovation.

The Animal Cards Activity is one that has multiple purposes and uses (Appendix A3). The main use was to create a bridge between the pre-visits and the island-visits (Appendix A3). Not a lot of programming exists within the CHICOP program that involved activities that span multiple visits. This activity was meant to be a way to connect things taught in the classroom for the pre-visit with things that the students will learn and experience during the island-visit. These cards can be excellent tools to inspire interest and excitement in coral reef topics discussed at each of the visits. With each student learning about one specific animal, they can tell their peers about it and, if they see it while snorkeling, it can foster excitement in something that they feel connected to. It can also bridge the gap between what the students are taught in a classroom environment with what they see while snorkeling. The cards are painted with bright colors and are placed on colorful backgrounds, which is also meant to be attention grabbing and inspire interest as opposed to a black-and-white fact sheet that involves no stimulation (Appendix A3).

The 3D Garbage Reef is meant to be a tool to aid in lessons that CHICOP already performs (Appendix A4). It was constructed almost completely out of trash that was collected during the study period, with the only non-trash items used being tape and glue (Appendix A4).

Garbage and trash disposal is an increasing problem in Zanzibar (Kloiber, 2013). Most people burn their garbage or leave it in random places outside (Kloiber, 2013). A lot of the garbage that is left on the streets and beaches is washed into the ocean by the tides, waves, and winds and this causes a lot of problems for sea life (Kloiber, 2013). Turtles will eat plastic bags they think are jellyfish, sea birds will eat plastic they think are fish eggs, and garbage can damage coral reefs by breaking and marking the coral as well as blocking sunlight from reaching the coral polyps and the zooxanthellae (Kloiber, 2013). The purpose of the 3D Garbage Reef is to bring awareness to the fact that garbage ends up on reefs. It is meant to aid in discussions and lessons about garbage, waste, and pollution. Chumbe advocates five ways to reduce trash and waste in Zanzibar; “Refuse what you do not need”, “Rethink and reduce what you do need”, “Reuse and repair rather than throwing away”, “Recycle what you cannot refuse, reduce, or recycle”, and “Rot (compost) bio-degradable waste” (Kloiber, 2013). Using the 3D Garbage Reef to emphasize these points, especially the recycling point since CHICOP’s materials discuss how using waste to create art is an ever-increasing industry (Kloiber, 2013), can be extremely helpful to illustrate examples of what ends up on coral reefs.

Two picture books were written and illustrated to provide materials suitable for younger children (Appendix A5). The first book, *Nguvu the Coconut Crab*, was written to help children learn about *Birgus latro*, or coconut crabs (Appendix A5a). There is not a lot known about coconut crabs, and, due to this, they are listed on the IUCN Red List as “data deficient” (Eldredge, 1996). Coconut crabs are special because they are the largest land-dwelling crabs, but, in many places, they are being over-hunted for food (Eldredge, 1996). The purpose of this book was to create an easy and fun way for children to learn about coconut crabs. Due to their size, the coconut crab can seem daunting and not “cute” to a lot of children, so by creating a

cartoon crab with facial expressions to describe the life cycle of a coconut crab as well as the harms that befall them, the crab is more relatable and more endearing to students. This was also the thinking behind the second book, *Adui vs. Shujaa*, the story of the *Acanthaster planci*, or Crown-of-Thorns-Starfish, versus the *Charonia tritonis*, or the Giant Triton (Appendix A5b). Both books were meant to humanize the animals to make them more approachable and relatable to students. This way, the problems that each of the animals face can mean more to the students than if they were given an oral lecture about why they should care.

The Electronic-Interactive Poster was created to incorporate technology into the CHICOP curriculum (Appendix A6). This activity is part game and part lecture. There is no ‘winning’ or ‘loosing’ involved, but the student can click on the different images on the poster to find out what the real animal looks like and information about why it is important (Appendix A6). A lot of the tools and activities that I created for this project involve drawings and paintings of the different creatures that are integral to the Chumbe and Zanzibar ecosystems. This tool is important in allowing the student to see what the animals look like in nature (Appendix A and B). This activity was created because it lets students learn about the different animals and circumstances surrounding Chumbe Island and Zanzibar by being engaged with the activity instead of just listening to a lecture (Appendix A6). There have been other studies conducted where they found that educational games that allow students to better engage with the knowledge presented helps the student better retain the information and be motivated to learn (Laghos, 2010; Pinder, 2013). This tool is also significant because it can be sent to schools and groups to review on their own time, even if they are unable to work with it on Chumbe Island or during the pre- and post-visits.

The “What Did You Learn from Chumbe?” Poster is an evaluative tool created to showcase what Chumbe has been doing with their educational program (Appendix A7). By enabling students to write out what they learned and seeing what other students have learned while on Chumbe, students can see how Chumbe reaches so many different groups and how many people have benefited from working with Chumbe. The goal is that multiple different groups will use the poster, including primary and secondary school students, collegiate students, community groups, and tourists. By having all these different types of people writing what they learned from Chumbe and why Chumbe was important in their learning journey, CHICOP can also know that their lessons have made an impact and where they might need to add. This poster is less a way to increase environmental knowledge and more a way for Chumbe to see the impact they are making in a concise way and, for other students to see the overarching impact that CHICOP provides.

In addition to the activities created that include materials, there were also several created that do not use materials (Appendix B). The first is the Tragedy of the Commons Activity (Appendix B1). This activity is one that has been adapted from an activity I participated in as a high school student in my Advanced Placement Environmental Science class. There have been multiple versions of this game created based on the original paper describing the Tragedy of the Commons, written by Garrett Hardin (APES Tragedy of the Commons Lab Activity; Hardin, 1968). The Tragedy of the Commons is a scenario in which there is a shared resource that is used by many people (Hardin, 1968). The ‘tragedy’ occurs when everyone uses this resource to maximize their gain without regard to how it will impact both the environment and the various stakeholders of that environment (Hardin, 1968). To maintain this shared resource, it is important to have active communication among the stakeholders to create sustainable use of the

resource and maximize use of that resource (Hardin, 1968). My Tragedy of the Commons Activity was designed for older students who would be better able to understand and discuss topics. It is meant to foster discussion and reflection and to bring awareness on how important it is to sustainably use communal resources on Zanzibar, such as coral reefs and coastal forests. Without sustainable management, the resource depletes, and eventually no one will be able to utilize it.

Another activity that was aimed towards adults is the Stakeholders Activity (Appendix B2). It is extremely important to remember that there are multiple stakeholders for every situation; there are multiple people who would be affected by changes in the environment. A joint research project between the Department of Geography (University of Turku) and the Department of Commercial Crops, Fruits and Forestry (Zanzibar) did a study on climate change in Zanzibar in 2009 and found that in circumstances where not all the stakeholders were consulted in situations of environmental upheaval, there were conflicts and unresolved issues (Mustelin, et al., 2009). This activity allows students to understand, first, that there are multiple stakeholders for every situation, but that there are different ways to interpret a situation. In terms of a coral reef, a fisherman would see the reef as a source for fish that s/he can take to sell and feed her/his family, but to a fish or a sea turtle, the reef is a home and a place where they feed, spawn, and live their lives. It is important to discuss how different groups would be affected by different anthropogenic and ecological impacts on the environment. This activity would hopefully foster intricate discussion among the students participating, which is why it is intended for older students, like secondary school students and adult community members (Appendix B2).

In addition to the two discussion-based activities created, six short videos were also created (Appendix B3). The videos range in topic from climate change and coral bleaching to

the sound of fish eating algae from the coral to what a group might expect to encounter on their island-visit to Chumbe (Appendix B3). These videos are short and can be played at any of the visits: pre-, post-, or island-. They are meant to grab attention and give students a snapshot of various topics and issues (Appendix B3). The videos were created because short videos are an increasing tool in education (Dreon, Kerper, and Landis, 2011). In an age where technology is steadily increasing, especially in the younger generations, forms of education that involve various forms of technology, such as film and video, have increasing levels of success in increasing students' knowledge of various topics (Dreon, Kerper, and Landis, 2011). In another study, Berk found that films and videos were excellent ways to impart knowledge on students because they elicit strong emotions in the viewers (Berk, 2009). Strong emotions of happiness, sadness, fear, and excitement can be triggered by viewing disturbing or joyous images in a video (Berk, 2009). These emotions can lead to higher levels of information retainment and a connection between the viewer and the subject matter (Berk, 2009; Dreon, Kerper, and Landis, 2011). Videos are becoming more and more present in the classroom because they grab the viewers' attention, generate excitement in the subject matter, inspire creativity, and can improve attitudes toward learning (Berk, 2009).

Four songs and poems also were created (Appendix B4). Initially it was meant to be four songs, but after writing *What is Coral?*, it became impossible to put it to a tune, so it became a poem describing the relationship between coral and zooxanthellae (Appendix B4b). These songs are meant to help students learn topics by hearing the songs, learning the tunes, and using the tunes to help remember the words and what they mean. Music has been found to be an important tool in younger students' development and cognitive abilities because music usually leads to enjoyment which leads to motivation (Eady and Wilson, 200; Van der Linde, 1999). The nature

of the songs that I wrote involve repetition and rhyming, both of which have been connected to an increase in younger students' cognitive ability and memory (Van der Linde, 1999). Repetition and mimicry are known tools in aiding in memory and retention of knowledge (Van der Linde, 1999). The goal with the songs created was to make something that could be easy to remember and repeat, to retain the most amount of knowledge. Two of the songs, *Little Polyp*, *Little Coral*, and *You've Got The Whole Future in Your Hands*, have original lyrics but are to the tune of two already existing songs (Appendix B4 and B4c and B4d). This was intended to provide songs that that students may already know and create a better bridge between the new lyrics and the information they provide. Overall, music is known to bring enjoyment and happiness to people, which can in turn create motivation and memory retention (Eady and Wilson, 2004; Van der Linde, 1999).

My recommendations for Chumbe would be to continue what they are already doing and never stop. The environmental education that Chumbe provides is essential in raising awareness of environmental issues and climate change. The programming that they already have in place is wonderful and successful due to the hard work of the CHICOP staff and Khamis, the environmental educator who was my best resource and one of my advisors. My recommendations for moving forward would be to include more visuals in their lessons. For certain students, it is hard to conceptualize different scientific and environmental topics because it is not something they have previously studied. Having visual tools such as pictures, videos, and physical objects can be extremely beneficial for students who are visual learners. Chumbe already does use some visuals for their lessons, but increasing their number could increase understanding of difficult topics.

It could also be helpful to have more interactive lessons. When on Chumbe Island, I observed some lessons where students were interacting as opposed to just listening, but increasing the number of these activities could be beneficial. One of the reasons snorkeling in the Coral Reef Sanctuary is so beneficial is because students are in the field experiencing what they are learning about. That is one of the reasons why Chumbe is so successful in the first place - because of their experiential learning programming. It is for this reason that many of the activities I developed involve experiential learning and hands-on activities.

Limitations

There were many limitations to this study. One of the biggest limitations was time. Most of the schools were at the time of the year where they were preparing for final examinations and getting ready for their break from classes. Thus, only one group of students younger than 18 years old was observed and it was for a post-visit. Many of the activities that were created were made with younger students in mind, and it was sometimes hard to conceptualize the tools that would best be suited for younger students without observing many younger students. While other groups of adult students were observed, which was still incredibly useful, the inability to visit younger students was a minor deficiency.

In addition to timing, CHICOP's schedule was another limitation. I am extremely grateful for all the opportunities to visit Chumbe Island, as well as classrooms on Unguja for the pre- and post-visits, but I was only able to observe six visits. Part of this had to do with the fact that CHICOP could only transport a certain number of students to the island for each visit, due to boat space and water safety regulations. It would have been beneficial to this study to have been able to observe more visits and more of a variety of visits. It was understood at the beginning,

however, that all the visits through CHICOP would be on CHICOP's schedule. The visits that were possible were incredibly useful to this study.

In addition to timing and scheduling limitations, equipment was also a limitation. In terms of material equipment, most of the supplies that were required could be obtained, but certain things, like a hot glue gun, were impossible to find. While the lack of some of these supplies made it more challenging to create some of the educational tools, the loss of them in no way lessened the quality or authentic nature of the tools created. In terms of digital materials, the videos created were done using a very basic movie editing software. Due to the lack of sophistication with the software it was hard to create videos more complicated than what was provided. For future projects, better technology for movie and video editing could greatly improve the quality of the final outcomes.

Conclusion

Chumbe Island and CHICOP have been working on their environmental education programming since the 1990s, and, since then, it has only become more and more successful (CHICOP, 2017). CHICOP provides multiple education opportunities, but the focus of this study was the environmental education programming, including the pre-, post-, and island-visits. To understand the already existing education that CHICOP provides, observations were made during two pre-visits, three island-visits, and one post-visit under the supervision of CHICOP. After evaluating the lessons and interactions between the students and teachers that were observed, new environmental education tools and activities were created (Appendix A and B). These activities ranged from children's picture books to board games to songs and videos (Appendix A and B). The goal of these activities was to create tools to aid in what Chumbe is already doing because their program is already extremely successful. They were just in need of

some new ideas. The hope is that the activities and tools that have been created will be beneficial to Chumbe and their educational efforts.

Recommendations

Future studies that could be important include a similar study, but at a different time of the year. When this study was conducted, most of the primary and secondary students were in examination periods and unable to be observed. CHICOP calls November ‘community month’ because of this and they focus their environmental education efforts towards community members. While observation of two pre-visits, three island-visit, and one post-visit with students and teachers was accomplished, it would be beneficial to observe primary and secondary students at consecutive pre-visits, post-visits, and island-visits to truly observe and learn how CHICOP works with younger students. This would also be a way to gauge excitement levels of students at pre-visits and compare it to excitement and engagement levels of those same students at island-visits and post-visits. This would allow the researcher to better develop ideas to enhance the existing environmental education efforts.

Another study might evaluate the success of the environmental education activities that are created. The activities created in this study were not used by any students or community member to test efficiency, usefulness, or engagement potential. Future studies could use the materials created during this study, or future original materials, and use them in classrooms and on Chumbe Island to see how students react and interpret them. This would determine if the tools created make an impact and what changes need to be made to create the best environmental education materials possible.

It might also be helpful to visit classrooms on Unguja without the presence of CHICOP. Visiting classrooms before CHICOP visits them would be a good way to understand the

environmental education that is already in place, if any, and to evaluate what environmental education in Zanzibar concerns. Observations of these classrooms' daily activities and lessons could better illustrate where there is a need for environmental education. This could be helpful to CHICOP in that they could tailor their lessons and presentations to where the need is in schools. Visiting classrooms after CHICOP provides the pre-visit, island-visit, and post-visit also could be beneficial to determine the impact CHICOP makes on the students, teachers, and schools.

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Appendix A: Activities Including Materials

All the activities included are accompanied by hard copy or digital materials necessary for success.

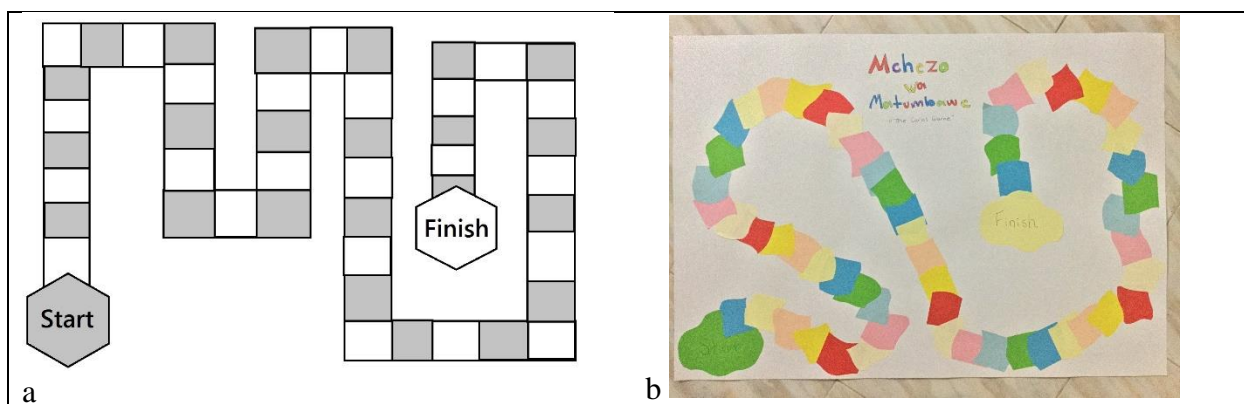
A1. Coral Reef Board Game; (Age Range: all)

Materials

- Board
- Deck of card (one printed set - unless there are more than 6 players)
- Game pieces (these can be any small objects – chess pieces, checkers, small rocks, pieces of plastic, etc.)

Rules of the game:

1. The game would best be played with 4-6 people but the number can be increased. (If more players will be playing the game it would be better to print out an extra copy of the cards to have twice as many in the deck.)
2. All players begin play on the 'start' space by placing all their pieces on that space. The deck of cards should be shuffled and placed where all players can access it.
3. Players take turns at picking up cards for their move. The player to go first is up to the players, and then players take their turn by going clockwise around the circle.
4. For each turn the player should pick up one card from the deck and read what it says. The card will have instructions on where to move that player's piece.
5. To win the game: the game is won when the first player reaches the end of the board and the space marked 'end'. Play can continue until all players have reached this space or the game can end when he first player does.

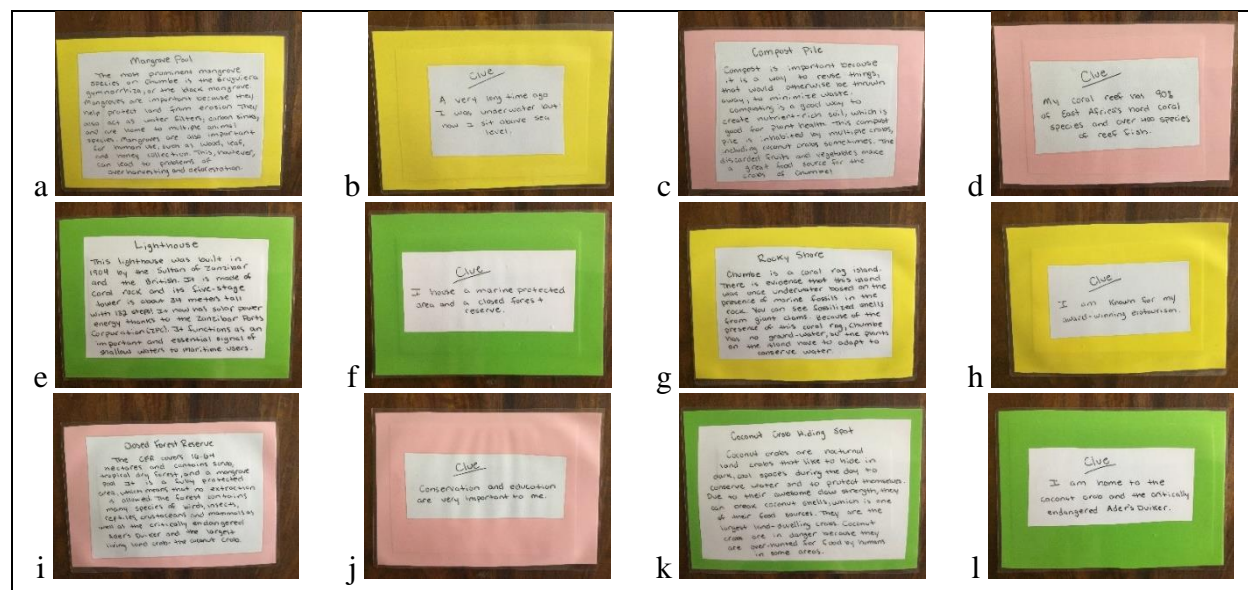


The digital and printable game board (a) and a picture of the hard copy game board (b) for the Coral Game.

A2. Scavenger Hunt; (Age Range: all)

This scavenger hunt is meant to be used for the Forest Walk conducted on Chumbe Island. While the cards can be placed anywhere on the trail the recommended placement is as follows:

Cards	Placement
Mangrove Pool	At the mangrove pool near the walkway
Lighthouse	At the base of the lighthouse
Closed Forest Reserve	At the very beginning of the trail, near the structure used for meals
Compost Pile	At the compost pile
Rocky Shore	Somewhere near the eastern shore, tacked to a tree or leaning against some rocks
Coconut Crab Hiding Spot	Near the tree at the beginning of the trail where a coconut crab can usually be found hiding



Pictures of the cards, front and back, for the created scavenger hunt. The first two columns are the same card with the left image the front and the right image the back of the card. The same can be said of the third and fourth columns.

A3. Animal Card Activity; (Age Range: all)

Instructions

- For this activity, each person receives a card with the image of a species that they might see on the reef at Chumbe. As intended, the students receive the card at the pre-visit and they would bring the card with them to the Chumbe island-visit where they would return them. The purpose of this activity is for the students to understand some of the creatures they could see when snorkeling on the reef at Chumbe. The cards have facts about the animal, and about the other animals that it interacts with along with any significant information about that animal.
- This activity is twofold. The students learn a little about a specific animal and then they can look for it while snorkeling, but the student can also see how their animal is impacted by other animals and humans.
- These cards can also be used when in the classroom on Chumbe to demonstrate how different animals are connected. Chumbe already does an activity where students represent different aspects of the ecosystem and use string to show how all the aspects are interwoven. The students could hold their cards and use the string to show how their animal connects to the other animals in the group.
- These cards could also be used as tools during lectures about the various species of coral reefs, as well as tools that could be displayed around Chumbe Island.

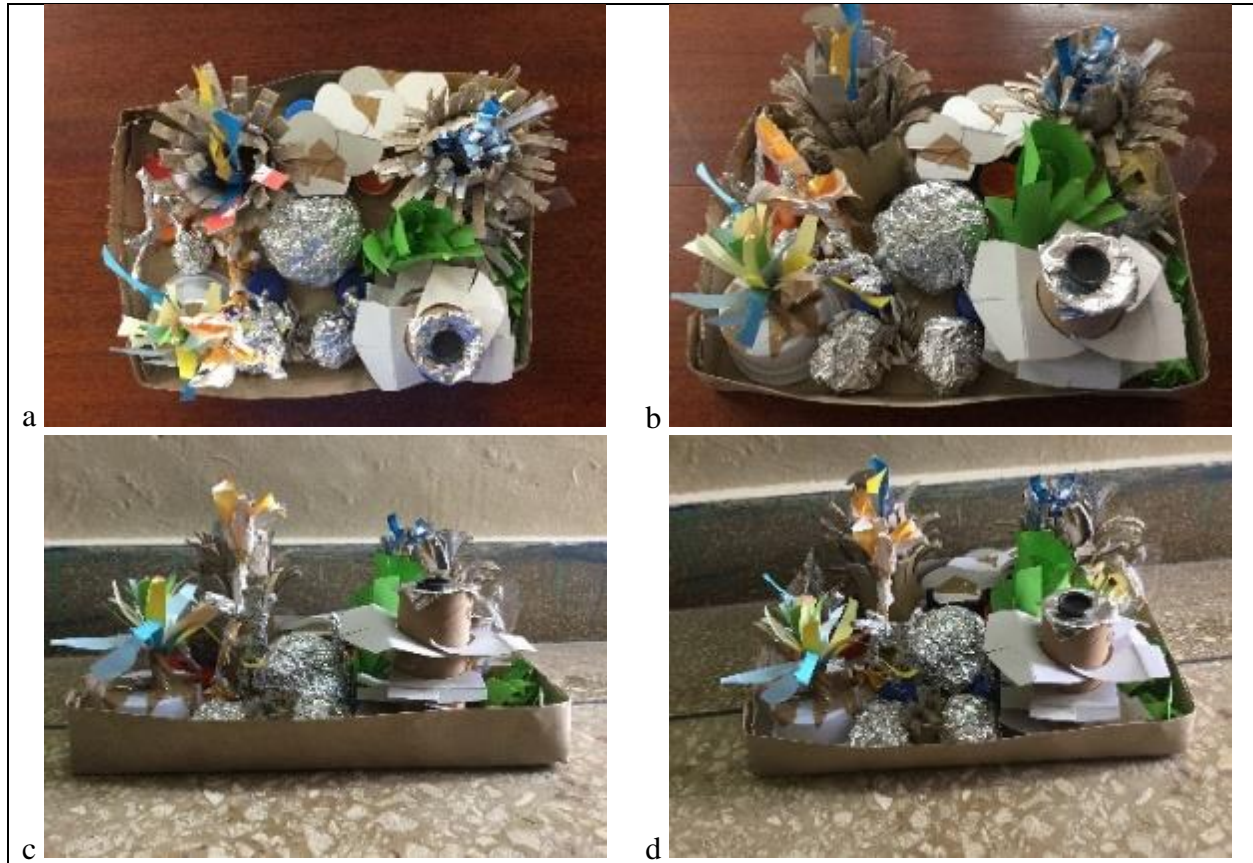




Pictures of all the animal cards arranged in no particular order.

A4. 3D Garbage Reef; (Age Range: all)

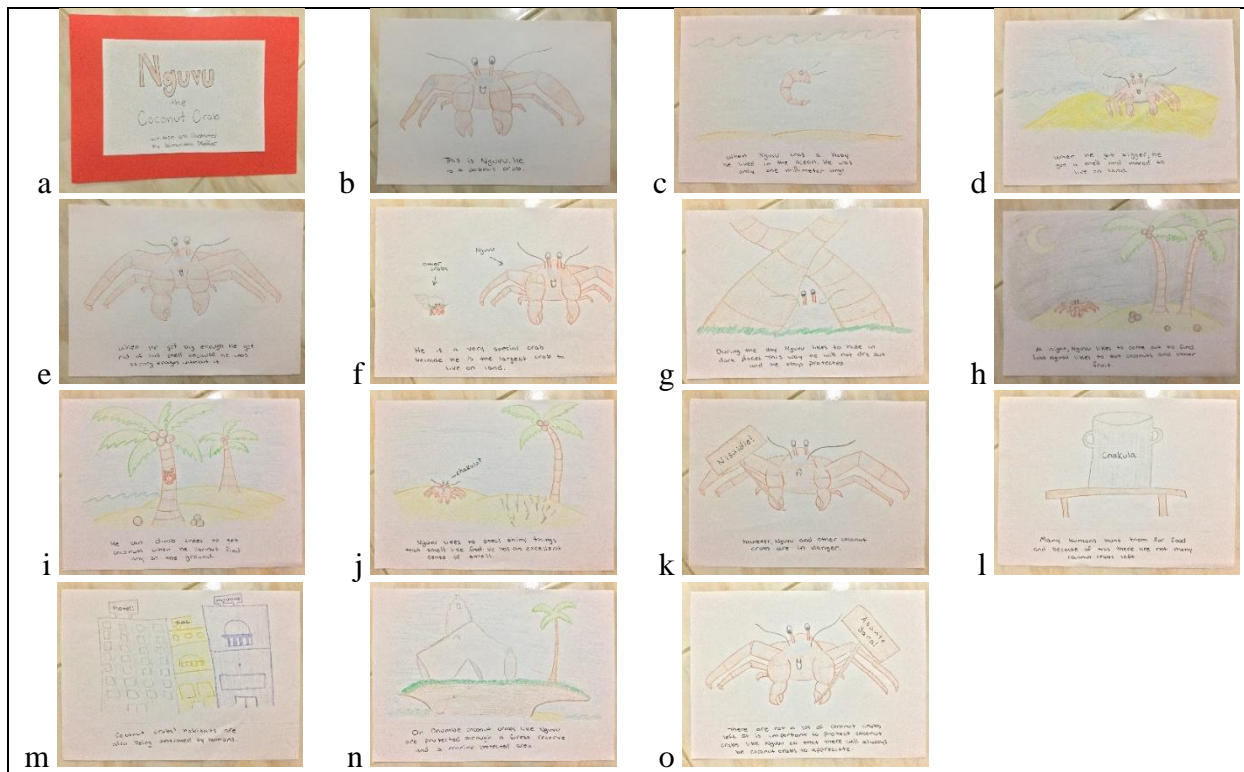
The purpose of this reef is to promote education about waste and pollution in Zanzibar. It is meant to be a tool to be discussed and interpreted.



Pictures of the 3D garbage reef from four different angles.

A5. Picture Books; (Age Range: younger students)

These books are meant to be educational tools that children can read during any of the visits, either on their own time, or as part of a lesson, read out loud to the whole group.



The pages of the storybook, *Nguvu the Coconut Crab*, in the order the book flows from left to right.



The pages of the storybook, *Adui vs. Shujaa*, in the order the book flows from left to right.

S6. Interactive-Electronic Ecosystem Poster; (Age Range: all)

This activity was created using PowerPoint. When the activity is in use, the students can click on any of the animals or plants located within the image and it will switch to a page with information on that topic, as well as pictures of what it actually looks like. On the actual presentations, clickable images are represented by red stars.

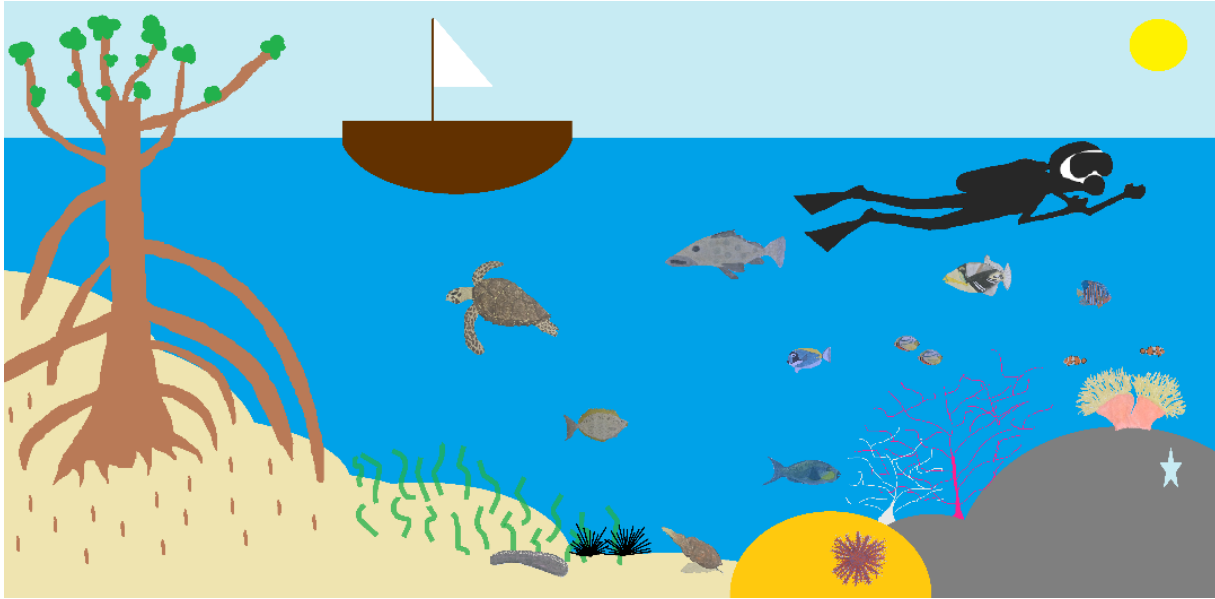
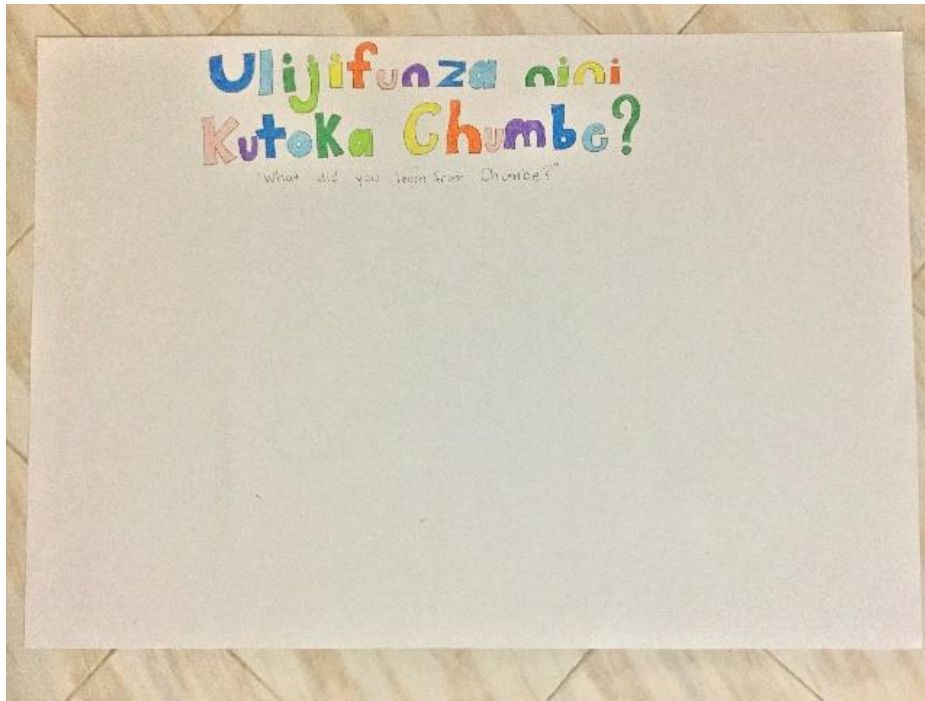


Image that was used for the interactive electronic ecosystem.

A7. “What Did You Learn from Chumbe?” Poster; (Age Range: all)

This poster is meant to be used as a way for Chumbe to see the impact they have on students across Unguja. Students and community members of all ages, as well as tourists, can sign the poster with what they learned from Chumbe and anyone that visits the island can see the poster. This is not only a way for Chumbe to see the impact they have, but for other students, community members, and tourists to see how widespread Chumbe’s reach is.



Picture of the “What Did You Learn from Chumbe?” Poster.

Appendix B: Activities Not Including Materials

All of the activities in this section require no additional materials. Activities in this section include games, songs, and short videos.

B1. Tragedy of the Commons Game; (Age Range: secondary school students and older)

Materials

- Pieces - any small materials that are roughly uniform in size and shape (i.e. small rocks / pebbles, bottlecaps, leaves, shells, pieces of paper, plastic pieces, popsicle sticks, etc.)
- Stopwatch - an actual stopwatch, a cell phone with a timer, a watch, a clock, etc. (anything that can determine when 60 seconds or 1 minute has passed)

Instructions/ Rules

- There are 2 rounds in this game
- Before the rounds begin the total group should be split into small groups of 4-5 people. Each group member represents someone in the community who needs fish to survive. The goal of this activity is to ensure that each group member has enough "fish" a "year" to survive.
- Each group should sit facing each other with some space in the middle for the pieces. This center area will be the "reef".
- The pieces that each group are given represent "fish".
- After each "year", in both round 1 and 2, the pieces that are left in the center will be doubled.
- One "year" equals 1 minute or 60 seconds.
- Before round 1 nothing except the rules should be explained. Nothing should be said about sustainability or about the need to preserve pieces or "fish". Before round 2 concepts of sustainability can be discussed because the goal of round 2 is to maintain a sustainable "reef".
- At the end of the activity it can be helpful to show how many "years" were possible in round 1 with no communication between group members compared to how many "years" are possible in round 2 when there is open communication between group members.
- The point of this activity is to show that it is important to maintain sustainable fishing methods to ensure that there will be fish for future generations. In round 1 it is typical that only a few "years" are possible because the group members want as many "fish" as possible so the "reef" becomes overfished after only a few "years". In round 2 after seeing that without discussion, the "reef" runs out of "fish" the group members should be able to find the best way to "fish" sustainably. The method that should become apparent is that by leaving enough "fish" in the "reef" at the end of each "year" to ensure that each group member can have at least one "fish" the next "year" the "reef" can be sustainable. This is important to real life because overfishing is one of the biggest problems that reefs face. In Zanzibar, where fishing is such an integral aspect of life for so many people, overfishing is an important issue to understand.
- This activity is meant to foster discussion and develop creative solutions to shared problems within an ecosystem.

Round 1

1. Each group is given 15 pieces. The pieces should be placed in the center - each group member should be able to reach the pieces. Group members can NOT speak to each other during round 1.
2. Round one consists of consecutive "years" until all the pieces are gone. Sixty seconds or one minute equals one "year".
3. For the first "year" group members can take as many pieces as they want in the time allotted. Each group member must take at least one piece to survive for the "year". For each "year" the group members should take all the pieces they want for that "year" at one time, with group members taking turns going first. (i.e. the first group member takes 2 pieces, the next takes 3, the next takes 5, and the last takes 3. This leaves 2 in the center after the end of "year" 1. Group members do not talk to each other during this round and can take as many pieces as they want as long as there are enough left after they take their pieces for the rest of the group members to have at least one piece each.
4. Any pieces that are left in the center are doubled for the next "year" (i.e. if there are 3 pieces left in the center, 3 more will be added for a total of 6).
5. For "year" 2, the same rules from "year" 1 are applied and at the end of the "year" any fish left in the center will be doubled.
6. Round 1 continues until there are no fish left in the center. At the end of the round the person with the most pieces wins - they got the most "fish". It is important to take note of how many "years" there were pieces before the "reef" was out of "fish".

Round 2

1. Each group is given 15 pieces. The pieces should be placed in the center - each group member should be able to reach the pieces.
2. Group members CAN speak to each other during round 2. They can talk between each "year" to discuss strategies to have sustainable "fishing". (i.e. how many pieces each group member can take each "year" or how many pieces should be left in the center at the end of each "year")
3. Round 2 will have "years" the same way that round 1 did and the rounds will proceed the same way. The difference is that the group members can talk between themselves to discuss how to best sustain their "reef".
4. Because the goal of round 2 is to have a sustainable "reef" there should always be pieces in the center at the end of each "year". This round ends after it becomes obvious that it is possible to keep "fish" in the "reef" by talking about sustainable methods. A good stopping place would be after round 2 has achieved more years than round 1.

B2. Stakeholders Activity; (Age Range: secondary students and older)

Instructions

- No materials required but for the discussion, a chalkboard / whiteboard could be used
- Depending on the size of the group, everyone can be split into groups of 1-3 people.
- Each group is assigned a stakeholder of the specified ecosystem (i.e. coral reef or coastal forest).
- Stakeholders can include, but are not limited to the following:
 - Fishermen
 - Shell and curio collectors
 - Invertebrate harvesters (non-coral)
 - People who harvest coral for various purposes (i.e. construction, road building, etc.)
 - Community members
 - Doctors who use animal or plant medicinal properties found on the reef
 - Scientists
 - Students / researchers
 - Tourists
 - Government agencies
 - Non-Governmental Organizations (NGOs)
 - Fish and other sea creatures who live on the reef
 - Coral that makes up the reef
 - Mangrove harvesters
 - Rangers
 - Animals who live in the forest
- For this activity, any number or combination of the above stakeholders can be used. The number used should be based on how large the group is and which stakeholders are deemed the most important for the specific group.
- Each stakeholder group should brainstorm how they interact with the specified ecosystem. How do they use it? How do they protect it or harm it? Do they need it to survive? Do they share a specific resource with another stakeholder? Do they interact with other stakeholders? Do they have direct interactions with the ecosystem?
- After brainstorming for a few minutes, the groups should talk about what they have discovered. The groups should explain why their stakeholder needs the ecosystem and what they use it for. Some stakeholders are directly related with the ecosystem and others have a more indirect connection.
- This activity is meant to foster discussion and develop creative solutions to shared problems within an ecosystem.

B3. Videos; (Age Range: all)

Six videos were created to be short snapshots of things that directly relate to Chumbe Island and Zanzibar. All of the pictures in each video were taken of Chumbe during the study period.

- a. *Get Ready for Your Visit to Chumbe!* – This is a short view of what a student might expect from their island-visit to Chumbe.
- b. *The Forest Matters Too* – This video is of pictures taken on the forest walk to illustrate that the forest is an important ecosystem. A lot of times the forest ecosystem is overlooked when compared to the coral reef ecosystem, but forest ecosystems are just as important as coral reefs and need to be remembered and learned about also.
- c. *Sounds of the Reef* – This video enhances the sounds that one might hear while underwater of the fish eating the algae off the coral. A lot of the student who come to Chumbe do not know how to swim and because of their anxiety they do not fully hear the reef when they are snorkeling. This is a way for students to hear what a reef sounds like without having to go snorkeling.
- d. *Chumbe Reef* – This is a short snapshot of some of the corals and other animals that could be expected to see while snorkeling on the reef.
- e. *Chumbe Reef Movie Trailer* – Using a movie trailer format, this video shows pictures and videos about Chumbe’s coral reef to protect the idea of conservation and encourage viewers to protect our coral reefs.
- f. *Climate Change at Chumbe* – This video talks a little about what climate change is and shows before and after pictures and videos of coral bleaching.

B4. Songs / Poems; (Age Range: all)

The purpose of these songs is to teach about environmental issues in a fun and simple way. Two of the songs use already existing tunes while the other two do not.

- a. The lyrics for the song/poem *C.O.R.A.L.*

Give me an C! Give me an O! Give me an R! Give me an A! Give me an L! What does that spell? CORAL! And what does coral stand for?

C is for conservation
 O is for ocean
 R is for reef-building
 A is for animal
 L is for life

These things may seem random
 But I assure you all
 They all have something in common
 Coral connects them all

b. The words to the poem *What is Coral?*

Coral is an animal
 Coral is alive
 We need coral, yes, we do
 We need it to survive

There are two types of coral
 Hard and soft alike
 Hard coral builds the reef up
 Soft corals look lifelike

Anchored to the substrate
 Coral grows so slow
 A skeleton of calcium carbonate
 Coral does its best to grow

Inside a coral's skeleton
 A little polyp has a place
 But the polyp is not alone in there
 Zooxanthellae share their space

Zooxanthellae are a type of algae
 Who photosynthesize
 They share the food they make with coral
 In this way, the coral is wise

The zooxanthellae get a home
 And the coral gets free food
 This relationship is called symbiosis
 And is of great magnitude

My little poem is over now
 I hope it has been clear
 Coral is a very important animal
 Let's all give a cheer!

c. The lyrics to the song *Little Polyp, Little Coral*, to the tune of *Twinkle, Twinkle Little Star*.
 (Tune comes from French melody of *Ah! vous dirai-je, maman*, which was published in 1761)

Little polyp, little coral
 How I'm saddened by your peril
 Climate change hurts you so
 It makes it hard for you to grow
 Little polyp, little coral
 How I'm saddened by your peril

d. Lyrics to the song *You've Got The Whole Future in Your Hands*, to the tune of *He's Got the Whole World in His Hands*.

(Tune comes from the originally published paperbound hymnal *Spirituals Triumphant, Old and New*, which was published in 1927)

You've got the whole future in your hands
 You've got the whole big future in your hands
 You've got the whole future in your hands
 You've got the whole future in your hands

The world is heating up a lot
 Global temperatures are getting really hot
 The world is heating up a lot
 Global temperatures are getting really hot

Carbon dioxide levels are rising up
 Sea levels are rising up
 Erosion rates are rising up
 Ocean temperatures are rising up

Corals are getting really white
 The zooxanthellae leave their site
 Corals are getting really white
 It's about time that we start to fight

You have the chance to make a difference
 The choices you make will make the difference
 You have the chance to make a difference
 The choices you make will make the difference

You've got the whole future in your hands
 You've got the whole big future in your hands
 You've got the whole future in your hands
 You've got the whole future in your hands