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EduLink: Integrating ESD into Namibian Secondary School Curricula through Online Modules

An Interactive Qualifying Project submitted to the Faculty of Worcester Polytechnic Institute as evidence of completion of a degree requirement.

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Submitted to the Faculty of

WORCESTER POLYTECHNIC INSTITUTE

In partial fulfillment of the requirements

For the degree of Bachelor of Science

Sponsoring Agency: EduVentures Trust

Report submitted to:

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Date: October 12th, 2018

Abstract:

Unsustainable societal practices are threatening earth's biodiversity. In Namibia, EduVentures is an organization promoting sustainable practices through Education for Sustainable Development (ESD). Our goal was to develop online modules that would train teachers to implement biodiversity concepts into Namibian school curricula. Based on the results of interviews and surveys with educators and EduVentures staff, as well as content analysis of Namibian curricula, we developed online modules. We tested the effectiveness of the modules with ESD educators and provided recommendations for future module development.

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Authorship

Laura Boccio - Laura served as the main interviewer for the project by creating interview questions and helping facilitate conversation with interviewees. Additionally, she helped make the games and interactive features of the modules utilizing her creativity. In the report, Laura was the primary author of the results and contributed to edits throughout the entire paper.

William Gaddis - Will served as the creative expert by utilizing his extensive background in interactive media and design to make the modules more enticing and user-friendly. He worked primarily on the educational videos and notes throughout the module. Will also played a major role in the interview processes, putting his personality to good use. In the report, Will was the primary author of the introduction and background sections and contributed to edits throughout the entire paper.

Ajay Manohar - Ajay served as the technical expert for the software used to create and implement the modules, as well as developing the module quizzes. He also resolved all technical needs and difficulties experienced by EduVentures during the workshop. In the report, Ajay was the main author of the methods and conclusions sections, and contributed to edits throughout the entire paper.

Kylie Smith - Kylie served as the primary contributor for the pedagogical module content, spending extensive time analyzing Namibian curricula standards and teaching materials. She also edited the module to make sure all information on it was clear and concise. Kylie took the lead as group secretary by keeping minutes at meetings with advisors and EduVentures staff. In the report, Kylie was the primary author of the executive summary and background sections, and contributed to edits throughout the entire paper.

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DESD: Decade of Education for Sustainable Development

ESD: Educations for Sustainable Development

LMS: Learning Management System

NAMCOL: Namibian College of Open Learning

NUST: Namibia University of Science and Technology

STEM: Science, Technology, Engineering, and Math

SD: Sustainable Development

SWF: Shockwave File

UN: United Nations

UNESCO: United Nations Educational, Scientific, and Cultural Organization

UNICEF: United Nations Children's Fund

WPI: Worcester Polytechnic Institute

Executive Summary

With increasing strain on the earth and its resources, the awareness of sustainability and environmental issues is necessary. Therefore, Education for Sustainable Development (ESD) was created. It is built on the belief that children educated about their environment and its importance will contribute to a sustainable society as they mature (UNESCO, 2014). Conservationists believe the world is entering its sixth mass extinction, therefore educating students about biodiversity loss at a young age has never been more urgent (Ehrlich, 2015). Since the mid-1990's, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) has been leading the push for worldwide ESD implementation. The Namibian government has created basic educational goals that coincide with UNESCO. However, Namibia faces many challenges regarding the integration of environmental topics, such as biodiversity, into school curricula. In particular, many teachers lack access to necessary resources and training.

EduVentures, a Namibian educational trust, has been working for the past fifteen years to implement ESD throughout the country. They have aligned their goals with those of UNESCO and the Namibian government. EduVentures has created several programs to promote environmental sustainability in Namibian schools, such as a mobile classroom that facilitates afterschool programs. Recently, EduVentures created the EduLink program to connect ESD centers in Namibia through a learning management system (LMS). These centers have educators trained in ESD that provide educational and pedagogical training to rural teachers who share this knowledge of sustainability with Namibian students. However, there is currently no content on the LMS for educators to reference.

The goal of our project was to create content for this LMS in the form of pilot ESD modules. These modules focused on one topic within ESD: biodiversity. Biodiversity refers to the variety of life in our ecosystems and their various interactions. Biodiversity is a key contributor to many resources and systems needed for a functioning society. However, biodiversity is rapidly reducing. The main

objective of these modules is to help teachers integrate biodiversity into their classroom curricula in a seamless manner. To achieve our goal, we outlined four objectives: determine content for our modules, construct our modules, implement our modules, and gain feedback to make recommendations for the future.

While determining the content for our modules, we held interviews and surveyed EduVentures' staff and educators that are part of the EduLink program. This information provided us context on the current status of the EduLink project and the educators involved. We analyzed resources, such as books and websites, given to us by our sponsor and identified key biodiversity concepts. Additionally, we examined the entirety of the Namibian secondary school curricula and identified areas where ESD could potentially be integrated.

After determining the content, we began constructing the modules. We interviewed EduVentures staff on what features of the modules were important to them. It was decided that the most important features were ease of use, cost, LMS compatibility, built-in analytics, and interactivity. We used these factors to compare eLearning software in a decision matrix. BookWidgets was the most well-rounded option since it was compatible with the chosen LMS, Google Classroom. Additionally, BookWidgets was cost effective, easy to use, and could have multiple users. Next, we determined the logical structure of our modules. This structure was achieved by providing educational content followed by pedagogical tools and resources. The modules consisted of videos, notes, PDFs, interactive games, pedagogical strategies, areas of implementation, additional resources, and assessments. Our focus was on providing interesting visual information, engaging user interactions, and informative content. Additionally, we made an assessment concluding each module that provides user data to the module administrator and gives feedback regarding module effectiveness. We used this layout to create modules on types of biodiversity, ecosystem services, and threats to biodiversity.

We started our implementation by running a mock workshop of the modules with five university students. These students confirmed the modules conveyed a logical approach. We then implemented the modules at a weeklong workshop in

Rundu with ESD educators. Nine educators completed our modules and provided feedback on the strengths and weaknesses through focus groups and interviews. This workshop allowed us to gauge the efficacy of our modules and revise them accordingly. Overall, the educators saw potential in the online modules as effective ESD resources. However, they expressed reservations toward the feasibility of the modules due to unreliable internet and power at many ESD centers.

Based on these results, we propose two recommendations. Since the online modules showed potential to be effective, our first recommendation is for EduVentures to establish reliable internet and power at each ESD center. If this is not a viable option, our second recommendation is that an alternative method of module implementation be used, one that is not reliant on internet and power. This could include a semi-online system where the modules are developed offline, accessed offline, and distributed either online through the LMS or downloaded offline onto a flash drive.

Chapter 1: Introduction

Well-educated citizens are able to contribute to a successful and ever-changing society. With an increasing strain on earth's resources, education systems must respond to these pressing issues by promoting skills, values, and attitudes that lead to a more sustainable and healthy society (UNESCO, 2017). Education for Sustainable Development (ESD) is a recent approach recognized as an effective tool for promoting sustainability education (McMillan & Higgs, 2003). The United Nations Educational, Scientific, and Cultural Organization (UNESCO) is a specialized agency leading the push for ESD. Their goal is to integrate ESD into primary and secondary school curricula throughout the world (UNESCO, 2005). Since ESD is inherently interdisciplinary, it is possible to integrate into curricula through a multitude of subjects such as science, English, history, math and foreign language (Walshe, 2016).

With this implementation, key sustainable and environmental concepts will be taught with the hope of promoting a conservational and environmental culture (UNESCO, 2017). These concepts go beyond the well-known issues of climate change and green movements, including topics such as desertification and biodiversity loss. Biodiversity loss is an issue that, if not addressed, will have irreversible effects on our environment's ability to support society's growing demands (Aguayo, 2006). Educating students on these threats and potential losses has the ability to create a society of environmentally aware individuals by relating ESD to all fields of study. Even though ESD is an interdisciplinary topic, it contains many complex theories, such as biodiversity, that require extensive training and tools in order to be taught successfully. For this reason, integrating ESD globally into existing national curricula has proven to be a challenge (UNECE, 2009).

Many teachers and educators do not have access to the resources they require to effectively teach ESD topics. Issues restricting this access include a lack of ESD teaching material, educator training, and communication among the local, governmental, and NGO parties involved with ESD (UNECE, 2017). This disconnect between teachers and organizations has led to inconsistent ESD teaching methods,

minimal teacher excitement, and insufficient educator support. Countries looking to integrate ESD into their educational system must consider these issues and how to resolve them to ensure ESD implementation is effective. Namibia is currently beginning to integrate ESD into its curricula, however, problems regarding limited teacher resources are especially pertinent (National Planning Commission, 2004).

Countries around the world have developed novel strategies to help teachers implement ESD into their educational system. Most implementation strategies begin at a macro-level, with international organizations providing strategic ESD frameworks and outlines for governments to use at their national and local levels (UNECE, 2009). Collaborations among private corporations, governments, and educational representatives have yielded the best results. Norway has created an environmental education network that acts as a meeting space for schools, research institutions, and other organizations. It provides suggestions for how ESD can be organized and taught in schools or businesses (UNESCO, 2007). ESD is spreading outside of Europe as well. The Kenyan government has identified ESD as a crucial skill for the future development of their country, and has made it a key concept at all education levels of their new curricula (Ogutu, 2017).

EduVentures, a Namibian educational trust, has been working for the past fifteen years to implement ESD in Namibia. They have aligned their goals with those of UNESCO and the Namibian government. With support from third-party donors, EduVentures has created several programs to promote environmental sustainability in Namibian schools including a mobile classroom that facilitates afterschool programs. Recently, EduVentures created the EduLink project to connect ESD centers in Namibia. These centers have educators who provide educational and pedagogical training to rural teachers. These teachers then disseminate this knowledge to Namibian students. EduVentures established a learning management system (LMS) to connect the ESD centers. The chosen LMS, Google Classroom, provided a platform for communication among the educators. However, Google Classroom lacked the content and pedagogical tools that would allow educators to effectively train teachers.

The goal of our project was to provide content for the aforementioned LMS in the form of pilot ESD modules. These modules focused on biodiversity. The main objective of these modules was to help teachers seamlessly integrate biodiversity into the curricula. To achieve our goal, we outlined four objectives: determine content for our modules, construct our modules, implement our modules, and gain feedback to make recommendations for the future. We first identified the critical educational and pedagogical content to include by analyzing Namibian curricula and interviewing EduVentures staff and ESD educators. We then compared software to construct our modules on with a decision matrix and selected BookWidgets. We built the modules around theories of blended learning and the principles of multimedia education. Implementation of the modules occurred at a week-long workshop with ESD center educators in Rundu. Following the workshop, we analyzed qualitative and quantitative data gathered from the modules and provided recommendations to EduVentures for future module development. The culmination of all future modules will become a key tool for educators to train teachers on the integration of ESD into curricula. The modules we created will assist our sponsor, EduVentures Trust, in creating a consistent and high-quality ESD resource for teachers in Namibia.

Chapter 2: Background

Education for sustainable development (ESD) is a crucial strategy for countries develop sustainably. However, there is little ESD support and resources for teachers in Namibia's education system. One strategy to resolving this issue could be creating an online training and resource network to help prepare teachers to incorporate ESD into their classroom curriculum. In this chapter, we will define ESD and its role in a global context to promote a sustainable future. We will also discuss the solutions and problems ESD is currently facing. Next, we will discuss methods and strategies of effective teaching and learning, especially focusing on blended learning pedagogical approaches and online learning. We will conclude by introducing the work Namibia has done with ESD, as well as discussing our sponsor EduVentures, their contributions, and their specific needs.

2.1 Education for Sustainable Development

Education for sustainable development (ESD) is an educational approach that aims to teach people about the environment and sustainable practices by implementing topics on sustainability into school curricula (UNESCO, 2014). Many ESD topics, such as biodiversity, can have a detrimental global impact if not addressed (GreenFacts, 2018). Due to the prevalence of biodiversity, many countries and organizations globally have begun implementing programs in primary and secondary school curricula. The goal of these programs is to instill awareness of ESD issues at a young age. In this section, we introduce what ESD is, the goals of ESD, how it is currently being incorporated in various countries, and the problems ESD faces

2.1.1 What is ESD?

Anthropogenically-driven environmental issues (e.g. climate change, air and water pollution, deforestation, soil erosion, pesticide contamination, biodiversity loss) have detrimental effects on populations globally. They reduce access to resources that support economies and affect quality of life for billions of people (Pocock, 2008). To

combat these environmental issues, Dunlap (2012) highlights the importance of spreading awareness about sustainability threats to both national governments as well as individuals to spark a preventative change in the earth's conservation.

Many national and international organizations have turned to education as a method for spreading sustainable awareness (UNESCO, 2017). Thus, ESD has become a recent approach designed to integrate concepts of sustainability into educational curricula around the globe. This will provide upcoming generations with a background understanding of environmental issues and hopefully promote sustainable practices in society. The United Nations (UN) defined ESD as follows:

> *Education for Sustainable Development means including key sustainable development issues into teaching and learning; for example, climate change, disaster risk reduction, biodiversity, poverty reduction, and sustainable consumption. It also requires participatory teaching and learning methods that motivate and empower learners to change their behavior and take action for sustainable development. Education for Sustainable Development consequently promotes competencies like critical thinking, imagining future scenarios and making decisions in a collaborative way. (UNESCO, 2010)*

This definition highlights the two main aspects of ESD: content and pedagogy (Hopkins, 2012). Content refers to a diverse range of environmental, economic, and social materials. Pedagogy refers to learner-teacher interactions that create a successful learning environment. Content and pedagogy must work hand-in-hand to provide a relatable and relevant ESD education. ESD has four main areas of emphasis: improving access to basic quality education, reorienting current educational programs to address sustainability, increasing public awareness of sustainability, and providing training to all sectors of the workforce (UNESCO, 2012). In order to implement these areas of study, it is important to understand and acknowledge the potential effects of ESD on the global community.

We are currently entering a period conservationists claim could hold the "sixth mass extinction" which refers to a rapid loss of biodiversity (Ehrlich, 2015). Biodiversity refers to the "variability among living organisms from all sources" (GreenFacts, 2018); it is one of the most relevant pieces of content covered in ESD today. Now, more than ever, it is pivotal that we maintain biodiversity and address the pressing issue of biodiversity loss. With the loss of biodiversity, comes a chain reaction in our world's ecosystems. Biodiversity is the foundation of so many services our ecosystem provides and which we, as humans, are intimately connected (GreenFacts, 2018). Due to the complexity of biodiversity, some areas in Europe have prioritized integrating it into primary school curricula. For example, in the United Kingdom, there is currently a program in place that is working to halt the overall biodiversity loss in the UK by the year 2020 (DEFRA, 2013). However, the push for ESD is not specific to certain countries; it is a global push unified by large international organizations.

2.1.2 ESD in a Global Context

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has been leading the push for ESD around the globe, supporting its implementation in many countries, especially developing ones. The United Nations (UN) implemented a ten-year plan called the decade of ESD (DESD) in 2005 to address ESD globally (UNESCO, 2005). This decade was led by UNESCO and lasted until 2014. The goal of the DESD was to enable citizens around the globe to acquire various critical thinking and collaborative skills, contribute to society, respect the earth and its diversity of life, and commit to promoting a peaceful, democratic society. DESD aimed to achieve these goals through promoting and improving education at all levels, reorienting educational programs, building public awareness, and providing practical training (UNESCO, 2005). According to a 2014 report following the DESD, UNESCO described the decade as marking "the beginning of 10 years of an explicit global movement towards improving and reorienting education systems towards sustainable development, building on earlier commitments to ESD."

The DESD served as a solid foundation for the promotion of ESD, increasing awareness and policies of sustainable practices as well as galvanizing interactive, learner-driven pedagogies (UNESCO, 2014). However, many countries still lacked a full integration of ESD into their education systems. To tackle this problem, UNESCO then developed the Global Action Programme (GAP). GAP was designed to follow-up the DESD and mobilize stakeholders and governments to scale-up efforts on ESD based on the results of the DESD (UNESCO, 2014). The GAP focuses on advancing sustainable policies, transforming teaching and learning environments, building capacities of educators and trainers, empowering youth, and accelerating sustainable solutions at the local level (UNESCO, 2018). Both the DESD and GAP fall under UNESCO's Education 2030 agenda, which is a global movement to eliminate poverty by the year 2030 through various sustainable development goals (SDG). According to UNESCO, "Education is both a goal in itself and a means for attaining all the other SDGs. It is not only an integral part of sustainable development, but also a key enabler for it. That is why education represents an essential strategy in the pursuit of the SDGs" (2017).

2.1.3 Current ESD Implementation Strategies

Following the DESD, UNESCO published results of effective ESD trends that had been developed. The most glaring observations from DESD showed that positive stakeholder involvement with ESD implementation is crucial to creating a climate where change is possible (UNESCO, 2014). Political leadership and multi-stakeholder partnerships are particularly effective at coordinating policies and national plans. Additionally, UNESCO reported that ESD has begun to spread among many areas of learning at all levels of education including primary, secondary, university, and educator (2014).

The Leuchtpol project in Germany, involving 4,000 kindergartens, introduced ESD as the primary educational guiding concept. Educators engaged students with energy and taught environmental issues in an interactive manner. After the program, "97% of educators participating were convinced that teaching energy conservation to young children is important." (UNESCO, 2012). The Matarajio Project in Kenya

engaged children through the sharing and learning of environmental threats and included many hands-on field work applications. This program has since been re-produced in many other institutions (Siraj-Blatchford, 2014). Other countries like China, Greece, and Costa Rica have reported exponential increases in ESD programs and activities in their primary and secondary school levels (UNESCO, 2014). UNESCO found ESD to be the most profound in primary and secondary school levels, and that the effectiveness and interest in environmental topics had, on average, doubled among the schools involved.

Other organizations have been formed to support the training and resources for ESD. The Regional Environmental Center created the "Green Pack," a multimedia environmental education curriculum kit used in European primary schools. The pack provides educational materials such as lesson plans for teachers, an educational film collection, and an interactive CD-ROM. Green Packs are developed by government and professional partners and distributed after training sessions with primary school teachers (UNECE, 2009). The Environmental Education Network in Norway functions as a communication hub for schools, institutions, and public management. This network shares information on how best to organize, improve, and implement environmental education among various educational programs (UNECE, 2009).

2.1.4 Obstacles to ESD Implementation

Despite the progress made in the DESD, there are still numerous obstacles limiting the effectiveness of ESD. Many countries struggle to create a cohesive working relationship between the government and local educational levels (UNESCO, 2014). Countries that fail to gather governmental support often lack clearly articulated strategies and policies for ESD implementation, leading to confusion among educators and a stagnating ESD integration. Limited teacher training and support also contributes to the poor implementation of ESD. According to UNESCO, "ESD implementation requires enhanced capacities among policy-makers, curriculum developers, school leaders, assessment experts and, most importantly, teachers" (2014). Because of these, ESD remains fragmented among most countries with "considerable variations in the availability, accessibility, and quality of programmes".

At the local level, many countries struggle with learners who are often disinterested or unengaged in the material. This is often due to a lack of familiarity with the topic. Learners who lack prior exposure to SD topics struggle to see tangible effects SD has in their local community. Because they are not aware of their own local environmental state, these learners will not put in the effort when learning about SD. Because of this, ESD will have to make sustainable topics relevant and exciting to learners through effective pedagogy.

2.2 Effective Pedagogy

Even with an effective ESD implementation strategy and support network, ESD will not be effectively translated to learners unless they are engaged and involved with the subject matter. The role of teachers in the education system is crucial to ensuring long-term ESD success. According to Tucker (2005), teachers provide students with the knowledge they need to function in society. The design of a teacher's curriculum is indicative of how much students will learn (UNESCO, 2017). An effective teacher's pedagogy will not only assess the progress of students, but it will also spark an interest in the subject. Most children learn through an active and engaging environment. Implementation of engaged teaching requires careful consideration of pedagogical methods and teaching quality. In this section, we will explore the importance to effective teaching and various pedagogical strategies to creating an engaging classroom, such as blended learning and multimedia lessons.

2.2.1 Qualities and Impact of Effective Teachers

Tucker (2005) categorizes highly effective teachers as having: formal teacher preparation, holding high expectations for themselves and their students, presenting information to students in a way that they can fully comprehend, and using pre- and post- assessments to monitor student achievement. An effective teacher possesses many of these qualities and uses them to create diverse teaching methods to use in the classrooms.

A student's understanding of a topic is directly correlated with how effective their instructor is at teaching that subject (UNESCO, 2017). According to Alber

(2015), effective teaching requires providing feedback and allowing students to make adjustments and teach themselves. A highly effective teacher will provide their students with the tools necessary to teach themselves. Further, students learn differently, and an effective teacher will conduct activities that tailor to each learning style. Thus, for a teaching style to be effective it must be flexible. Providing online modules that are easily adaptable to various learning environments is a valuable tool for improving teaching efficiency. This provides fluidity for teachers to develop their own pedagogy that can be integrated into any classroom.

2.2.2 Pedagogical Methods

Learner-centered pedagogy considers students to be independent learners and stresses active development of knowledge rather than passive learning experiences. The learners' prior knowledge and experiences in a social context are the starting points for the learning processes in which the learners construct their own knowledge base. Learner-centered approaches requires that students reflect on their own knowledge and learning processes in order to manage and monitor them. Educators should play on these reflections to create an engaging atmosphere. Learner-centered approaches alter the role of educators to that of facilitators of learning processes (UNESCO, 2018). This type of learning is effective in an environment where students have had experiences to build upon.

In action-oriented learning, learners engage in action and reflect on their experiences in relation to the intended learning process and personal development. The experience might come from a project, an internship, facilitation of a workshop, implementation of a campaign and so on. Action-learning draws upon Kolb's (1984) learning cycle of experiential learning. Experiential learning has the following stages: (i) having a concrete experience, (ii) observation and reflection, (iii) formation of abstract concepts for generalization and (iv) application in new situations (McLeod, 2017). Action-learning increases knowledge retention, competency development and values clarification by connecting abstract concepts with personal experience. The role of the educator is to create a learning environment that prompts learners' experiences and reflexive thought processes.

Transformative learning can be defined by its goals, not by a concrete teaching or learning strategy. It aims to empower learners to question and change their ways of seeing and thinking about the world. This, in turn, helps to further develop their understanding of the world (UNESCO, 2018). The educator acts as a facilitator who challenges learners to change their worldviews. The related concept of transgressive learning goes one step further, stating that "learning in ESD has to overcome the status quo and prepare the learner for disruptive thinking and the co-creation of new knowledge." (Lotz-Sisitka, 2015).

Blended learning is a pedagogical strategy that involves a combination of face-to-face interactions between learner and teacher and online digital media. This learning model both increases the flexibility and personalization of each students' learning experience, and allows teachers to expand the time they spend as "facilitators of learning" in the classroom (DreamBox, 2013). With this approach, students can learn from the online resources at their own pace, and interactions with the instructor can be used as group collaborative activities or review discussions rather than one-way lectures.

Another crucial strategy to ensure engaging students is to provide relevant content that learners can relate to and see tangible result of. According to UNESCO:

Ideally, efforts to reorient education will be based on national or local sustainability goals. A properly reoriented curriculum will address local environmental, social, and economic contexts to ensure that it is locally relevant and culturally appropriate (2010).

This final point, about local relevancy and cultural contextualization, is critical to the success of sustainable development (Schumacher, 1973). By using local examples and relevant field work in ESD curricula, students are more likely to adopt and put into practice the concepts being taught. With this, and effective pedagogical methods, students will be able to learn and relate to environmental issues surrounding them.

2.2.3 Online Learning

An effective classroom is both engaging and informative. One approach to creating this type of atmosphere is online learning modules. Levy (2007) emphasizes the fact that an online learning module can create a starting point in which teachers can base their lectures on. They provide the standard knowledge for all students while giving space to perform activities that are tailored to specific students. This pedagogical method is very beneficial for both students and teachers. Students are provided with education that they can relate to, while teachers are able to have a flexible curriculum. Teachers can adapt their own teaching methods into the learning modules. This allows the teachers to be creative and build their own activities, which in turn helps them expand their own knowledge on the given subjects.

One key thing to consider when developing an online course or material, however, is how to engage students even when they are not interacting with the teacher. Digital educational tools should consider the 12 principles of multimedia learning when being designed (*Appendix C*) (Mayer, 2001). These principles suggest that simplified and efficient materials, with a variety of visual, auditory, and interactive learning, provide the best results (Mayer, 2001).

South Africa is one nation that has recognized the benefits that online learning offers (ICEF, 2012). Online resources, like EduNet and Thutong, offer courses for high school and college level students countrywide. The online higher education sector in South Africa has steadily grown since 2010 (PWC, 2018). With this growth, the demand for highly qualified teachers, which the country is lacking, is reduced. While online education is still a new concept in South Africa, the government seems dedicated to improving and expanding learning opportunities.

2.3 ESD in Namibia

Namibia is a growing country in southern Africa exploring ways to implement ESD into its educational system. Since the turn of the 21st century, Namibia has greatly revamped and improved its educational system. However, The Namibian government has yet to push any national policies or agenda to implement ESD

nationally. Instead, NGOs have led the charge with bringing environmental education to Namibia. In this section, we will talk about the current situation of education in Namibia, obstacles to education in Namibia, obstacles to introducing ESD, and cover the work that NGOs have been doing to achieve ESD implementation.

2.3.1 Current Namibian Education System

The Namibian government has initiated a plethora of educational programs since the turn of the century to help progress the education system. Namibia has increased the funding for education by 20-25% since 1992 and it has placed a high priority on education ever since its independence (UNICEF, 2011). One of the first and most influential steps was Education Act no. 16 (RON, 2001). This was implemented in 2001 and increased the structure of the education system by creating national advisory councils, increasing the structure of school boards and creating regional education forums.

Additionally, the Namibian government in 2004 developed a program called Vision 2030 (NPC, 2004). This program is a nationwide push to better Namibian education. The goals of Vision 2030 are important to ESD in Namibia because the educational funding and focus of the program will provide more resources to teachers and other educators around the country. For example, sustainable development is a "cornerstone" of the Vision 2030 project; and the project focal areas of focus for the project are: education, science, technology, health and development, sustainable agriculture, peace, social justice, and gender equality. (NPC, 2004). A direct quote from the President of the Republic of Namibia, Dr. Sam Nujoma, stated:

> *Namibia Vision 2030 presents a clear view of where we are, where we want to go from here, and over what time frame. It is a vision that will take Namibia from the present into the future; a vision that will guide us to make deliberate efforts to improve the quality of life of our people.*

However, the Namibian government has yet to provide any specific guides or action plans for long-term ESD implementation in the country (NIED, 2010).

2.3.2 Current Issues Impeding ESD

ESD educators in Namibia struggle most with effectively bringing sustainable concepts to the classroom due to a lack of support and resources. These include limited ESD training, few teaching materials, poor communication networks between teachers and supporting organizations, and lack of consistent ESD guidelines.

ESD is inherently an interdisciplinary topic, and managing to incorporate ESD concepts into various classes in a curriculum is tough for teachers. Currently, there is no ESD training course for educators to learn how to incorporate sustainability concepts and teaching methods into the class. Additionally, a lack of prepared lesson plans, activities, and reading resources gives teachers little ability to teach themselves on the concepts of ESD if they felt inclined to incorporate it anyway (EduVentures, 2007).

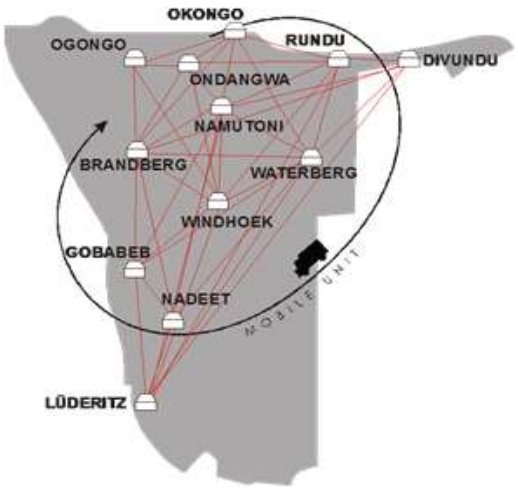
As explained earlier in section 2.1.3, governmental and stakeholder support is often crucial for an effective ESD implementation. However, since Namibia lacks this organizational support, teachers throughout the country lack any guidelines or network that provides a framework for ESD educational approaches. Teachers with no helping hand or support cannot manage to develop an ESD plan on a national level, leading any attempts of ESD implementation throughout the country to vary wildly in topics, quality, and effectiveness.

Finally, the sparse population and limited infrastructure in Namibia limits teacher collaboration and support. Many teachers after receiving their degree will begin their career in schools isolated in extremely rural parts of Namibia. These educators get a “bush allowance” to incentivize their movement to these less-developed schools. However, teachers at these schools rarely have access to internet or other forms of communication with other teachers. These teachers also rarely get visits from supervisors to check for their effectiveness or provide supplemental

training, causing unengaged and disinterested teaching in the classroom (EduVentures, 2007).

2.3.3 EduVentures and Efforts for Namibian ESD Improvement

To combat the issues ESD has had in Namibia, NGOs such as EduVentures have created various programs to provide ESD knowledge to students in primary and secondary schools. (EduVentures, 2007). The EduVentures: EduMobile program was created to provide supplemental afterschool programs on environmental education and sustainable practices. In this program, a mobile classroom drives around Namibia and stops at different rural schools for a week at a time. The classroom provides engaging, hands-on learning through interactive SMART lessons and activities. However, this mobile classroom can only visit a limited number of schools in a given time, leading many other schools to lack any ESD supplemental education. To combat this, EduVentures is starting a new initiative to complement this mobile classroom



called the EduLink project.

Figure 1: ESD center distribution throughout Namibia

This program will create a network of ESD centers as see above in figure 1 which provide training and online resources to teachers year-round. At these centers,

teachers from various rural areas of Namibia will attend seminars ranging from one day to one week held by fellow educators. These educators will be trained in ESD prior to the workshop so then they can effectively teach the teachers content on ESD. In addition to this the educators will be trained on current pedagogical tools and will relay these tools to the teachers (EduVentures, 2007). The flow of information in the EduLink project can be seen in figure 2 below.

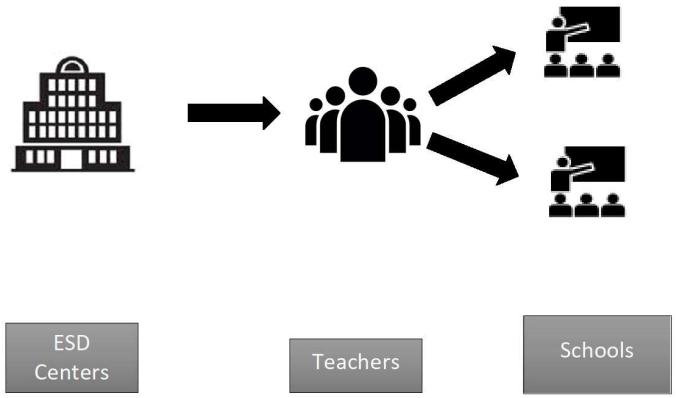


Figure 2: ESD information flow conceptual model

EduVentures then installed a learning management system (LMS) that connected the ESD centers and educators with each other which offered a means for collaboration and the sharing of materials and information (EduVentures, 2007). According to Chakravarti et al. (2018), this LMS is designed to connect the ESD educators of Namibia together to improve the ESD implementation in Namibia. The EduVentures LMS is designed to be the platform for a wide variety of ESD modules that will be made available to educators and teachers. These modules will go into depth on certain topics within ESD such as biodiversity. However, this LMS and ESD network currently has no informational resources on it.

2.4 Summary

ESD is a mechanism for educating students about environmental issues from the local to the global scale. Using contextualized curriculum for environmental

education helps students relate to environmental problems in their own region. This, in turn, helps students become aware of larger environmental issues that are prevalent beyond their own homes. Online learning modules are a flexible way for teachers to teach ESD. Online modules give teachers the chance to incorporate contextualized content and activities into the curriculum. These teaching resources can be very effective in isolated regions as they are easily accessible and provide basic content for underprepared teachers. EduVentures has constructed an LMS used to connect teachers across the country. Currently there is no ESD content on the LMS; thus, creating effective pedagogical and ESD content for the LMS is a logical next step for EduVentures to accomplish their overall goal of spreading ESD through Namibia.

Chapter 3: Methodology

The goal of our project was to create educational online modules that teach pedagogical tools to educators and focus on the topic of biodiversity. EduVentures intends to use these modules to promote better teaching practices throughout Namibia. Therefore, we strived to make these modules as effective as possible for the educators that would use it. To achieve this goal, we developed the following research objectives:

1) Identify educational and pedagogical content for the online modules.

2) Determine methods to construct the online modules.

3) Identify techniques to implement the online modules.

4) Assess the effectiveness of our modules.

In this chapter, we describe the methodology we used to achieve each of the research objectives.

3.1 Identify Educational and Pedagogical Content

Before beginning construction of our online modules, we needed to determine what content would be important to include to create the most effective learning tools. To determine this information, we surveyed ESD center educators to gauge their teaching background and knowledge of biodiversity, as well as interviewed various EduVentures staff to understand the EduLink project goals and the progress that had been made so far. We also conducted content analysis on the national Namibian school curricula to ensure that our modules would include the correct topics as mandated by the government and identified where in the curricula environmental content could be integrated. Additionally, we researched various methods of learning and pedagogical tools that would be beneficial to include for the educators utilizing our modules.

3.1.1 Interviews and Survey

We administered interviews and surveys to gain contextual information on the EduLink program and the current state of teaching at the established ESD centers. In order to assess the EduLink project, we interviewed a variety of EduVentures staff about the goals of the project's progression and what had been done in the past. For our interview protocol taken with EduVentures staff, see *appendix D.* Additionally, EduVentures held a workshop for ESD educators at the Ontanda ESD center in Luderitz. We were unable to attend the workshop; however, we formulated a survey (*appendix E*) for each of the six educators present at Ontanda that focused on identifying their experience and educational background. The purpose of this survey was to assess what kind of information would be pertinent to include in the online modules. We included mainly open-ended questions when creating the survey in order to allow for a variety of answers with few restrictions. These open-ended questions were the best way to replicate an interview structure without the opportunity to talk to each educator in person.

In preparation of the Ontanda workshop, we drafted the survey and reviewed our choice of questions with our sponsor and the lead of the EduLink project, Corris Kaapehi. His prior work with EduVentures and the educators gave helpful insight on how to word our questions and what specific teaching styles to look for. Due to our inability to administer the survey, Corris then administered it on our behalf

3.1.2 Sponsor Guidance

A guideline of information for the module was also provided for us by our sponsor EduVentures. This included a rough outline of the topics within biodiversity that our modules should have focused on (*appendix F*) as well as a collection of books, websites, and other resources where we could find the information on Biodiversity and pedagogy that we needed. Additionally, we talked with Corris to identify the scope of our project based on what had previously been accomplished by the prior WPI group, what EduVentures had done over the summer, what EduVentures needed from us as a group, and what EduVentures planned to do once our stay in Namibia had concluded.

We also gathered previously developed presentations, lessons, and documents that Corris and the other EduVentures staff had from previous work on other projects. This would allow us to focus our time and efforts into compiling information and constructing the modules rather than having to develop all information and resources from scratch, as well as use the knowledge from workers already trained in the study of biodiversity and sustainability.

3.1.3 Content Analysis

In order to identify what information was relevant to the classroom for future implementation at schools across the county, we conducted content analysis on the Namibian curricula. The intentions behind conducting this content analysis were to identify themes within different subjects and allow for an ease of ESD integration.

We performed this quantitative content analysis by downloading the curricula for computer studies, accounting, art and design, biology, business studies, design and technology, economics, geography, history, math, and physical science from the National Institute for Educational Development website (NIED, 2010). We used the keywords regarding biodiversity listed in *appendix G*, and searched through the curricula to see how often the words appeared in the various curricula. These keywords were developed from the biodiversity content that we had previously outlined. Additionally, we examined the main topic ideas for every subject to determine the relevance to ESD. The curricula from each subject were analyzed to find the places in which we could incorporate ESD seamlessly. This meant identifying where EduVentures content could fit into the national secondary school curricula.

3.1.4 Supplemental Information and Resources

In order to make our online modules effective, we wanted to provide educators with a maximum amount of information. However, it was important not to overwhelm the modules with content. To create this balance, we provided additional resources the educators could review on their own to expand on the information presented in the modules. We conducted online research to find books, documents, websites, and videos. We also included some materials and resources provided by EduVentures.

3.1.5 Pedagogical Content

ESD is an interdisciplinary field of study, and the topics that it covers, such as biodiversity, can be related to a variety of subjects. Therefore, one objective of EduVentures' online modules was to incorporate teaching methods that could be applied to any subject, as well as relate to different student learning styles. This objective is intended to give educators and teachers a wide range of pedagogical tools they could use to teach students in the classroom in conjunction with the existing curricula. To determine which learning styles were beneficial to include, we researched several effective learning methods, which can be seen in section 2.2.2. These learning techniques were what the layout and content of the module were based around. The main technique that applied to the modules we created was blended learning. Since we utilized an online platform, blended learning was very relevant in the creation of the module (an in-depth description of the techniques can be found in paragraph four of section 2.2.2).

To assist our individual online research, we requested resources from the EduVentures staff. They had several books and materials regarding pedagogical content that we read through. We searched these materials and took note of information that would help make our modules effective for visual, auditory, and sensory learners. We focused on determining how to implement these styles, how to make the content engaging, which styles pair well together, and other aspects of cognitive learning. We hoped a better understanding of effective learning techniques would help create well-rounded modules for a educators, teachers, and learners with a wide range of learning styles.

3.2 Determine Methods to Construct the Online Modules

After determining the content that had to be included, our next objective entailed the development of the online modules. In choosing the platform on which we would build our online modules on, we first needed to evaluate the priorities of the EduVentures team. An extensive background in effective teaching requires understanding a variety of learning methods. Therefore, we researched ways to make

the material interactive and applicable to the classroom while also maintaining a logical flow of information.

3.2.1 Determining an eLearning Software

In researching how to create online modules, we discovered that a simple tool is an eLearning software. An eLearning software houses a variety of educational features with different methods of relaying content. There was a plethora of eLearning software to choose from that had the potential to fit the needs of our modules.

To determine what eLearning software to use, we needed to identify the qualities most important for the modules. We discussed, face-to-face, with Corris Kaapehi and three other EduVentures staff members about what the eLearning software must encompass. Cost, interactivity, ease of use, and the ability to integrate with the existing LMS Google Classroom were all things to consider when choosing a software. After talking with the staff, we realized one of the top priorities for the software was that it had to be compatible with Google Classroom. Compatibility would ensure the educators using the modules would be familiar and comfortable with the presentation of material through the eLearning software. We created a decision matrix to be a visual for us to compare each quality. We also asked the staff what they aimed to achieve through the modules to better understand how to direct our design. The goal of the modules were to engage educators in a way similar to how learners would be engaged. This would ultimately show educators different pedagogical tools that they could use to train teachers.

3.2.2 Constructing Module Components

While researching how to integrate the content into the modules, we discovered the importance of creating a logical flow of information, this entailed making sure the content in the modules built on what was previously taught so the individual taking the modules can see how all the content is connected. This would, in turn, make the modules more effective, and the teachers/educators could then use this technique in their future lesson plans.

We discussed with Corris what he considered to be the priority for presenting information to educators through our online modules. Corris suggested we make the modules as interactive as possible, and to make sure there aren't large blocks of text that could make the reader lose interest in the content. We then studied some EduVentures lesson plans (which included SMART lessons on biodiversity and other various lessons that had been created for use in EduVentures mobile classroom) in order to better understand how to incorporate this new information. Because we only had three weeks to complete our modules for the training of educators workshop, we began working. We had Mr. Kaapehi and some of the other EduVentures staff look over the modules and provide feedback to determine what ways of presenting the content would be effective. Collectively, we talked through each part of the module creation at first to work out any discrepancies. This helped us find the most effective techniques to relay information while maintaining our unity as a group.

3.2.3 Creating Effective Modules

While providing educators with content is important, it is just as vital to ensure that the educators have the pedagogical tools to deliver this information to others. To identify which educational tools to use, we conducted an informal interview with one of the EduVentures staff members. The information we gathered from this interview further guided our module creation.

EduVentures online modules are targeted to teach educators at the top level and have the information trickle down until it is being taught in classrooms at various schools throughout Namibia. This flow of information can be seen in the Figure 2 in section 2.4.2, and the modules we constructed target the relationship between the ESD centers and the teachers. Therefore, it was important to identify common learning methods of educators, teachers, and student learners. We utilized a survey (3.1.2) to gather information from educators on their background and learning methods. Using the information gathered from this survey, we identified the main learning methods and tailored our online modules to include resources for all of them. By providing educators with a full toolbox of resources, we hoped to give them the ability to modify their lessons to the learning styles of their audience, including: visual,

auditory, or sensory methods. Although not all of the provided resources would be utilized at once, having a variety of options is intended to make the online module flexible enough for any audience.

3.3 Determine How Best to Implement the Modules

After constructing the modules, we developed a plan to introduce it to the ESD educators. When implementing the modules, it was important to ensure the process was thorough and allowed users to explore all parts of the modules. An effective feedback system would also have to be part of the implementation process to help us improve the modules after the implementation. Implementation would also need to fit into EduVentures' schedule for the EduLink program.

3.3.1 Planning the Program with EduVentures Staff

Our group met with Corris Kaapehi and the EduVentures staff to discuss strategies introducing our biodiversity modules to ESD educators. Our ideal implementation goal was to create a multi-day workshop to allow ESD educators extended time with the web-based modules. EduVentures also supported a workshop, hoping to host a program training ESD educators on how to run an ESD center and educate teachers that would visit. EduVentures wanted this implementation process to have many different types of activities, including hands-on explorations, group discussion, and presentations to train the educators. Our modules could fit into this workshop as another training method.

We also needed to resolve logistics of the workshop. Because we chose BookWidgets, we knew internet would be required wherever the modules were used. We were told that all ESD centers in the EduLink network were outfitted with internet, a SMARTboard, and computers, so these were our initial choice for implementation location.

ESD educator input was also crucial for implementing the modules. Understanding what times and approaches worked best for the educators would be crucial to ensure maximum participation from ESD educators. To gather ESD input

for planning the workshop, Mr. Kaapehi ran a meeting at a workshop in Ontanda to gather feedback and finalize plans with the educators.

3.3.2 Schedule Program Agenda and Activities

Once the date, location, and format of the workshop were confirmed, we collaborated with EduVentures to develop a detailed schedule for the week. Since we had a full week to run events, it was a priority to provide numerous strategies for presenting information. Since we wanted the educators to learn many pedagogical strategies during the week, we planned our training to include different instruction types. Based on the different learning styles and effective teaching strategies discussed in section 2.2.2 of our background, we drafted potential lessons utilizing PowerPoints, interactive SMART Lessons, our web-based modules, collaborative activities, discussion groups, and Namibia-specific case studies.

After discussions with Corris and EduVentures staff, we also determined the content we would cover during the workshop. Our main goal of this training was to teach educators educational and pedagogical skills for teaching biodiversity to Namibian teachers. Therefore, all activities and lessons during the workshop had to tie into biodiversity and provide information on how to integrate biodiversity into a secondary school classroom. We also determined that there should be a section of the workshop devoted just to pedagogical strategies. At the end of our collaborative discussion, we finalized a five-day agenda with each instructional session and the topics we included.

3.4 Assess Modules' Effectiveness

After implementing the modules, it was important to determine a strategy for assessing the effectiveness of the modules. Understanding the successes and shortcomings of our modules would be crucial for helpful and accurate recommendations to EduVentures for their future modules. To assess our modules' effectiveness in training and improving ESD education, we identified three primary methods (direct interviews, focus groups, and data analysis) for receiving thorough and accurate feedback on our module during its implementation at the workshop.

3.4.1 Interview Educators at the Rundu workshop

The first method we used to gather feedback on our modules was direct interviews or focus groups with educators at the workshop in Rundu. After each session where one of the web-based modules was used, we talked with educators and asked about their experience with the program. We asked questions to help us identify the strengths and weakness of the modules to consider during future iterations. We also asked educators about the ease and intuitiveness of the modules, since they will eventually utilize it themselves when training teachers.

We chose interviews because it allowed us to gather more personalized and honest first impressions of our modules, as well as give us opportunities to ask follow-up questions on specific areas of the modules the educator mentioned. Interviews also provide a fluid dialogue that make educators invested in providing feedback rather than filling out surveys or questionnaires that are impersonal or potentially mundane especially after already spending time individually completing an online module. Focus groups were also an effective choice. We believed that being able to talk as a group would open educators up and allow them to bounce ideas off of each other.

3.4.2 Module Use Observations

To expand on our qualitative results, we wanted to draw quantitative data from the educators at the workshop. To do this, we made observations of the educators use regarding each module. To guide these observations, we made an observation rubric (*appendix H*) with specific actions to look for. During each module implementation throughout the workshop, we sat in the back of the room with as clear a view of the educator computers as possible. We always had at least one group member keeping track of how the educators interacted with the modules. The other group members assisted in making these observations by walking around the room to see the computer screens not visible from the back of the room and answering questions the educators had while going through the material.

The observation rubric covered both positive and negative module interactions. We determined the criteria for each observed action. To determine if an

educator demonstrated confusion we looked for educators who did not click through the tabs and stayed on one screen for an extended period of time; educators who let their screen go into standby, or were unable to find certain features of the modules. Additionally, to determine if an educator was distracted in unrelated activities we looked for internet browsing, phone use, and an absence from the room for extended periods of time.

We then quantified the observations based on how many educators were completing the different parts of the module. We did this looking at which tabs each educator was on, as well as observing if the educators skipped around the module or completed it in chronological order. Additionally, we observed if the educators were taking notes or working collaboratively as this also can share some insight into how educators interpret the modules that we created. These observations helped us make alterations to the module for future use, and in tandem with the assessment data can share insight into the overall effectiveness of the modules as a whole.

3.4.3 Analyze Assessment Data

In addition to qualitative data gathered from interviewing the educators and observations, we wanted to gather quantitative results to back up our findings. To gather this data, we developed two assessments for the educators. The first was a pre- and post-assessment given at the beginning and end of the workshop. Both the pre- and post-assessment were the same test, and covered general information about biodiversity. These assessments would show us the progress that educators made throughout the week, and a significant improvement in score on the post vs pre-assessment would suggest that educators effectively learned during the week. For the full assessment, see *appendix I*.

The second type of assessment we made was built into the online module itself. The e-learning software, BookWidgets, provides immediate feedback on any assessments that educators take in our module. Whether the assessment is a quiz, worksheet, or interactive game, the educator's answers are uploaded directly into the assignment on Google classroom. We were then able to analyze this data and

determine if educators performed well in our assessments based on their knowledge of biodiversity and pedagogical strategies before and after completing the ESD module.

This data provided insight on two main issues: is there a certain module type that promotes better learning than another, and are there types of assessments or questions that educators struggle with? For the first question, we compared the assessments of various modules. If a quiz has bad scores and the informational part of the module was a PDF, but another successful quiz was based on information taught through a video, we can infer that videos are more effective at conveying info than slides. For the second issue, we compared if teachers are struggling more on questions regarding biodiversity or pedagogy. All this data provided from the assessments helped us strengthen areas of confusion and emphasize areas of strength.

3.4.4 Focus Groups Conducted with ESD Educators

The final method we used to gather feedback about our module was focus groups conducted once per day with the educators. These focus groups were facilitated by our group of WPI students, but were mostly run as a conversation among the educators. These focus groups covered broad topics such as opinions of the modules, effectiveness of the workshop, questions the educators had after the day, and other general subjects. As facilitators, we made observations and took notes on the discussion as the educators talked amongst themselves about the workshop, and we noted what things they agreed or disagreed with. The goal of this strategy was to provide us with a good understanding of the whole group impression of our module and workshop, and also spark new points and opinions that may not have arisen in a one-on-one interview.

3.5 Summary

With the goal of enabling educators to effectively train teachers about biodiversity in mind, online modules were constructed. These modules served to not only provide basic biodiversity lessons but to also show teachers different pedagogical tools that could be utilized to teach these lessons. The construction of the modules began with background analysis into what to teach and how to teach it. This

content was then used to construct the modules with various educational components. These modules was ultimately implemented in multiple workshops with teachers and educators. We received feedback following these workshops which aided us in improving the modules for further work on the EduLink project.

Chapter 4: Results and Analysis

Once the content for the modules was compiled and the modules were constructed and implemented, we were able to filter through our results. From the content analysis on the Namibian curricula, we were able to find where ESD could be implemented. Using interviews, focus groups, and surveys we received feedback that showed us the effectiveness of our work and allowed us to gain further insight on the strengths and weaknesses of our modules. The ultimate goal of our modules was to provide educators with a tool that can assist the teaching of teachers about biodiversity. The modules did this while also showing different pedagogical methods teachers could use to implement ESD into their curriculum.

4.1 Content Included in Modules

Based on the surveys we distributed at the Ontanda workshop, we learned that the ESD educators had varied educational background. From this data, we determined that the content in the modules should cover basic biodiversity. We also realized that the pedagogical content in our module should be extensive as to supplement the lack of prior educational instruction among the educators. For the educational content, we searched through Namibian secondary school curricula and identified key themes and concepts to include in our modules. We also found areas within the curricula in which ESD could be implemented. For pedagogical content, we researched effective online learning as well as how other countries have utilized online teaching. Additionally, we came up with suggested activities and case studies for teachers to use. We compiled a list of educational content covering types of biodiversity, ecosystem services, and threats to biodiversity. Along with this, we gathered different pedagogical tools that could be utilized while teaching these topics.

4.1.1 Ontanda Workshop Survey Results

At the Ontanda workshop, we gave out a survey and received feedback from six ESD educators. We found that three out of the six educators had no training as teachers and only one educator had a degree in education. Additionally, 83% of the

ESD educators had never worked with or trained teachers. Instead, most ESD educators had only worked directly with student groups, outside visitors, or companies. We also found that most educators agreed that a combination of teaching methods, especially visual learning followed by practical hands-on experience, was the most beneficial for learners. From this data we determined pedagogical content would be needed in our module to supplement the lack of prior educational experience. We focused on ensuring the modules provided a mixture of theory and practice while tailoring content to users with little background on biodiversity.

4.1.2 Module Content

Through our extensive search of Namibian curricula, we identified many different places in which ESD could be implemented. The table below contains keywords we looked for as well as how often they appeared in the curricula.

SYLLABI	biodiversity	cells	conservation	cultural	degradation	ecosystem	extinction	genetic	identification	organism	preservation	species	TOTAL
Computer Studies (2016)	0	0	1	2	1	0	0	0	0	0	0	0	4
Accounting (2010)	0	0	0	1	1	0	0	0	0	0	0	0	2
Art and Design (2013)	0	0	0	6	1	0	0	0	3	0	0	1	11
Biology (2010)	1	34	5	2	1	6	0	17	3	43	0	11	123
Business Studies (2010)	0	0	0	1	1	0	0	0	0	0	0	0	2
Design and Technology (2011)	0	0	1	3	1	0	0	0	0	0	0	0	5
Economics (2010)	0	0	0	3	1	0	0	0	1	0	0	0	5
Geography (2009)	1	0	3	15	2	3	0	0	0	0	0	0	24
History (2010)	0	0	0	2	1	0	0	0	0	0	1	0	4
Math (2010)	0	0	0	2	1	0	0	0	0	0	0	0	3
Physical Science (2009)	0	1	5	2	1	0	0	0	6	1	0	0	16
TOTAL	2	35	15	39	12	9	0	17	13	44	1	12	

Table 1: Content Analysis

Taking this into consideration, we looked further into each of these syllabi. Using the content analysis discussed in 3.1.3, we found content that could be included in our modules as well as places in the curricula in which ESD could be implemented. As seen in Table 1, the biology syllabi contained the most keywords. This was to be expected, considering ESD is most easily implemented into this subject. Other subjects that could readily implement ESD were geography and physical science. One surprising result was that the art and design syllabus could house ESD topics. The cultural aspects of ecosystem services can be implemented into any class, proving the interdisciplinary nature of ESD. To view a full list of where and how ESD can be incorporated into Namibian curricula, see *appendix J*.

After going through the resources provided to us by EduVentures on biodiversity, we compiled key points and concepts for types of biodiversity, ecosystem services, and threats to biodiversity modules. The entirety of our educational content compiled can be seen in our modules, *appendices K, L, and M*.

We wanted to provide a variety of pedagogical knowledge, teaching strategies, and educational resources to the educators and teachers using our modules. Based on research and discussion with EduVentures staff and educators as described in Section 3.1, we identified effective pedagogical strategies. In our modules, we explained the strategies of blended learning, student-centered teaching approaches, micro-learning, and multimedia education. These types of learning proved to be the most effective in an online setting. We also provided case studies and suggested activities. The entirety of the pedagogical content compiled can be seen in the modules, *appendices K, L, and M*.

4.2 Constructed Modules

Once we compiled all the educational and pedagogical content, it needed to be built into our online module. We first had to select an e-learning software to construct the module. After conversations with EduVentures staff and their priorities for a module, we developed a decision matrix to compare multiple software. BookWidgets Teacher Edition was selected as the best option, and we proceeded to use it to create the module. We organized the module into segments based on topic and learning method, providing educational and pedagogical knowledge with interactive elements.

4.2.1 Choosing BookWidgets as e-Learning Software

BookWidgets was found to be the e-Learning software that met EduVentures' needs. We determined this by creating a decision matrix (*see figure 3*) that compared four software based on the priorities EduVentures wanted in their module. The main priority for the modules was compatibility with the already existing LMS, Google Classroom, chosen by the previous WPI group working with EduVentures. Google Classroom does not accept files in the Shockwave Flash file (SWF) format, and since a majority of eLearning module software use SWF files, we were restricted with what

e-Learning software we could utilize. SWF files are not impossible to integrate into Google Classroom, but they cause a lot of analytics data to be lost since the modules are not directly integrated into the LMS. Adobe Captivate 9, which was recommended by the previous WPI group, has a score of 1 in compatibility since it is in the SWF file format. While it was still considered due to the creative freedom that it offers, its incompatibility was a key factor in deciding not to use it as the e-Learning software for our modules. Another determining factor that made us choose BookWidgets was the ability to have ten users create, edit, and publish modules. This allowed multiple educators at different ESD centers to use the software simultaneously.

Interactivity was another key feature for EduVentures. Therefore, the software that we chose needed to have interactive templates, or the freedom to create interactive templates. This was critical to the success of the modules because EduVentures stressed the importance of interactive learning to make sure educators keep learners engaged throughout the modules. Adobe Captivate gave the user a lot of freedom to be creative and show information in an interesting way, scoring five out of five in the interactivity category. BookWidgets provided 40 pre-made templates that can be edited. These templates gave a broad range of interactive games, presentations, and quizzes. However, BookWidgets does not support the creation of custom widgets, which means there are some restrictions when developing the modules and received a score of three out of five in our decision matrix. iSpring Suite is an add-on to Microsoft PowerPoint that is easily compatible with the LMS, however it only focuses on making interactive presentations. It does not support making educational games or activities, scoring two out of five in interactivity.

Having unique features was also important to our group and sponsor since we wanted to have a wide range of features to make our module as effective as possible. We found that Adobe Captivate 9 had the highest ranking for unique features because the software provided the most flexibility and control to the user. This resulted in Adobe Captivate scoring a five out of five in the unique features category. BookWidgets also has many interactive features, and although it lacks as much freedom, it provides assessment feedback and data that Adobe cannot. BookWidgets

scored a four out of five in unique features. iSpring Suite is limited to the features of PowerPoint and thus scored a two in the category.

Ease of use was another important aspect that was taken into consideration when choosing the best software. This was important because when our group leaves, the EduVentures staff will still continue to create new modules, as well as edit modules that were made previously based on feedback from the ESD educators. While Adobe would have produced aesthetic modules, it is a very difficult e-Learning software. Learning the program properly could take some people weeks if they are brand new to the system. Due to this steep learning curve, Adobe Captivate received a score of one out of five in ease of use. The most intuitive software to learn was iSpring Suite, an add on to Microsoft PowerPoint. Since a majority of EduVentures staff is already familiar with PowerPoint, it would be easy to learn the additional tools that iSpring Suite offers. Due to this it received a perfect score of five in the ease of use category.

e-Learning Software	iSpring Suite 8.1	Adobe Captivate 9	Book Widgets Premium	Book Widgets Teacher Edition
Integration Capability with LMS	4	1	5	5
Interactivity	2	5	3	3
Unique Features	2	5	4	4
Ease of Use	5	1	4	4
Cost	2	3	1	4
TOTAL	15	15	17	20

Figure 3: Module Software Decision Matrix

The final aspect that was considered was software price. EduVentures is a non-profit organization with a limited budget. The cost range for the products was from US$350 - US$1000. We compared two subscription option of BookWidgets to Adobe Captivate and iSpring Suite. BookWidgets Teacher Edition was the cheapest and Premium BookWidgets was the most expensive. The Teacher Edition of BookWidgets received a four out of five in cost as it was priced at US$350 for ten users. This gives the opportunity to have every ESD site able to create, edit, and upload BookWidget modules onto the LMS. Our final decision matrix can be seen above in *Figure 3*. As shown, BookWidgets scored the highest in the categories most crucial to EduVentures, and was selected as our software of choice.

4.2.2 Module Structure

After we determined the E-learning software, pedagogical content, and educational content for the modules, we used BookWidgets to develop the online modules. These modules were centered around types of biodiversity, ecosystem services, and threats to biodiversity. Based on section 3.2, a variety of learning methods in our module would be key to make them as effective as possible. Our final structure for each module followed a similar format. First, an introductory video would introduce users to the topic of the module. Following the video, an informational section would provide users with knowledge on the educational information of the module. This information was given in two ways; directly through notes and graphics, as well as a visual PDF that users can open to access more in-depth information. The PDF was also tailored to visual learners as it was focused around pictures and was not as text heavy as the notes section of the module. For an example section of an informational PDF, see Figure 4 below:

Figure 4: Module PDF Image

The next section in the module included interactive games and activities to provide users with an opportunity to practice the knowledge learned in the past two sections in an interactive setting. Examples of activities include clickable images, crosswords, and memory matching games. For an example image of an interactive game, see Figure 5 below:

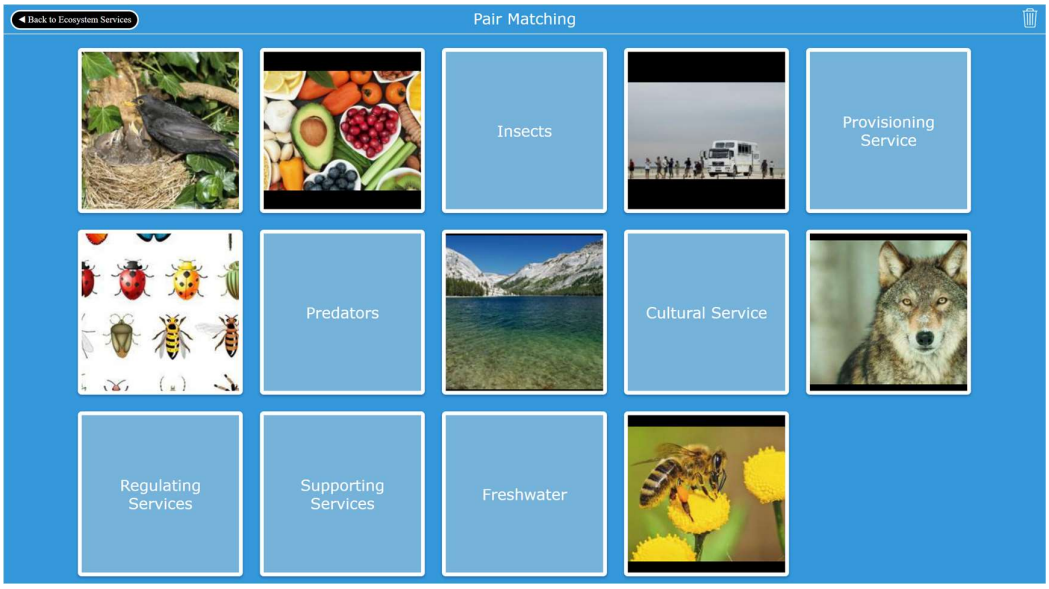


Figure 5: Module Game Image

Following the interactive section, we discuss pedagogical information with three subsections: learning styles, curriculum implementation, and suggested teaching activities. Following this section, we provide external resources such as books and websites that users can visit to further their knowledge on the given subject if desired. Finally, the module concludes with an assessment section containing a flash-card review activity followed by two quizzes. One quiz focuses on the education information of the module and asks questions on biodiversity. The other quiz focuses on pedagogical information presented in the module and asks open-ended questions where users must explain ways they might teach biodiversity to a group of learners.

4.3 Module Implementation

Based on a mock workshop with students and the final workshop with educators, we were able to implement and assess our modules among the ESD educators. We continually collected feedback from the educators at the workshop through interviews, focus groups, observations, and assessments. This feedback allowed us to determine that our modules require further development and reliable internet to be as effective as possible. From this information, we were able to compile quantitative and qualitative results provided in this chapter.

4.3.1 Mock Workshop

When facilitating the mock workshop in Windhoek, we made observations and conducted a focus group to gather feedback and make adjustments. The five students that reviewed our module on ecosystem services only briefly read the content as the information was presented to them on a projector. From the focus group, we determined the layout was visually pleasing and easy to comprehend. The information flowed in a logical manner and provided enough examples to grasp the material. The games, while not played by the students, seemed like useful tools. However, one of the matching games did not work properly and we determined this should be fixed before the final workshop.

Students suggested we send out the modules to allow them to have more time to thoroughly review the material and test the games and assessments. We sent links to each module to allow students the opportunity to take assessments located throughout the modules. None of the students completed that post module survey questions outside the organized focus group that we conducted during the workshop. Although we gathered some qualitative data through a post module focus group, there were many limitations in gathering results. Due to the busy schedules of the students, we had limited time to go through the modules. We would have liked to have each student individually go through the module the way an educator would to provide more tangible feedback. Because of the minimal nature of the workshop, there may be issues not caught. Additionally, the lack of post-module assessment data eliminated potential quantitative results.

4.3.2 Rundu Workshop Assessments Data

Using BookWidgets online analytics, we were able to examine the results of the assessments we administered during the workshop in the modules. We gathered results from the pre-assessment and each of the three module assessments. The results from the pre-assessment showed us the baseline educator knowledge before the workshop. We wanted to conduct a post-assessment with the same questions in order to do a comparative analysis and determine the effectiveness of our modules. Due to logistical difficulties, however, we were not able to administer the post-assessment.

We were still able to gather reasonably comparable results regardless, since the pre-assessment was comprised of quiz questions that the educators took in the post-module assessments.

A total of six educators completed the pre-assessment quiz, referenced in 3.4.2. From the pre-assessment quiz data, we can see that all the educators had a general understanding of biodiversity and some definitions. Educators mainly struggled with the question regarding the four ecosystem services as well as naming the eight specific threats to Namibian biodiversity.

Throughout the module implementation, the educators' participation was varied. Since the questions meant to follow-up the pre-assessment were scattered throughout the three modules, the sample size of educators changed as some were not present during all three module sessions. A total of six educators completed the pre-assessment while only four educators completed both the pre-assessment and the post-module questions that could be compared with the pre-assessment. When comparing the results of the pre-assessment to the results of the post-module quiz data, it is clear that the educators gained some knowledge of the biodiversity material. However, the amount the educators learned is subjective due to the fact that the post-module assessments were taken immediately following the presentation of information. These questions were embedded directly into the modules and therefore the information was not only freshly taught, but it was also still accessible. Educators had the opportunity to look at the questions and search the modules for the answers before completing the quizzes. With a post-assessment at the end of the week, we could have actually drawn conclusions on if the educators retained the knowledge they had learned.

These limitations make our results subjective and non-conclusive. Although the information is not as direct as we would have liked it to be, we can still analyze it and create a hypothesis. The data collected from the six educators that completed the pre-assessment and some of the post-assessment questions can be seen in figure 6 below.

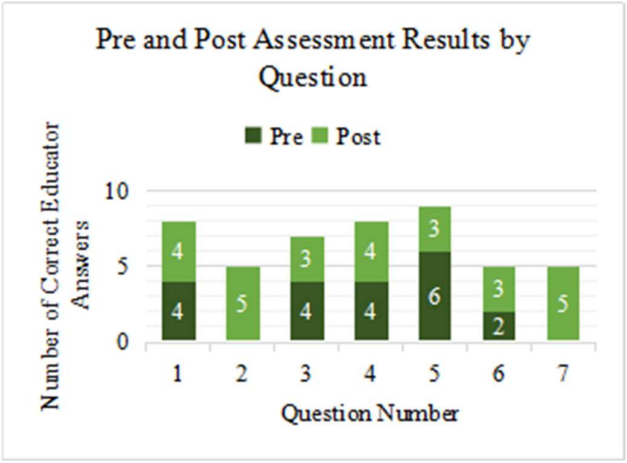


Figure 6: Pre and Post Assessment Results by Question

This data shows that some of the information within our modules overlapped the background of the educators present. Specifically, questions 1, 3, 4, and 5 had a high percentage of correct answers during the pre-assessment. Questions 1, 3, and 4 regard information from the first module, types of biodiversity. This exemplifies the fact that the educators had the most extensive background information regarding this module. Each of the four aforementioned questions had at least a 50% correct response rate. Therefore, the post-assessment answers showed no improvement. In fact, questions 3 and 5 showed a decrease in correct answers from the pre to post-assessment. Questions 2 and 7 had the highest increase of correct answers. Each of these questions rose from zero to five educators answering correctly which shows significant improvement in both of these areas.

After looking at the quiz data by question, we examined the data by educator results and improvements. Of the six educators that completed the pre-assessment, only four completed every question again in the post-module assessments. Their results can be seen in figure 7 below.

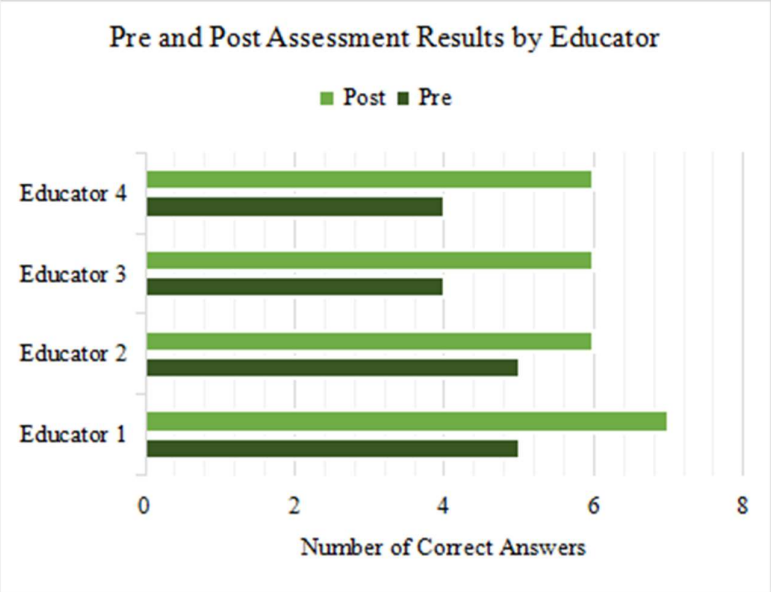


Figure 7: Pre and Post Assessment Results by Educator

From this data, it is clear that each educator improved from the pre- to post-assessment. Although this information is evident from their answers, the results are not the most accurate due to the circumstances and inconsistencies in assessment distribution.

After examining the pre- and post-assessment data, we reviewed the results of each post-module educational assessment and compared the results. The mean score and standard error were graphed in *figure 8* below. Based on the data collected, it is evident that most educators knew or learned the most information on types of biodiversity, followed by ecosystem services, and finally threats to biodiversity. Additionally, *figure 8* highlights the standard error of each module data. The standard error of types of biodiversity was the smallest with 0.04. This shows that the range of educator scores was small for this module. Comparatively, the standard error for the other two modules was significantly larger, each at 0.09. There was not a consistent sample size for each of these quiz grades, making it difficult to draw any conclusions from this data. Had there been a constant number of educators being averaged, you

could claim with certainty that they struggled the most with the threats to biodiversity quiz.

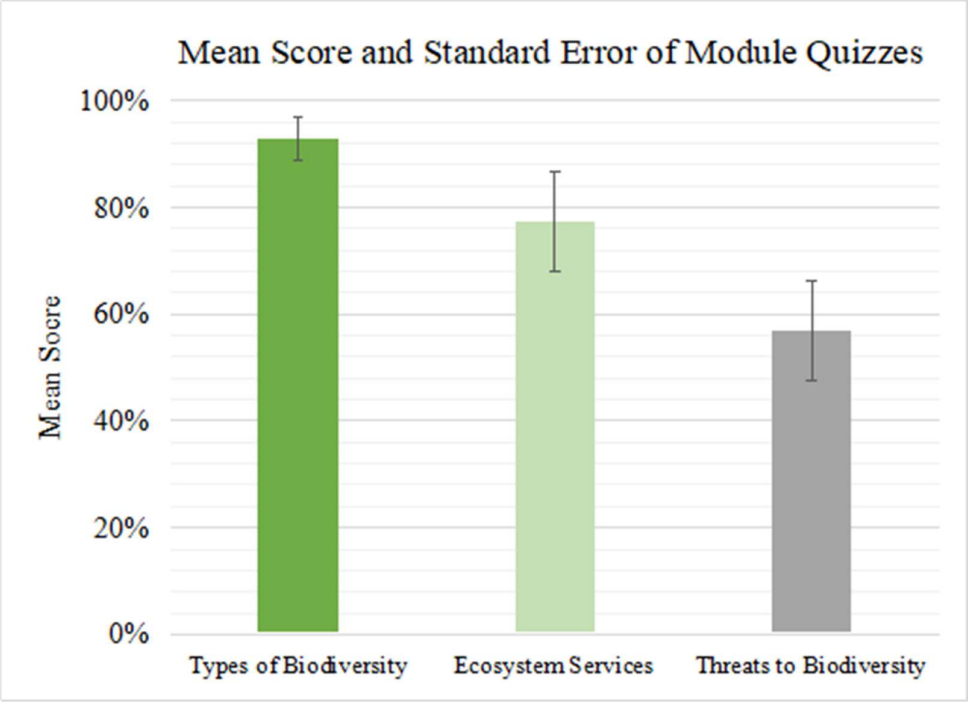


Figure 8: Mean Score and Standard Error of Module Quizzes

4.3.3 Interviews and Focus Groups

After every module, we conducted either interviews or focus groups to gather feedback from the educators. The intention behind this was to gather immediate opinions and first impressions regarding their experience with the module. When conducting these focus groups and interviews we experienced some limitations. We wanted to conduct mainly interviews to gather as much feedback as possible in a personal setting. However, due to time restraints and educator's unreceptiveness to staying late to provide feedback, we conducted mainly focus groups. Focus groups were more time efficient and created a collaborative environment to share feedback,

but interviews would have allowed educators to share their educational experience more in-depth and voice any individual reactions to the modules.

After the first module session on types of biodiversity was completed, we held two interviews with educators who finished early and two small focus groups with the rest of the educators at the conclusion of the session. We found that both the interviewed educators had at least one bachelor's degree in environmental sciences. They had each studied, at least partially, at a university in Namibia. One of the two interviewed educators, Viktoria, received her environmental sciences and sustainable technologies degree at a university in the Netherlands after receiving her degree in nature management from the Namibian University of Science and Technology (NUST). From these interviews, it was evident that the information provided was useful but mostly provided a "refresher" from university knowledge. For a full transcript of our interview protocol, see *appendices N and O*.

The focus groups we conducted gave similar feedback regarding the educational content of our modules. Users said the information was helpful in both providing new information and reinforcing topics learned in university. A full transcript of our focus groups can be found in *appendix P*.

One of the most shocking points made by an educator was that their ESD center lacked any internet. Until this point, we were under the impression, based on the information provided by EduVentures, that each center was equipped with consistent internet access. However, it was made clear that EduVentures faces many challenges when attempting to implement internet at the centers. One center, NaDeet, has no internet access at the education center at all. This is intentional to remove distractions and create a remote, disconnected environment where the focus is only on environmental education. Additionally, during our workshop at Rundu, we were forced to relocate sites on the second day due to ineffective internet and a lack of power that prevented access to our modules. This unreliable internet is a serious issue since our modules require internet to work properly. One question and common suggestion from the educators was whether these modules would be available for

download or if they could be converted into a PDF or word document to provide to teachers as a resource or brought back to ESD center with internet limitations.

During the next focus group, following the module pertaining to ecosystem services, one of the main points brought up by educators was a need for more Namibia specific examples. Some educators reported losing interest due to examples in the module they found irrelevant. Although there were many examples within the notes section, the introductory video and many of the pictures in the PDFs were not Namibia specific. Additionally, the educators said they spent too much time on the games tab. They agreed that placing games throughout the notes tab would have been more beneficial than having a separate tab for games. This would provide a checkpoint style method of learning that prevents users from skipping the educational content and focusing on interactive activities. Additionally, it adds a break between the text heavy portions of the module. The rest of the transcript from this focus group can be found in *appendix Q*.

After our third module was tested, we conducted a final focus group. Most of the comments made during the discussion echoed thoughts from the discussion surrounding the other two modules. The full focus group discussion for threats to biodiversity is found in *appendix R*. Some suggestions discussed during this focus group included the benefits of having a set time limit to follow. Having a general idea of how long the entirety of the module should take gave them the ability to assess how much time they had to spend on each section of the module. Another unique point of discussion was that educators wanted the integration portion of the module and teaching pedagogy to include not only secondary school curricula but also primary school curricula. This is an edit that we were unable to make based on time restrictions after the workshop, but shows EduVentures should also focus on making resources for the primary level as well. Additionally, during the threats to biodiversity focus group, we lead a discussion on the combination of the three modules and how they functioned as a series. The educators reaffirmed that the flow of information was logical and that the modules continued to make more sense as the educators used them more.

4.3.4 Observations

Throughout the workshop, we collected observations of the educator interactions with the modules. Most of our quantitative results from this were gathered using a pre-constructed observation rubric. This completed rubric is found in *appendix H*. Our observations recorded both positive and negative behaviors including but not limited to note taking, working collaboratively, and obvious disinterest or confusion.

Many of the observations surrounding each of the modules shared similarities. The most prevalent positive interactions with the modules were reading through the notes tabs and utilizing the provided PDFs. Although not all educators made use of these features, the majority of educators at least explored them. Throughout the three modules, the number of educators using the notes section decreased while the number of educators using the PDFs increased. The PDFs provided a more comprehensible set of notes and were presented in a visually pleasing manner that made them easy to read. Although there was a shift toward the PDFs, the information in the notes sections was the main source of Namibia specific information and examples.

The collaborative work of educators decreased as the workshop progressed. This was due to an increased comfort level with the layout, information, and software. Therefore, it should be noted that there is a learning curve in using these modules and the collaborative efforts were the most effective in this familiarization process. Additionally, the educators took more notes on the second two modules than on the first. This could be due to a number of factors including familiarity, interest in content, inspiration for future implementation, etc.

The most prevalent negative observation was educators engaging in unrelated activities. This was especially prevalent in the first two modules. Educators would become distracted by these activities and leave the room or redirect their attention away from the module. During the third module facilitation, however, the number of educators distracted by unrelated activities was relatively low. This can be attributed to the fact that we set a stricter time limit on the module. Additionally, the educators

were more familiar with the software and the content was not as lengthy. These factors made it easier for the module to retain the attention of the educators.

Throughout all of the modules, there was at least one educator demonstrating confusion or, potentially, disinterest in the modules. This may have stemmed from a lack of exposure to technological software, unreceptiveness to learn new material, or a lack of attention during the facilitation of directions. Without the willing participation, the modules lose a majority of their effectiveness.

These trends are demonstrated in figure 9 below. The positive observations are noted by green bars, while the negative observations are noted by orange bars.

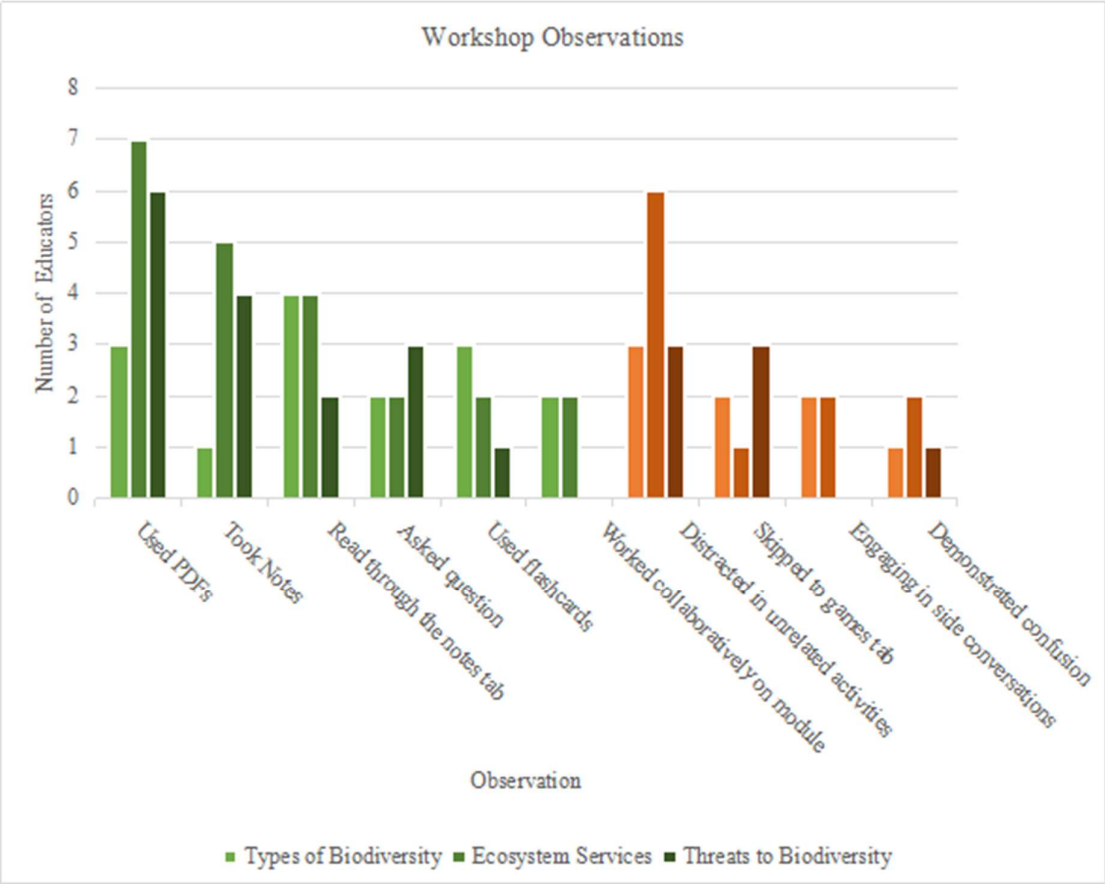


Figure 9: Module Observations

During the module distribution, we also gathered qualitative observations. Most of these observations aligned with the quantitative data noted above. One

notable observation from the ecosystem services module regards the presentation of the layout and the confusion of educators. We intentionally did not review the layout of the module in terms of the different tabs and how to access the PDFs when giving instructions on the module. The intention behind this was to see how easily the educators would be able to navigate the modules with minimal instructions so they could utilize the software on their own at their respective ESD centers. Many of the educators were confused by the module and did not click through any of the tabs beyond the introductory video page. This was observed by one of the other educators in the room who proceeded to go up to the front of the room and utilize the SMART board to point out the different tabs and links to PDFs and additional resources. After this, most of the educators had a much better grasp on how to navigate the module.

Our observations, both qualitative and quantitative, were useful in assessing the effectiveness of our modules and gauging the reactions of educators. They provided context on the future use and what edits would be beneficial.

4.4 Summary

Utilizing a mock workshop, quiz data, interviews, focus groups, and observations we were able to compile data to see if the modules created were effective. Using the feedback gained from the mock workshop we were able to make visual and logistical adjustments to the module before administering them in Rundu. From our interviews and focus groups in Rundu we were able to get first hand feedback from the ESD educators. This was extremely helpful in determining what was useful in the module and what was not. Additionally, we were able to confirm that the content that we provided in the module was accurate and effective. During the workshop, we made observations while the educators utilized the modules. These observations mainly detailed the behaviors and tendencies of the educators such as what parts of the module they spent the most time with and if they worked slowly or quickly. Taking into account all the information that was gathered in this section we were then able to draw conclusions and make appropriate recommendations.

Chapter 5: Conclusions and Recommendations

Our online biodiversity modules have shown potential as effective teaching and learning tools in the EduLink project. Although the modules can still be improved, ESD educators are excited about the possibility of online interactive learning as a supplemental resource in their workshops and trainings at ESD centers. The content provided in the modules is much more thorough and engaging than the slides or posters currently established at the centers. However, access to consistent and reliable internet and hardware is required for the online modules to function, and this access is still limited at many EduLink project centers. Due to this, we have developed a set of recommendations that detail further steps needed to improve online module effectiveness in Namibia. We have also provided overall recommendations for the direction of the EduLink project and ways that modules can be expanded in the future.

5.1 The Value of Online Modules Regarding ESD

Our online modules had many positives that can continue to be built upon. The personalization and interactivity of online modules make them a very effective resource for teaching biodiversity and other ESD topics. However, our modules can still be improved to provide a more engaging experience for the users.

5.1.1: Benefits of Modules

ESD educators are open to and excited about the potential of using online software and modules to supplement their workshops and trainings at ESD centers. After presenting our modules at the EduVentures workshop in Rundu, educators praised the online modules for their ability to provide learners with thorough and interactive educational content. Currently, most centers only have simple posters or PowerPoint presentations introducing ESD topics. These basic informational sessions are followed by hands-on activities. Online modules will greatly improve the initial presentation of information and get visitors of the ESD center more excited about the workshop. Educators were also excited about the possibility of using the BookWidgets software to develop their own modules and lessons. Educators could use BookWidgets to make custom modules that work seamlessly with their own teaching style and structure, improving the center's education even further.

Based on these results, we recommend EduVentures continue to invest in developing online ESD modules. Creating modules on other ESD topics such as Ocean Literacy, Sustainability, and Community Based Natural Resource Management would give ESD educators even more resources to improve ESD trainings. We also recommend EduVentures host a training workshop for educators that will teach them the BookWidgets software and provide instruction for educators to develop their own modules.

5.1.2: Areas of improvement

However, the modules can still be improved. The two main issues with our modules were user engagement and confusion. Most educators had never used an online module before, and navigating the interface was difficult for many during the first session. Additionally, some educators during our workshop became distracted while working on our modules, instead engaging in other computer activities or side conversations. Some educators mentioned that irrelevant games and non-Namibian examples may have caused this.

Based on these results, we recommend that when EduVentures or educators develop future modules, they guarantee the modules have very clear instructions and a

simplified layout. This will ensure users can easily navigate the module and not miss any content, utilizing its full effectiveness. We also observed many educators skipped directly to the interactive games section of each module. Re-organizing the module so that games are interspersed among the notes that relate to them will force educators to view information rather than just play games. Many educators also thought the games were graded and spent too long on each activity. Providing explicit notices explaining the goals of the games could help prevent this. Adding suggested time-limits in each part of the module would also help pace the users and prevent them from spending too long in one section or skipping past another. Finally, some educators were confused by visual differences between the three modules. Creating a consistent structure and look among all modules will make them easier to use as more modules are attempted.

We also recommend that all content, case studies, and images in EduVentures modules relate directly to Namibia so that users will be more invested and relate better to the content. Some educators explained that they lost interest in the module when an example of biodiversity in the United States was mentioned, since that seemed irrelevant to the user who had never been to the States before. Other educators also complained about repetition in the notes section and games. Reducing redundancy will make the modules less dull and more engaging. To continually assess user opinions of modules, test-runs should be done monthly with local teachers to obtain feedback and continually improve the modules.

5.1.3: Online ESD Modules as a global educational strategy

As discussed in section 2.1, many countries besides Namibia are struggling to implement ESD into their education system due to a lack of teacher support and ESD resources. EduVentures' online ESD modules could be a possible solution to these limited resources. Since our modules only require a computer and internet to use, any teacher with access to these resources could use ESD modules in their classroom or training. Additionally, teachers around the globe could also turn to online modules as a form of teaching ESD. Online modules are more interactive and engaging than traditional lecture instruction. If ESD is developed in tandem with progressive

educational methods like the modules developed in the EduLink program, learners will better learn about environmental and sustainable topics.

Just like our research in section 2.2.3 on South Africa, Namibia could develop their online learning into courses used by universities and secondary schools alike. These methods could then be implemented at a global level. With multiple nations using online learning, the resources and collaboration that come with an online network would be extensive. Based on the potential of online modules in the EduLink project in Namibia, it is feasible these modules could see similar success in other countries that have yet to make any significant ESD progress.

5.2 Implementing Online Modules

Our online modules require internet to access and use. During our workshop in Rundu, internet was unavailable one of the days and we were forced to relocate sites to obtain sufficient internet. Additionally, while at the workshop, multiple educators voiced concerns about the modules because their ESD centers had either weak internet, unreliable internet, or no internet at all. Without internet, our modules will be useless during any teacher training. Access to computers also varies from center to center. Each user of the module should have their own computer to use the module on, since the games and assessments on the module require individual interaction. Additionally, one of the biggest advantages of online modules is the ability for users to learn at their own pace. If a center only has one computer and projector, then putting the module on that projector for multiple learners will be counter-intuitive to the benefits of an interactive module.

Based on these challenges we experienced, we recommend EduVentures work to establish consistent and reliable internet at all ESD centers. Currently, EduVentures plans to have internet and computers set up at all ESD centers in the next few months. If this plan is successful, the modules provided on BookWidgets will work as intended. However, even with routers and computers, internet service may be an uncontrollable factor that will not meet sufficient requirements. If resolving the internet is not a viable option, we recommend modules be developed offline in an

alternate e-learning software. These modules can then be downloaded and distributed through a flash drive or similar memory storage. The main downside of using this proposed system is the loss of quiz data and feedback from the modules. Additionally, there will be no way to confirm that the centers without internet completed the module. These limitations of the proposed system are not ideal, but as more and more ESD centers gain internet access, these issues will be resolved.

Limited internet is not an isolated problem within Namibia. Many countries, especially developing ones, have unreliable technological and web-based infrastructure. In many of these developing countries, ESD has struggled to gain a foothold in the education system. Many are trying, but find integration of ESD a challenge. Since internet service is such a crucial aspect of communication, and since communication between various individuals and organizations is crucial for effective ESD programs, it is possible these countries will not be able to develop a fully functioning ESD program until this web-based infrastructure improves. Perhaps from our findings, other countries can surmise that for ESD to become truly effective in a country, that country must first invest in an educational and technological network capable of supporting any ESD resources made in the future. Proactively managing how ESD will be run may save wasted time, energy, and resources.

5.3 Recommendations for Future Expansion and Development

We recommend that EduVentures next step in the EduLink project, once determining whether to use an online or offline approach, is to continue to develop three more series of modules on additional ESD topics. If developing these modules online, develop these with BookWidgets and follow the recommendations provided in 5.1. If developing these modules offline, we recommend using Adobe Captivate or iSpring Suite since BookWidgets is only online and its main advantage of compatibility is irrelevant in an offline system. We also recommend EduVentures continue to host workshops with educators once every 3-6 months to continue testing and improving their developed modules.

In regard to hosting a workshop, we suggest that planning start *at least* one month in advance. Constant confirmations with bookings, EduVentures staff, and anyone participating in the workshop is also recommended so that everyone is on the same page. We also suggest that a backup plan for each of aspect of the workshop be planned, i.e. accommodations, power supplies, dates of the workshop, etc. This will allow for flexibility when planning the workshop, since things can change very suddenly. At any workshops, we recommend utilizing focus groups and interviews since we gained our most important results from those. We also suggest using pre- and post- assessments to gauge effectiveness.

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Appendix A: EduVentures Sponsor Description

EduVentures (2018) is an environmental non-profit organization located in Windhoek, Namibia. The organization was founded in 2003 and works to expand on the scientific knowledge of Namibia and improve understanding of its environmental and cultural history. EduVentures is sponsored by the National Museum of Namibia, the Global Environment Facility and the Rössing Foundation, but they rely heavily on donations. They are partnered with the National Museum of Namibia and together, they lead two week long scientific expeditions for Namibian youth, in which students and educators venture into the wilderness of Namibia to learn the social and natural history of the country through a hands-on experience. They also collect samples for the museum during these trips.

The expeditions occur in specific remote regions that meet particular criteria. In order for a location to be chosen, three things are considered: remoteness, under-collectedness, and potential high biodiversity interest. During expeditions, EduVentures has focused on three main topics to improve the environmental knowledge of Namibian students: education, scientific data collecting, and social upliftment. Expeditions include a small group of secondary school students, teachers from their school, and scientists from the museum. EduVentures conducts about 2-3 expeditions a year.

Another project of the EduVentures organization is the Ombombo mobile classroom This van travels out to rural schools in Namibia to teach an afterschool program based around ESD. The schools write to EduVentures explaining why they believe EduVentures should visit. EduVentures and the National Museum of Namibia then selects a school and travels there in a truck equipped with SMART screens, desks and other facilities found in a modern classroom. A five-day workshop is held where students from primary and secondary school are educated about environmental sustainability. In the past, EduVentures has collaborated with the Namibian Education

Department to spread awareness of its Ombombo Mobile Classroom outreach. Environmental sustainability content for the mobile classroom courses is provided by the expertise of the National Museum of Namibia.

EduVentures is proposing an ESD Network of ESD centers where teachers can travel to and learn about ESD from educators. Educators will focus on developing teacher skills. These educators will be trained to teach teachers. Strategically located ESD Centres will be established country wide. They will serve as centres of excellence for knowledge transfer and capacity building. At each ESD Centre a SMART classroom will be developed to serve as a hub for ESD.

Appendix B: Project Proposal from Sponsor

P.O. Box 1203, Windhoek, Namibia
59 Robert Mugabe Avenue
Tel.: +264 61 276 829/809

"Children working for heritage"

Development of didactic modules for Web Based Training

Topic:	EduMobile – EduLINK
Sponsor NGO:	EduVentures Trust
Liaison Person:	Corris Kaapehi
Cell: +264 (0)81 148 59 71	Tel. +264 (0)61 276 809
africa.org/	corris@eduventures-
africa.org	info@eduventures-

Place/Date: Windhoek, National Museum of Namibia (Science Lab) 2018

Project Background:

Traditionally, EduVentures main activities have been expeditions with school learners and students to Namibian remote areas to collect biological specimens for the National Museum of Namibia, National Botanical Research Institute and other scientific and education centers. In this activity, participants were accompanied by scientist, teachers and experts in various fields; this exposes learners to various environmental issues of significance to the Namibian context such as the lack of biological data on species distribution, climate change impacts and the significance of Environmental Impacts Assessment to ensure sustainable utilization.

In 2013, EduVentures launched the Ombombo Mobile Classroom. Referred to as the **EduMobile project,** the mobile classroom broadened our services to target ***Namibia rural schools and communities***, hence the lack of experience based education due to lack of facilities and isolation of these areas. The aim of this project is to supplement the Namibian Education system with a hands-on experiential learning on theoretical topics covered in the Namibian school curriculum. EduVentures has collaborated with WPI since 2009 with a total of 20 students participated.

After the experience of the EduMobile project, EduVentures is currently working on the EduLink project. The aim of this project is to equip teachers with pedagogical content knowledge, so as to enable cross-curricular teaching of ESD through hands-on learning using real life examples. The project proposes an educational model for strengthening the implementation of EE/ESD in schools in Namibia. The model is based on the principle of a multiplier effect by advocating three tiers of training, namely ESD Educator training, teacher training, and primary and secondary school learner education. EduLink satisfies all five Priority Action Areas as set out in the recently launched Roadmap for Implementing the Global Action Programme (GAP) on Education for Sustainable Development of UNESCO. The model itself is neither target nor discipline specific; it can be adapted for different countries and needs.

Project description

The here proposed ESD Network model focuses on developing teacher skills. The model focuses on the training for ESD Educators, who in turn train teachers. Strategically located ESD Centres will be established country wide (**Error! Reference source not found.** 1). These will serve as centres of excellence for knowledge transfer and capacity building. At each ESD Centre a 'smart classroom' will be developed to serve as a nucleus where ESD Educators and teachers are trained in, and contribute towards, EE/ESD concepts and training techniques.

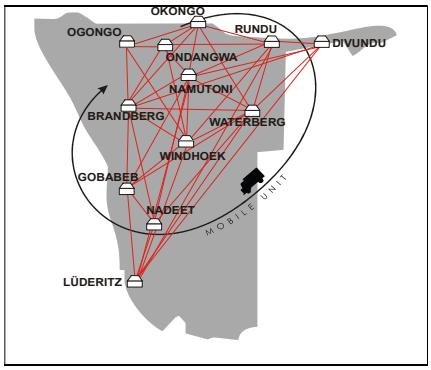


FIG 1: PROPOSED ESD NETWORK MODEL

ESD Centres will be connected to each other, and to an e-tutor group to form a web-based learning environment, or virtual classroom (Fig. 2). Such an e-learning platform will allow participants to work through web based training modules at their own pace, while the virtual classroom environment will facilitate interaction between the participants (e.g., discussion of ideas, reciprocal assistance), and between the participants and the e-tutors. This can be done through, for example, an interactive whiteboard, text-chat, audio - or video conferencing, discussion forums, and resource and application sharing.

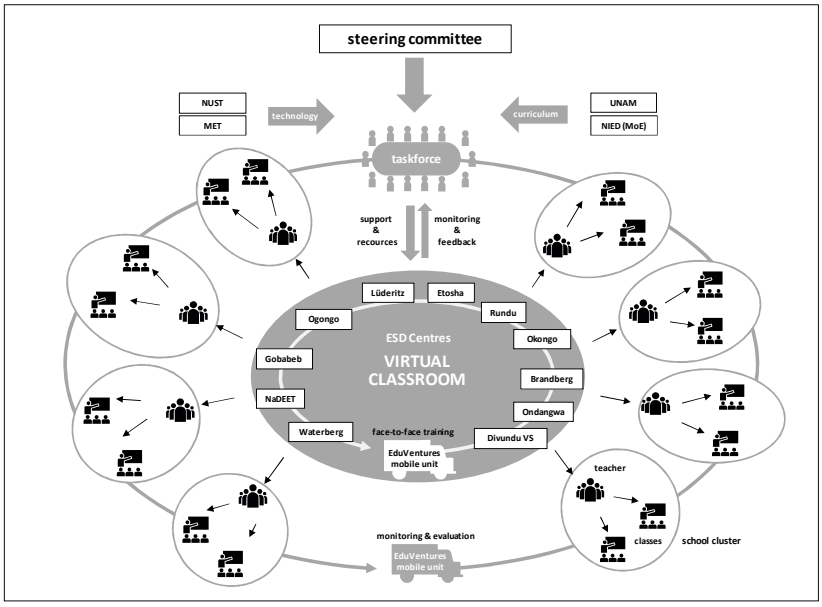
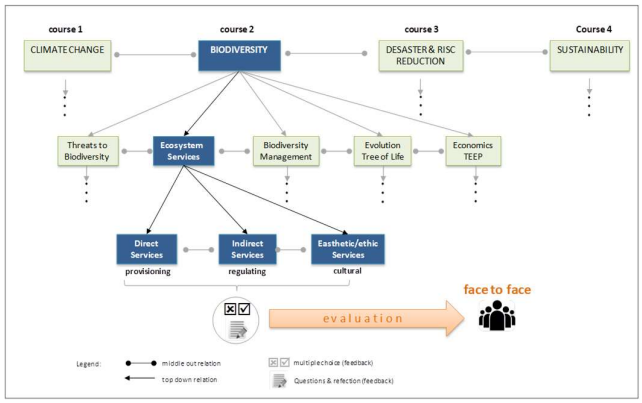


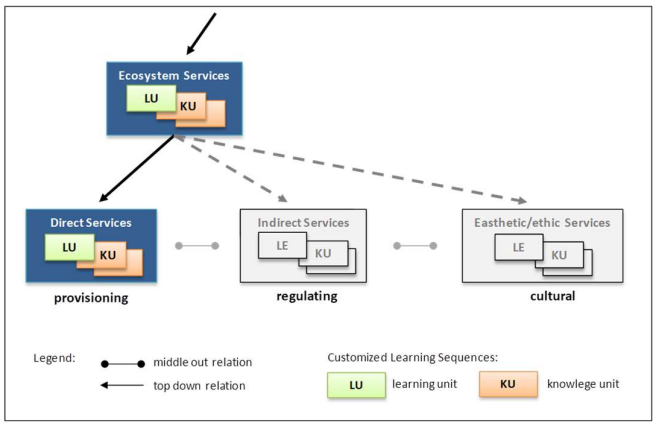
FIG 2: PROPOSED WEB-BASED LEARNING ENVIRONMENT

In addition, a group of student from WPI will be working on the development of a Learning Management System for the proposed E-learning platform. However, there is a need to develop modules for training of educators at EE centres and modules that for training of teachers by the educators. Therefore the present request is for students to develop modules to be used by to train educators at EE centres. The same modules will be used by educators to transfer knowledge to teachers. These modules should be Namibia specific and linked to the National School Curriculum so as to target the implementation of ESD in the schools.

Furthermore, Namibia has a lot of literature and educational materials available. However, most of the materials are not harmonised with the school curriculum and are repetitive at times. Therefore, it is necessary to use these materials and harmonise them with the school curriculum.



Didactic course design of WBT



LEARNING UNIT AND KNOWLEDGE UNIT OF DIRECT SERVICES

Some of the educational materials that exist in Namibia

Project Objectives

Primary objective

1. Develop four WBT modules to be used to give instructions to educators at EE centres which have to transfer to teachers when they are training teachers.

Supporting objectives

1. Assist in determining content for modules to be developed.
2. Develop 4 WBT modules as guidelines for related SMART lessons
3. Upload the course modules on the e-learning platform developed by the current WPI group.

Project outputs

1. Content for the project
   - What to teach the Educators?
   - What existing information can be used?
   - Content should be Namibia specific (Usage of local examples)
2. Collection of resources for educators / teachers (didactic methods, pedagogical tools and in class activities)
3. **Development of 4 course modules and SMART lessons for the e-learning platform.**

Skills required from the students

1. Extensive computer skills including software programs such as Smart notebook, , Adobe captivate and more.
2. Extensive skills on environmental issues such as biodiversity functioning, sustainability science, climate change and Renewable Energy.
3. Knowledge about teaching practices, organizational methods and didactic methodologies
4. Creative designing and artistic skills.
5. Ability to work in a team, adaptability and willing to work extra hours.
6. Respect for cultures and humanity

Appendix C: 12 Principles of Multimedia Learning

1. **Coherence Principle**
   - People learn better when extraneous words, pictures and sounds are excluded rather than included

2. **Signaling Principle**
   - People learn better when cues that highlight the organization of the essential material are added

3. **Redundancy Principle**
   - People learn better from graphics and narration than from graphics, narration and on-screen text

4. **Spatial Contiguity Principle**
   - People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen

5. **Temporal Contiguity Principle**
   - People learn better when corresponding words and pictures are presented simultaneously rather than successively

6. **Segmenting Principle**
   - People learn better from a multimedia lesson presented in user-paced segments rather than as a continuous unit

7. **Pre-training Principle**
   - People learn better from a multimedia lesson when they know the names and characteristics of the main concepts

8. **Modality Principle**
   - People learn better from graphics and narrations than from animation and on-screen text

9. **Multimedia Principle**
   - People learn better from words and pictures than from words alone

10. **Personalization Principle**
    - People learn better from multimedia lessons when words are in conversational style rather than in formal style

11. Voice Principle

- People learn better when the narration in multimedia lessons is spoken in a friendly human voice rather than a machine voice

12. Image Principle

- People do not necessarily learn better from a multimedia lesson when the speaker's image is added to the screen

Appendix D: EduVentures Staff Interviews

Prior to interview, we will inquire about recording the interview.

Introduction

Interviewer: "As previously stated, to facilitate our note taking, we would like to audio tape our conversations today, is that still okay with you? After the interview has been performed and the recording has been transcribed, we will send you the transcription to ensure that you approve of the specifics from the interview. For your understanding, only our project group and advisors will have access to the recordings, and names connected to information will be changed if you would like."

The following questions will be asked to each of the EduVentures staff members specified in 3.1.1.

1. Could you please provide us with a brief overview of your background with EduVentures, such as how long have you worked here, and what your specific role is?
2. How are teachers with whom EduVentures works currently trained?
3. What do you see as the biggest problem that you would like the online learning modules to solve for EduVentures?
4. Why do you feel that the implementation of online learning modules by EduVentures will help facilitate communication amongst teachers and teacher trainers?
5. Do you have any specific content of online learning modules in mind that you know you would like EduVentures's modules to have?
6. Of this content, what do you see as most important for EduVentures' programs?
7. How do you feel the teachers and teacher trainers current attitudes are towards the implementation of online learning modules? Are they excited about having online learning modules in the future? Will they be looking forward to learning how to use them in their everyday teaching practices?
8. Have you ever used or been exposed to online learning before?
9. How do you see the students benefiting from the use of online learning modules by their teachers?
10. Is there anything specific you would like us to know about EduVentures in general, or about something we may have not touched on in the previous questions?

Conclusion

Interviewer: "Thank you very much for your time and insight, it is greatly appreciated. We will provide you with the interview transcription as soon as it is available."

Appendix E: Ontanda Survey

Current Practices Survey

25 August 2018

Name (optional): _____

The purpose of this survey is to gather information about your experience as an educator and what methods you have found successful or unsuccessful in the past. This information will help us provide suggestions and tools to help your experience as an educator in the future. To assist us in the most efficient way, please answer these questions as honestly and with as much detail as possible. Thank you :)

1. How long have you been an educator? What ESD Center do you teach in? (Ontanda, Windhoek, NaDEET, etc.) Please provide any other background information you think may be applicable.

2. How were you trained to be an educator? How did you get started as an educator?

3. What does a typical day look like as an educator? Do you teach face-to-face or in a different way? Please explain.

4. What type of content do you currently teach teachers? Where does this content come from?

5. How do you present this information? (online, face-to-face, radio, etc.)

6. Do you currently have a way to assess if your audience is retaining the information you provide them? If so, what is it? If not, what are some ideas that you think would work well?

7. Is there anything specific you would like us to know about EE centers or being an educator in general, or about something we may have not touched on in the previous questions?

Appendix F: EduVentures Outline for Biodiversity Topics

Outline of Biodiversity Lesson

1. What is Biodiversity
    a. What is Life in the first place?
    b. How did life originate?
    c. The basics of cells and origin of life
2. Types of Biodiversity
    a. General Biodiversity introduction
    b. Genetic
    c. Species
    d. Ecosystem
    e. Functional diversity
3. Ecosystem services
    a. Provisioning services
    b. Supporting services
    c. Regulatory services
    d. Cultural services
4. Measuring Biodiversity
    a. Collecting and preserving
    b. Identification
    c. Reporting
5. Threats to Biodiversity
    a. Extinction process
    b. Ecosystem degradation
    c. Exotic species
6. Maintaining Biodiversity
    a. Managing Biodiversity
    b. In situ and ex situ conservation
    c. Setting priorities
7. Practical ways to teach Biodiversity
    a. Examples and activities

Appendix G: Content Analysis

We used the words below perform a content analysis on syllabi, national curricula, teacher lesson plans, EduVenture modules, etc. This aided our project to find what was already being taught so we could build upon that.

WORD
Biodiversity
Cells
Conservation
Cultural
Degradation
Ecosystem
Endemic
Exotic
Extinction
Genetic
Identification
Organism
Prevention
Provisioning
Regulatory
Species
Supporting

Appendix H: Observation Rubric

Observers: Laura Boccio, Will Gaddis, Ajay Manohar, and Kylie Smith

	# of Teachers to Exhibit Behavior		
Observation	***Types of Biodiversity***	***Ecosystem Services***	***Threats to Biodiversity***
Total Number of Educators	***7***	***9***	***8***
Positive Observations			
Took Notes	*1*	*5*	*4*
Used PDFs	*3*	*7*	*6*
Read through the notes tab	*4*	*4*	*2*
Worked collaboratively on module	*2*	*2*	*0*
Used flashcards	*3*	*2*	*1*
Asked question	*2*	*2*	*3*
Negative Observations			
Engaging in side conversations	*2*	*2*	*0*
Skipped to games tab	*2*	*1*	*3*
Distracted in unrelated activities	*3*	*6*	*3*
Demonstrated confusion	*1*	*2*	*1*

Appendix I: Pre and Post Assessment

Pre and Post Assessment

We used the following assessment to evaluate the effectiveness of the modules we created. This gave us a means to recommend edits to the modules and gather feedback from the educators.

What is species diversity?

What are the 8 main threats to Namibia's biodiversity and environmental services?

What is the definition of biodiversity?

What is genetic diversity?

Choose one of the 8 main threats to Namibia's biodiversity, and explain it in depth. (why it is a threat, how it impacts Namibia, what can be done to fix it)

What is ecological diversity?

What are the 4 different ecosystem services?

Appendix J: Namibian Curricula Integration

With our content analysis, we determined places in Namibian curricula where biodiversity topics could be implemented. Below is a list of each syllabi that incorporates biodiversity topics as well as places that they can be elaborated on. The integration portion of this chart refers to which section of each syllabi biodiversity could be discussed. This information came from the National Institute of Educational Development (NIED) website: http://www.nied.edu.na

Namibian Higher Level Secondary School Curricula	
Syllabi	***Integration***
Art and Design (2013)	*environmental/architectural design, fashion, jewelry, product design*
Biology (2010)	*cells, conservation, evolution, living organisms, nutrition, organism and environment relationship*
Business Studies (2010)	*economic systems, product availability, regulation*
Design and Technology (2011)	*design and technology in society, materials, metal, plastics, wood*
Economics (2010)	*economic scarcity, living standards, resources*
English-FL (2009)	*active listening, critical reading, comprehension, continuous writing, presentations*
Geography (2009)	*agriculture, climate, economic activities, environmental risks, physical world, tourism, water resources, weather*
History (2010)	*imperialism, international relations, the United States*
Physical Science (2009)	*environmental chemistry, sources of energy, uses of metals*
Namibian Ordinary Level Secondary School Curricula	
Syllabi	***How to Integrate***
Agriculture (2010)	*crop husbandry, general agriculture, livestock husbandry*
Art and Design (2018)	*environmental/architectural design, fashion, jewelry, product design*

Biology (2009)	*cells, conservation, evolution, living organisms, nutrition, organism and environment relationship*
Business Studies (2009)	*economic systems, product availability, regulation*
Design and Technology (2018)	*design and technology in society, materials, metal, plastics, wood*
Development Studies (2009)	*Development, health, industrialization, rural development, urbanization*
Economics (2009)	*economic scarcity, living standards, resources*
English-FL (2009)	*active listening, critical reading, comprehension, continuous writing, presentations*
Entrepreneurship (2013)	*ethical behavior, idea generator*
Geography (2009)	*agriculture, climate, economic activities, environmental risks, physical world, tourism, water resources, weather*
History (2010)	*imperialism, international relations, the United States*
Physical Science (2009)	*environmental chemistry, sources of energy, uses of metals*

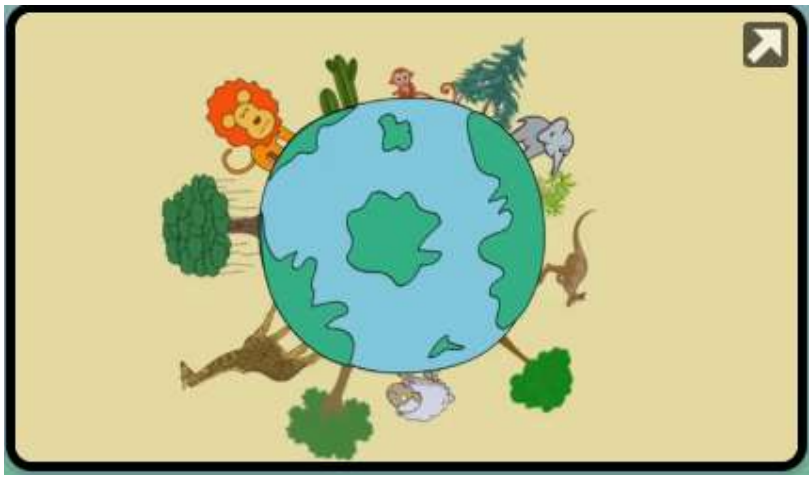
Appendix K: Types of Biodiversity Module Content

Types of Biodiversity Module

BookWidgets short code: FE39SQ

This Module will cover the different types of Biodiversity that exist, and will provide strategies for conveying this information to Namibian Teachers at your respective EE Centers.

To get you started, we have provided a brief video introducing Biodiversity and its different forms.



Video short code: QE4LS3

Biodiversity

In simple terms the word **BIODIVERSITY** can be described as the variety of all living things; including plants, animals, microorganisms (species) and their interrelationships in the places they live (their ecosystem). Life on earth is so diverse and complex, that we must understand how to organize and observe the way our world and its inhabitants are structured.

Structure and Function

The definition of biodiversity provided above emphasizes **STRUCTURE** - forms of life and levels of organization - as well as evolutionary **FUNCTIONS** or processes among those forms of life and their environment.

The diversity of ecological functions is enormous. Each of the earth's millions of species interacts with many other species through ecological processes such as:

-competition

-predation

-parasitism

-mutualism

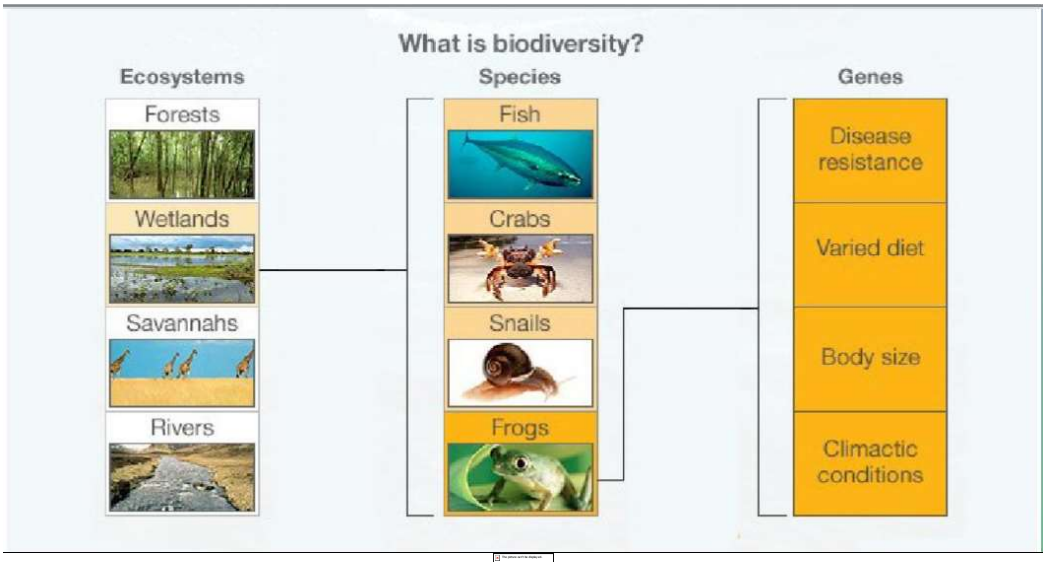
Additionally, every species interacts with its physical environment through processes that exchange energy and elements between the living and nonliving world such as:

-photosynthesis

-biogeochemical cycling

-respiration

The diversity of evolutionary functions includes all these ecological processes because they are key elements of natural selection, in addition to processes such as genetic mutation that shape each species' genetic diversity.



Species, Genes, and Ecosystems

It is easiest to comprehend the idea of maintaining biodiversity in terms of species that are threatened with extinction. When a species becomes extinct in an ecosystem, its part in maintaining the structural and functional balance of the ecosystem is lost as well. This then begins a domino effect that affects many other environmental function and processes, risking our earth of further damage. Many people can understand the concern around protecting species when discussing the extinction of large animals such as cheetahs, rhinos, and whales. However, it is harder to elicit concern for smaller, yet just as important, species such as insects, fungi, and mosses.

Species Diversity

The first type of biodiversity covered is Species Diversity.

SPECIES DIVERSITY refers to the variety and distribution of animals and plants within an ecosystem. A rich species diversity ensures that an ecosystem can carry out all functional processes that it should to benefit the environment and provide resources to us.

For a more in-dept exploration of species diversity, click the widget below:

PDF short code: TE2K7N

Namibia in Context: Species Diversity

To look at Species Diversity and how it specifically looks in Namibia, we are going to break down the mammals that live within our country. Currently, there are approximately 250 mammal species estimated to reside in Namibia. Of these, 14 mammals are considered endemic to Namibia. On first glance, this seems like a good amount of species richness and would suggest a good level of species diversity. However, the distribution of this species diversity is considerably uneven.

As you can see, besides in the Caprivi Strip and at Etosha, most of Namibia does not have a high species richness. Especially in the desert and southern half of the country, often there are no more than 3 or 4 mammals present in an ecosystem. Additionally, approximately 50% of Namibian mammals are considered as of conservation concern. Of that 50%, 36% are possible or probable threats categories and another 8% are given the definite threat category. Although these stats are not a tremendous issue right now, we must continue to monitor our species diversity as Namibia continues to develop and expands into our country's ecosystems.

Ecosystem Diversity

The second type of biodiversity covered is ecosystem diversity.

ECOSYSTEM DIVERSITY refers to the diversity of species in an ecosystem, and all the complex interactions those communities have with each other and with their environmental factors and variables. Ecosystems are crucial building blocks for the different biomes of our globe, and the more complex the ecosystem means a healthier globe.

For a more in-depth exploration of ecosystem diversity, click the link below:

PDF short code: PE2K9Q

Namibia in Context: Ecological Diversity

Namibia has four main Ecosystems/Biomes. They are categorized and separated based on the dominant and co-dominant vegetation in the region and often line up aridity and seasonal rainfall. The four ecosystems of Namibia are Desert, Nam-Karoo, Succulent Karoo, and Savanna. The distributions of the ecosystems are shown in the figure below:

The Desert ecosystem is described by its lack of rainfall (less than 100mm annually) and surface water. It has sparse vegetation that is mainly grasses and small shrubs. There is high diversity among habitats in the desert ecosystem, with mountains, gravel plains, sandy beaches, and steppes. Coastal fog and oases formed by ephemeral rivers are crucial to supporting life in this climate. Systems within the desert biome are extremely fragile, and subtle changes in the environment, especially prolonged droughts, could cause long-term degradation with long recovery periods.

The Karoo ecosystems are described by low rainfall between 100-200mm annually. Vegetation is dominated by small shrubs, or "Karoo bushes," and has relatively poor species diversity. It can host vast herds of small mammals, like springbok, but hunting has limited the amount of animals prevalent. Karoo ecosystems are very sensitive to over-grazing and droughts which can lead to desertification.

The Savanna ecosystem has more rainfall than the other Namibian biomes, ranging from 250-700mm per year, with rainfall increasing the close you get to the Caprivi strip. This is where more trees begin to appear in the vegetation, especially Acadia and deciduous trees. The Savanna ecosystem has very high species diversity, and is home to most of Namibia's famous large mammals. It also contains most of the headwaters of Namibia's temporary rivers. Savanna is mainly at risk of over-use by locals as well as forest fires.

Genetic Diversity

The third type of biodiversity covered is genetic diversity.

GENETIC DIVERSITY refers to the genetic variation of species in a community. Genes determine the appearance and attributes of an organism. Communities with a large genetic variation are more prepared to withstand environmental pressures than a community with all individuals having very similar genetics.

For a more in-depth exploration of genetic diversity, click the link below:

PDF short code: CE2LDW

Namibia in Context: Genetic Diversity

Genetic Diversity in Namibia is the least studied and well known of the three types of biodiversity. Hardly any genetic information is known about Namibia's microorganism and plant life. Local food crops are one of Namibia's highest genetically diverse sources. Crops from indigenous farmers in northern Namibia have a large variety among different provided crops. This is different from many imported crops from around the world, mainly maize and rice, which have such little variety due to the industrialization of most large-scale corn and rice farms.

Wild animals genetic diversity is also relatively unknown in Namibia. However, with recent studies, many species are shown to have low variety. Especially among predators, species such as lions and cheetahs have especially low genetic variety and are at high risk to depletion from a disease or other change. Cheetahs, especially, are famously similar in species. It may be due to hunting style or population bottleneck, but cheetah populations must be carefully monitored.

Another issue Namibia has with genetic diversity is the introduction of new species. For example, the black-faced impala is a rare, unique type of impala endemic to northwest Namibia. Farmers, because it is cheaper and easier, have been bringing in stock common impala onto farmers in black-faced impala territory. These new impala are breeding with the local black-face, and thus mixing the genetics of the two types and reducing the amount of already rare black-faced impalas. This process is considered "polluting" the genetic pool of the black-faced impala. The effects of the farmers were obviously not intentional, but understanding the risks of species importation can help us predict biodiversity trends that may occur in the future.

Games

To practice what you have learned about species diversity, complete the following crossword:

Crossword short code: TEZ3B3

To further explore genetic diversity, click the following image to visually explore the genetic variety among toucans in the rain forest:

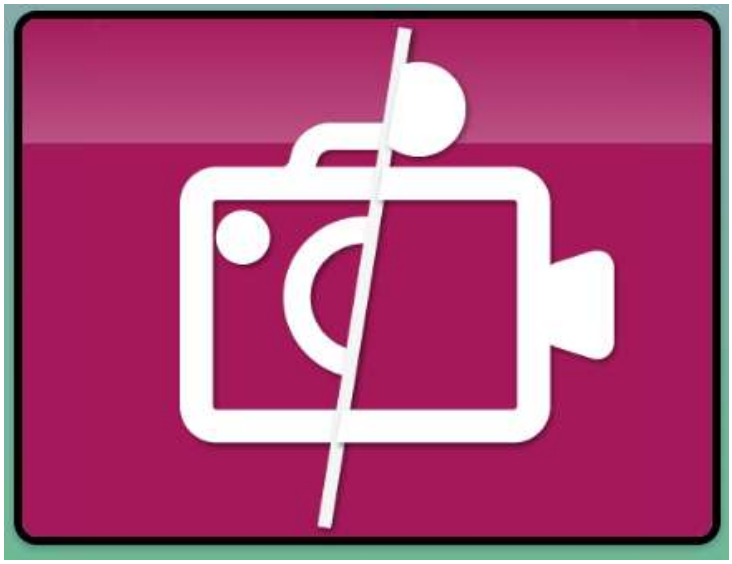


Image exploration short code: UE2YEZ

Teaching Styles

Blended Learning

Blended Learning is a term increasingly used to describe the way e-learning is being combined with traditional classroom methods and independent study to create a new, hybrid teaching methodology. This method can be utilized in the classroom through online modules or SMART lessons.

Micro Learning

Micro Learning is the learning strategy that delivers content to learners in short, focused, and easily digestible learning segments. This can be accomplished through short SMART lessons that give students the needed information. They can then focus on applying their new knowledge in games and activities that keep them engaged.

Possible Activities

Jeopardy

Provided in the Google Classroom is a template on book widgets for a jeopardy game. Jeopardy allows students to learn from each other while also maintaining an engaging environment.

How do Animals Shape their Surroundings?

Go outside and look at ways animals and plants have had an impact on their environment. Some examples to look for are termite mounds, large trees that provide shade, and random

patches of vegetation. Talk about each in turn and discuss how one organism could affect a chain of other things.

King Phillip Came Over For Ginger Snacks

Each student can choose an animal or plant that they have to research. They will then look up that animals' kingdom, phylum, class, order, family, genus and species. They can compare with each other their findings and see where their animals diverge. Some animals are not very similar but are still classified in a similar way. Discuss findings after to find which animals are the most alike and which are the most different.

Exploring Your Local Environment

Take a brief 15-30 min walk around your schoolyard and other areas. Any animal, bug, or plant that you see, write it down. Return to class, and write all the species you found on the board. Have the learners discuss if they think the species richness is good or bad. Then, remove one or two species from the board, and have your learners discuss what effects on their life and ecosystem losing this animal may cause.

Practicing Genetic Diversity

Have a deck of cards, 1/3 of which are red, 1/3 of which are blue, and 1/3 of which are green. Randomly hand out these cards to each learner in your class. The learners do not need to be an even split among colors, randomness is good. Explain that all learners are an animal (ex: lion), and how each color represents an animal with different genes (ex: Red lions are immune to diseases, Blue lions can survive better in droughts, and green lions can eat a wider variety of prey.) then, come up with environmental disasters that will affect the different animals (ex: disease in food, drought,

or lack of food). For each issue, tell the learners with the colors that are not fit to adapt to the change "die" and fall over. The remaining students are the surviving population, and could be very small or large: showing the importance of genetic diversity to surviving potential extinctions.

An Outdoor Exercise Activity: Predator vs Prey

Break students up into prey and predators. Place hula hoops around a large area. These are "safe" places for prey animals to hide. Place "food" items around the area for the prey animals to eat. Assign certain students to be prey animals. The goal of the prey animals is to not get eaten and gather at least three food items. Predators will roam the area searching for prey. If the prey animal is tagged the predator has killed and eaten the prey. Predators need to tag at least two prey animals. Prey animals may go into the hula hoops to avoid the predators and communicate with other animals by making noise. A few random prey animals will be given black "plague cards." When these prey are tagged and killed, the predator also dies. When a prey learner collects three "food" items, they can go to the edge of the play area and re spawn a dead prey player. Play the game for 5 minutes, then assess how many predators and prey learners are left, and how balance is important for an ecosystem.

Case Studies

A great way to present information is through a case study. Providing a case study with local relevance will help students relate to different topics. This will, in turn, make it easier for students to learn the information. You can utilize a case study in a variety of

class subjects like English, history, or math to incorporate environmental education into the curricula. Here is an example of a case study that could be used:

"Genetic Diversity: The Cheetah"

About 12,000 years ago, a mass extinction event occurred that eliminated 75% of the world's large mammal species. Fortunately, a handful of cheetahs managed to survive this extreme extinction event and were able to restore the world's population of cheetahs.

This event caused an extreme reduction of the cheetah's genetic diversity, known as a population bottleneck, resulting in the physical homogeneity of today's cheetahs. Poor sperm quality, focal palatine erosion, susceptibility to the same infectious diseases, and kinked tails characteristic of the majority of the world's cheetahs are all ramifications of the low genetic diversity within the global cheetah population.

Suitable levels of genetic diversity are vital to a population's ability to adapt and overcome environmental changes and unexpected disasters. Unsustainable human expansion and consumption leads to more unstable environmental conditions, and when habitat is destroyed and fragmented, the rate of inbreeding increases, which leads to even more reduction in genetic diversity. The coupling of these factors increases the risk of environmental variability to the world's cheetah population. Therefore, ensuring that the low levels of genetic diversity in the world's cheetah population do not decrease further is vital to the survival of the cheetah.

Additional Resources

Books:

Biological Diversity in Namibia – a country study (Phoebe Barnard, 1998)

Fundamentals of Conservation Biology – second edition (Malcolm L. Hunter, 2002)

Websites:

http://www.biodiversity.ru/coastlearn/bio-eng/boxes/geneticdiv.html

To learn more about Biodiversity in general and suggested methods of teaching the subject, visit the following PDFs developed by UNESCO:

Part 1: What is Biodiversity: http://unesdoc.unesco.org/images/0024/002459/245981e.pdf

Part 2: Biodiversity Activities: http://unesdoc.unesco.org/images/0024/002459/245982e.pdf

Assessment

To practice and prepare for this section's assessment, feel free to use the following flash-card activity to see what you know and what you may need to go back and review.

Flashcards short code: 6EZ37U

To test how much you learned from this unit, take the following assessment quiz. Answer all questions to the best of your ability and take your time, there is no rush.

Educational assessment short code: GE23AE

To test your pedagogical thinking, please answer these two questions.

edagogical assessment short code: GE3X5N

Post-Module Activity

After completing the module, split up into three groups and assign one type of Biodiversity to each group. One has species, one has ecosystem, and one has genetic. Discuss what you learned about that type of diversity amongst yourselves and share experiences or thoughts about that type of diversity in Namibia. After 15-20 minutes of discussion, choose one representative of each group to briefly present what you discussed to the

Appendix L: Ecosystem Services Module Content

Ecosystem Services Module

BookWidgets short code: CE58D7

This module will cover Ecosystem Services, their importance to our environment, and how they relate to biodiversity. To get started, we have provided a brief inroductory video introducing ecosystem services. You can access the video by clicking the image below:

Video short code: UE4NAD

Ecosystem Services

Ecosystem services can be defined as the many and varied benefits which people gain from the natural environment and properly-

-

functioning ecosystems. They are categorized into four different types: provisioning, regulating, supporting and cultural.

To dive deeper into ecosystem services and the many types of services provided by a biodiverse environment, click on the image below to learn from EduVentures' ecosystem services PDF.

PDF short code: ME6495

Click on each of the different types of ecosystem services on the left-hand side to learn more about them and see some examples.

Provisioning Services

Provisioning services are the natural and material products obtained directly from the ecosystem. They are often the most obvious benefits of our environment, and are relied on by many people, especially those in rural areas, for income as well as survival.

Some examples of provisioning services are food, freshwater, raw materials, and medicinal resources.

food from crops

Our Earth has the ability to produce a variety of food sources. This food can be game meat, seafood, fruits and vegetables, as well as other forms of vegetation. In order to ut animals hunt their prey and gather vegetation. The image to the right shows some of the food resources that can be grown, gathered, and consumed.

ria

Freshwater is a source of life. All living organisms need water to live. Therefore bodies of freshwater are ecosystems of their own and house a variety of organisms. Additionally, freshwater can be harvested to provide populations with drinking water as well as a source of energy with hydraulic power or the use of water to generate electricity. The image to the left shows one of the largest sources of freshwater in Southern Africa, Victoria Falls.

Our ecosystems provide a variety of different raw materials. Wood, rubber, and metals can be used for construction purposes to build up cities, towns, and

raw materials for construction

houses. Animal and plant byproducts such as wool, fiber, and bones can be used to make clothing and tools. There are also many other raw materials such as dyes, beads, shells, etc. that can serve a variety of decorative purpose. The image to the right shows some of the raw materials that can be found and used.

om herbs

The last type of provisioning services we will cover is medicinal resources. These often come from plants and herbs found in the surrounding ecosystem. The image to the left shows how these herbs can be combined for use in the medicinal field.

Regulating Services

Regulating services are defined as the benefits obtained from the regulation of ecosystem processes. They are often invisible and taken for granted, but when they are damaged the resulting losses can be substantial and difficult to restore.

Processes include maintaining the quality of air and soil, preventing disease and natural disasters, and pollinating crops.

night

Light pollution is a major concern in large cities. One of the most noticeable ways to see the level of light pollution in an area is through the visibility of stars in the sky. Many areas of Namibia have a very low light pollution which is excellent for the ecosystem. Therefore it is easy to see many stars, constellations, and even the Milky Way in areas such as the Namib Desert. This can be seen in the image to the left.

Additionally, disease and disaster spread throughout an area. This spread is often hard to notice until it affects an entire area or population. One example of disease spread is Malaria. It is transferred from person to person through the bitspread of Malaria pictured to the right. Although many areas of the world do not encounter Malaria, it is prevalent in parts of Namibia

.

Pollination is another regulating service that often goes unnoticed. However, without the pollination of plants, there amount of vegetation would be significantly decreased. Pollination occurs from the wind and through insects such as bees, pictured to the left.

Supporting Services

Supporting services are ecosystem services that are necessary for the production of all other ecosystem services.

Providing living spaces for plants or animals and maintaining a diversity of plants and animals are examples of supporting services.

Cape Cross seals

Etosha animal diversity

It is important to provide enough living space for plants and animals. In Cape Cross, there is a huge population of seals (pictured above). Because of this overpopulation, there is limited space for

these seals. This causes the seals to become aggressive and fight amongst each other.

Additionally, it is important to maintain the diversity of plants and animals. In Etosha, it is easy to see the diversity of animals at a watering hole. They all come together peacefully to indulge in the limited supply of water. This animal diversity can also be seen pictured above.

Cultural Services

Cultural Services are the non-material benefits people obtain from their ecosystems. Cultural services are deeply interconnected with each other and often connected to provisioning and regulating services.

They include aesthetic inspiration, cultural identity, appreciation of nature, recreation, and tourism.

Spitzkoppe rock formations

Kavango River in Rundu

Camel rides through the Desert

Nature is beautiful and complex and therefore has many cultural benefits. It inspires art, music, decor, and literature. It brings about a sense of unity in its ability to encompass an entire population or area. It evokes an appreciation because of its aesthetic and serenity. It can also result in recreation and tourism in an attempt to

further learn about the natural history of the planet. The photos above represent some of the natural wonders of Namibia.

Games

Practice your knowledge with any of the following games!

Crossword short code: 8E59WR

Word Search short code: AE6AH2

Teaching Styles

Blended Learning

Blended Learning is a term increasingly used to describe the way e-learning is being combined with traditional classroom methods

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and independent study to create a new, hybrid teaching methodology. This method can be utilized in the classroom through online modules or SMART lessons.

Micro Learning

Micro Learning is the learning strategy that delivers content to learners in short, focused, and easily digestible learning segments. This can be accomplished through short SMART lessons that give students the needed information. They can then focus on applying their new knowledge in games and activities that keep them engaged.

Where to Integrate?

Economics

Provisioning services can be incorporated into the senior secondary, ordinary and higher levels, Economics syllabi. Food and water can be considered when looking at limiting resources.

Geography

Regulating services can also be addressed in the senior secondary, ordinary level and higher level, Geography syllabi. Soil erosion and buffers against natural disasters can be brought up when talking about weathering processes.

Biology

Provisioning and supporting services can both be brought up within the senior secondary, ordinary and higher levels, Biology syllabi. Food as a provisioning service can be discussed when going through nutrients and diet while maintaining genetic diversity can be addressed when going over selection and evolution.

History

In the senior secondary, ordinary level, History syllabus, you can mention regulating and supporting services. For example, when explaining the impact of the Second World War on Africans, you can reference the environment.

Agriculture

Regulating Services such as erosion prevention, soil maintenance, and pollination could all be integrated into the senior secondary, ordinary level, Agriculture syllabus. These topics could be discussed in sections like "Environmental influences on agricultural practices" or "Crop Husbandry".

Art and Design

Cultural Services could be brought up in the senior secondary, ordinary level, Art and Design syllabus. Various product designs, jewelry, or fashion that are unique to Namibia could be discussed and made. Other cultural art could also be incorporated.

Possible Activities

Buckets

One example of an activity that can be done, either using technology or not, is sorting different items into their respective ecosystem service. Students can be provided a list of words or phrases which they then have "drop" into the correct services bin. If used as an online module, students can drag each word or phrase into the bin that categorizes it: provisioning, regulating, supporting, or cultural. If technology is not accessible, a teacher can write down

each word onto a piece of paper and have the students actually drop this paper each bucket.

Debate

Have students split into teams based off of each ecosystem service. Students will create a debate on why their service is the most important. Everyone will come together after and talk through the importance of each service.

Outdoor Activity

Take students outside and have them list the different ecosystem services that are around them.

Case Studies

Case Studies

A great way to present informtation is through a case study. Providing a case study with local relevance will help students relate to different topics. This will, in turn, make it easier for students to learn the information. You can utilize a case study in a variety of class subjects like english, history, or math to incorporate environmental education into the curricula. Here are some examples of case studies that could be used:

Overall Case Study

"The Neem Tree"

Wheat, corn, rice, potatoes-- many species of plants have profoundly important to the welfare of humanity. Indeed, some scholars have argued that one of the key defining events in western civilization was the hybridization, about ten thousand years ago in

the Middle East, of two species to produce a form of wheat amenable to cultivation. From an historical perspective, at least one animal might rival these plants in its value: the horse, backbone of early transportation, exploration, and too often, war. When we consider species in terms of the diversity of their instrumental values, not many species equal the neem tree, a member of the mahogany family from southern Asia.

The most remarkable thing about the neem is the myriad ways it is used as a health product.People use neem products to treat boils, burns, cholera, constipation, diabetes, heat rash indigestion, malaria, measles, nausea, parasites, pimples, rheumatism, scorpion stings, sleeplessness, snake bites, stomach aches, syphilis, tumors, and ulcers, and they drink neem as a general tonic. They clean their teeth with neem twigs and need-derived toothpaste and make a disinfectant soap with the oil of the neem seeds. Recent research suggests that neem products may provide the basis for a birth-control pill for men and as a spermicide.

These marvelous features may account for the spiritual importance of neem as well. It is considered sacred by many Hindus, and its leaves are hung in the doors of a house to ward off evil spirits and burnt as an incense to drive evil spirits out of anyone who inhales the smoke. Some Hindu holy men place neem twigs in their ears as a charm. The wood of the neem, attractive, strong, and durable, is one of the few types used for carving idols. Returning to secular uses, neem wood is also used for fuel, furniture, and house building; neem foliage and seeds are used as livestock fodder; and neem seed oil is used as lamp fuel and to make lubricants and disinfectants. Neem trees grow well on marginal sites, making them appropriate for reforestation, and they produce a deep shade that is especially

valued in hot climates. People place neem leaves in their cupboards, grain bins, beds, and books to repel insect pests. Various neem extracts are also effective as repellents and antifeedants for insects and nematodes that are agricultural pests.

The qualities of the neem are well known among millions of people in the Indian subcontinent: it is often called the "village pharmacy." It is being explored by foreigners as well.

Cultural Services Case Study

"Herero Traditional dress"

A well known Namibian traditional dress is the colorful gowns worn by Herero women, known in Herero as ohorokueva. Between 11 and 13m of material are used to make the full skirt of one of these dresses, along with even more cloth that is used for the many petticoats (ondoroko) worn with the dress. Three or four of these petticoats are usually worn, but in some cases women wear five or six. The style of these dresses is very Victorian, and was copied from the wives of Rhenish missionaries who came to Namibia in the early 19th century – a symbol of colonialism that has been incorporated into our tradition and cultural heritage. A complicated headdress, similar to a turban is worn to cover the head – in Herero tradition a woman's head is revealed only to her husband.

Before a Herero woman can don this dress, she must go through a ritual called okusanekua ovikaiva which is held at her home. During the ritual cattle are slaughtered, and the women is introduced to the sacred fire where a blessing is asked from the family's ancestors. Only women over 20 or who have children can go through this ritual.

In earlier times, Herero traditional dress was made from animal skins and ostrich beads. Herero women wore a leather headdress, now no longer used, called the ekori ro vakazendu. This leather helmet had a long fringe of iron beads that covered the back of the head and a tightly rolled leather trip that framed the face. Three leather points stood up on the top of the head.

Regulating Services Case Study

"Wastewater Treatment in Windhoek"

In this city, which suffers from chronic water shortage, Veolia and its partners have managed a wastewater plant since 2002. The facility recycles large volumes of wastewater in order to produce drinking water for nearly 300,000 inhabitants. Windhoek is one of the only cities in the world to recycle its water for domestic use, and the only one to do so on this scale.

The WINGOC (Windhoek Goreangab Operating Company) contract is a 20-year O&M contract signed in 2001 with the municipality of Windhoek, Namibia's capital. The project company's two partners are Veolia (67%) and Wabag (33%). Veolia is the majority holding company.

The project consists of a clean water treatment plant constructed in 2003. Clean water is produced from wastewater originating from the Goreangab Dam and the Gammam Reservoir, and is distributed to the city of Windhoek. The treatment process is very complex with a series of filtration (including a number of membrane stages) and ozonation stages.

This is a global benchmark, as around the world clean water is only produced from waste water in Windhoek and Singapore. In particular, reaching clean water standards is difficult in view of the level of pollution that enters.

Additional Resources

Websites

https://biodiversity.europa.eu/topics/ecosystem-services

PDFs

http://www.met.gov.na/files/downloads/698_Policy-Brief-3.pdf

Videos

https://www.youtube.com/watch?v=D6luBEJfi3s

Assessment

To practice and prepare for this section's assessment, feel free to use the following flash-card activity to see what you know and what you may need to go back and review.

Flashcards short code: 5E6DC9

To test how much you learned from this unit, take the following assessment quiz. Answer all questions to the best of your ability and take your time, there is no rush.

Educational assessment short code: QE65EU

To test your pedagogical thinking, please answer these two questions.

Pedagogical assessment short code: BE65J5

Appendix M: Threats to Biodiversity Content Module

Threats to Biodiversity Module

BookWidgets short code: VE8XZ8

This Module will cover the current threats that Biodiversity faces in Namibia. Biodiversity loss affects all people on earth, and losing our ecosystems limits the natural resources and services that we depend on for a high quality of life. Click the video below to be introduced to some threats our globe is facing before continuing on with the lesson.

Video short code: WE8V82

Threats to Biodiversity

Click on the link below to read more about the threats and consequences to biodiversity loss in Namibia..

-

PDF short code: AEZ29P

Biodiversity Loss

Biodiversity loss is a pertinent threat to our world. There are many services and values that can be lost forever if we do not protect the biodiversity that currently exists. Some of the services and values that the threats to biodiversity jeopardize include: (pictured)

- erosion control
- Medicines
- pest control
- pollination
- raw materials
- energy
- clean water
- environmental barriers
- food supply
- livelihoods

Threats to biodiversity have the ability to destroy the preservation and maintenance of these services and values.

Threats in Namibia

As previously discussed in the PDF, there are eight main threats to the biodiversity in Namibia. Among these are unsustainable land use, human wildlife conflict, unsustainable water use, uncontrolled mining, alien invasive species, increasing population and consumption, climate change, and tourism.

The identification of each of these threats is the first step in preventing them. There are conservation actions that can be put in place to preserve the biodiversity in Namibia. For example, limiting water use in the bathroom and kitchen can be one way to support the efforts combating unsustainable water use. Additionally, the government and local communities can set guidelines and restricitons on land use, wildlife conservation, mining, and tourism. By utilizing a collaborative approach, it is possible to fight against these threats to the surround ecosystems.

Games

Practice your knowledge with any of the following games!

Memory Game short code: 7EZ2RA

Crossword short code: 6EZZ8V

Teaching Styles

Blended Learning

Blended Learning is a term increasingly used to describe the way e-learning is being combined with traditional classroom methods and independent study to create a new, hybrid teaching methodology. This method can be utilized in the classroom through online modules or SMART lessons.

Micro Learning

Micro Learning is the learning strategy that delivers content to learners in short, focused, and easily digestible learning segments. This can be accomplished through short SMART lessons that give students the needed information. They can then focus on applying their new knowledge in games and activities that keep them engaged.

Where to Integrate?

Biology

In the higher and ordinary level of biology, topics like conservation and damage to the environment can be discussed when going over human influences on the ecosystem.

Possible Activities

Skit

Students can act out different kinds of threats to biodiversity like deforestation, poaching or climate change. Have students come up with their own scripts that accurately depict different threats. The skits should show the problem and then possible solutions to this problem.

Case Studies

Case Studies

A great way to present information is through a case study. Providing a case study with local relevance will help students relate to different topics. This will, in turn, make it easier for students to learn the information. You can utilize a case study in a variety of class subjects like English, history, or math to incorporate environmental education into the curricula. Here are some examples of case studies that could be used:

Threats to Biodiversity

Threats to ecosystems and species have been partially assessed, although since earlier work undertaken in 2002, a systematic assessment of such threats has not been updated during the reporting period. Among the identified key threats to biodiversity are: (1) unsustainable water uses, (2) climate change, (3) uncontrolled mining and prospecting, (4) continued population growth and increased consumption patterns, (5) unsustainable land management practices, (6) alien invasive species, (7) some poorly

directed tourism and recreation activities, and (8) human wildlife conflict. Several project and policy interventions are underway in Namibia to address these threats. Notably, dedicated projects strengthening Namibia's capacity to deal with climate change and land management are underway, and human wildlife conflicts are being managed proactively by the MET through the framework of National Policy on Human Wildlife Conflict Management, which was approved in 2009. Alien invasive species are currently not very aggressively managed, although policy instruments are partially in place controlling imports of exotic animal and plant species. Tourism and Recreation are generally considered to make positive contributions to biodiversity conservation in Namibia. It has however been observed that certain irresponsible tourism activities can have negative impacts on natural resources including biodiversity, and that uninformed and uncontrolled tourism can lead to vandalism in protected areas and the disturbance of protected species.

Black-faced Impala (Aepyceros melampus petersi)

The black-faced impala is an arid-adapted antelope endemic to Namibia with great ecological and economic value. It is classified in the IUCN Red Data Book as vulnerable with a population of less than 4,000 in the wild (Matson 2007). A management strategy for black-faced impala has been drafted aiming to enhance the distribution and abundance of the species in Namibia. The vision of the management plan is to re-establish black-faced impala as a distinct, valuable subspecies in viable breeding populations in Namibia. It also recommends the removal of common impala and hybrids from the core area as hybridization is a real threat to maintaining the genetic integrity of the black-faced impala. As part of this management plan, the black-faced impala have been translocated to five conservancies in their former range.

Damara Tern (Sterna balanaerum)

The Damara Tern is an endemic bird species to Namibia, which breeds along the harsh coastal zone. It breeds in the Namib dune belts, salt pans and gravel plains in summer time and its offspring are particularly vulnerable to predators, popular tourism activities such as quad biking and off-road driving, as well as habitat destruction through increasing mining activities. However a programme initiated to create awareness of the dwindling numbers of Damara terns has led to concrete action aimed at protecting the threatened breeding sites of the bird. The following successes have been achieved:

Breeding areas of the Damara Tern in the dune belt have been fenced off and people (and quad bikes) have been prohibited from entering the areas

Namdeb funded a two year monitoring project on the impacts of diamond mining on the breeding productivity of the Damara Tern within the Sperrgebiet

Over 2000 individual terns have been ringed to inform researchers on migration patterns, whether pairs are monogamous and whether they come back to breed in the same areas amongst others (Braby 2009)

Climate Change

Given Namibia's extreme vulnerability to climate change, a number of studies have been produced in recent years both independently and as part of Namibia's Second National Communication (SNC) to the United Nations Framework Convention on Climate Change. Of most relevance to biodiversity conservation have been studies on "Farming Systems Change to Enable Adaptation to Climate Change" (UNAM 2008); "Sea-level rise in Namibia's Coastal Towns and Wetlands: Projected Impacts and Recommended Adaptation Strategies" (Consulting Services Africa 2009); and a more recent study facilitated by the SPAN project entitled "Climate

Change Vulnerability and Adaptation Assessment for Namibia's Biodiversity and Protected Area System''.

The first study assessed research needs on farming systems change in Namibia to enable adaptation to climate change. It used a modelling approach to assess the impact of climate change on various types of agricultural practices and identified a number of possible adaptation strategies for Namibian farmers to pursue such as conservation farming, water harvesting technologies and improved crop varieties among others. The paper calls for long-term research and development and investment in breeding, biotechnology and seed technology programmes, particularly in relation to indigenous livestock and plant breeds. The selection and multiplication of crops with high tolerance to abiotic stresses has the potential to harness genetic variability in crop varieties and contribute to agricultural productivity and food security in the face of climate change.

The second study analysed another aspect of climate change that is likely to have far-reaching effects on Namibia's biodiversity, namely that of sea level rise. A rise in mean sea level rise is projected to slowly inundate wetlands and lowlands, which will cause an increase in the salinity of estuaries and aquifers. This is a major threat for biodiversity in coastal areas and wetlands as these provide spawning and nursery grounds for many fish species. Increased salinity in these areas is likely to lead to the decimation of organisms that are not resistant to the highly saline environment. This in turn could affect shore birds that rely on these organisms for foraging habitat during their migration and nesting sites in the coastal wetlands (Consulting Services Africa 2009).

The third study offers a more explicit insight into how climate change is likely to impact upon biodiversity in terms of species distribution, composition and migration. The following predictions were made:

- Greatest loss of plant species is expected to be felt in the central, northern and eastern areas
- The distribution range of 7% of plant species may move out of Namibia; 52% of species may experience range contraction; while 41% will expand their ranges
- Wildlife grazers are to decline on average by 13% by 2050 and by about 24% by 2080
- None of the ranges of plains game species are likely to move out of any of the national parks
- Springbok and gemsbok are likely to expand their ranges to the Bwabwata National Park
- Human wildlife conflict may increase due to pressure on habitats (SAIEA in press)

The study concludes that an improved management approach over natural resources and rangelands, which facilitates the mobility of plains game species, is key in this context. It is recommended to build on Namibia's CBNRM programme and to extend the coverage of community and private conservation areas further into areas threatened by biodiversity loss (SAIEA in press).

Additional Resources

Website

https://www.cbd.int/doc/world/na/na-nr-04-en.pdf: This site has a lot of great examples of case studies relevant to many different areas in Namibia. It also provides an in depth background of current threats to biodiversity and biodiversity as a whole in regards to Namibia.

Assessment

To practice and prepare for this section's assessment, feel free to use the following flash-card activity to see what you know and what you may need to go back and review.

Flashcards short code: SE8YBY

To test how much you learned from this unit, take the following assessment quiz. Answer all questions to the best of your ability and take your time, there is no rush.

Educational assessment short code: DE9U4P

Appendix N: Types of Biodiversity Interview (I)

Interviewee: Pandu

10/1/2018

Members in attendance:

Laura Boccio, *Interviewer*

Ajay Manohar, *Interviewer*

Pandu, *NaDeet ESD Educator, Interviewee*

Interview began after Types of Biodiversity Module was complete

What parts of the module were the most useful?

Most of the content was useful and relevant.
The SMART technology is something the educators already have experience with. The software used in these modules (Bookwidgets) seems hard to learn and therefore will be difficult when educators try to make their own modules.

What did you think of the content of the module?

The final version should have only Namibia specific material and examples. The birds should be something different that better relates to Namibia. "The birds, it has to be Namibia"

For future use, what would you change?

In a group of teachers/learners, activities are very useful to get the audience engaged.
The educators will develop more content evaluations.

What did you learn from the module?

"Well. . I learned"
"Functional biodiversity. I did not know that" He said that there were topics not covered in his university education or by standardized tests. Therefore, he said the information was helpful and that he was able to learn from it. Pandu said that the information was a good refresher from the information taught in the schools he attended in Namibia.

What is your background as an educator?

He attended the University of Namibia and studied environmental sciences. He was a teacher previously in a rural, remote, government school in Northern Namibia teaching upper primary first and junior secondary first education. He now does natural resource accounting.

Appendix O: Types of Biodiversity Interview (II)

Interviewee: Viktoria

10/1/2018

Members in attendance:

Laura Boccio, *Interviewer*

Ajay Manohar, *Interviewer*

Viktoria, *NaDeet ESD Educator, Interviewee*

Interview began after Types of Biodiversity Module was complete

What is your background as an educator?

Vicki has two bachelor's degrees. One is in nature management at NUST where she spent two and a half years at an internship at the NaDeet ESD center teaching teachers (35+) in communities about sustainability. She then studied environmental sciences and sustainable technologies at Avans University of Applied Sciences in the Netherlands this past summer. Now she is managing the NaDeet education center and will be the lead person regarding the implementation of these modules.

If you were to make a module, how would you structure it?

Vicki said she would create more of a hands-on focus rather than having so much individual work on an online module that seems boring. She wants the teachers to stay engaged. She was very interested during the presentation of the module in how to make modules of her own. She wants to make them as interactive or "boring" as she pleases. Additionally, since NaDeet is one center without any internet connection, she would like the ability to download the modules. This way, using the only computer and the SMART board, the modules could be more effective and you could prevent the SMART board from becoming just "an expensive whiteboard."

What are some problems you see arising when implementing these modules at your center?

The biggest problem with these modules is the need for internet. Overall, EduVentures faces challenges when implementing internet. At NaDeet specifically, the remote location is intentional. It is set back from the main office to remove distractions and create a remote, removed, disconnected environment where the focus is only on environmental education.

Appendix P: Types of Biodiversity Focus Group

Members in attendance:

Laura Boccio, *Interviewer*

Ajay Manohar, *Interviewer*

Viktoria, *Interviewee*

Vilho, *Interviewee*

Lee, *Interviewee*

Interview began after Types of Biodiversity Module was complete

What were your thoughts on the module?

Vilho said it takes a little while to familiarize yourself with the equipment and get comfortable with the software. He is used to the information being presented in different ways, such as books and websites, so this method of learning takes a little getting used to.

Lee said she learned a lot and that it seemed like a refresher from her University studies. She would have liked to see more marine information applied to biodiversity, regardless of the fact that ocean literacy will be a module in the future. She liked that it was "class based" because teachers are often not told to think outside the box or beyond the books. They are expected to memorize an answer and repeat it for a test question. The "class based" method of learning sparks a move away from this "parenting" style of learning.

What could be changed about the module?

There needs to be many more examples, which can be added when educators edit the module themselves. Vilho liked the idea of being able to use your own pictures that you took at local places (Etosha watering hole, etc.) Lee liked the quality of the toucan picture where you can click on each toucan an learn more. However, they would prefer this to be an image to be a Namibian example. Also, Vilho did not realize you can click on different spots on the image to find out more about each toucan.

Vicki would like the modules to have the ability to be put on a USB. This would allow for them to be given to teachers as resources. Even if they are in PDF format or converted to screenshots or word documents they would serve as a guide for teachers to adapt to their classroom. Therefore, future modules would hopefully come with this teacher guide.

What would you remove from the module?

Vicki said that there is nothing to remove until she sees how the rest of the week and the modules come together. But she would base her removal on repetitive information.

Appendix Q: Ecosystem Services Focus Group

Members in attendance:

Laura Boccio, *Interviewer*

Will Gaddis, *Interviewer*

Ajay Manohar, *Interviewer*

Kylie Smith, *Interviewer*

Educators, *Interviewees*

Interview began after Ecosystem Services Module was complete

We held a group discussion with all the educators to gather feedback on the Ecosystem services module and gauge the effectiveness and interest. Some of the feedback we received includes:

- The educators wanted to see the quizzes give the correct answers after completion.
- Regarding games:
  - The games need more instructions, especially Hangman
  - Some educators focused on different parts. One spent too much time on the games and not enough time on the content.
  - Wordsearch could use hints to prevent people from spending to much time on it.
  - Hangman could use pictures for each word that serve as a hint and just make it more aesthetically pleasing.
  - The information in each games was the same which created a very repetitive feeling.
- Regarding content:
  - Some of the wording was confusing (pest control doesn't use predators)
  - The notes were fair - not too repetitive. They liked how everything was aligned. It was the right level of challenging.
  - The information in the PDFs go through the same information as the notes tabs. Since it goes more in depth in the PDF, all the information is still relevant so it's okay to leave it as it is.
  - They loved the Namibia relevant examples in the notes tabs.
  - The examples were a good starting point that teachers could add to.
  - All pictures should be localized, even in the PDFs.
  - The introductory video should be Namibia specific.
- Regarding Format:
  - We suggested putting the games throughout the notes tabs rather than in a separate games tab. The educators liked this idea and agreed that it would make the flow better, more interactive, and less mundane.
  - The educators would like to see the additional resources websites be hyperlinks to make it easier to access these materials.
  - The PDFs were awesome.
- The module would serve as a good guide for teachers, especially if it could be available offline. Or if it could be converted to a PDF or word document to be put on a USB.

We should determine the average amount of time for each part of the module and give that as a suggested amount of time (written on the module). This would prevent people from spending an excessive amount of time on any one part.

Appendix R: Threats to Biodiversity Focus Group

Members in attendance:

Laura Boccio, *Interviewer*

Will Gaddis, *Interviewer*

Ajay Manohar, *Interviewer*

Kylie Smith, *Interviewer*

Educators, *Interviewees*

Interview began after Threats to Biodiversity Module was complete

We held a two small group discussions with the educators. Ajay and Will met with half of the educators while Laura and Kylie met with the other half. The purpose was to gather feedback on the Threats to Biodiversity module and the summation of the three modules as a series. Our observations included:

- Having a time limit helped educators gauge how much time they should spend on certain aspects of the module and prevented them from taking too much time on any one section
- Most educators skipped or did not complete the matching question because it was too long (we noticed this while they were completing it as well and separated it into three different questions to make it more manageable)
- Educators wanted the information and integration to include primary schools rather than just secondary school curricula
- They wanted more Namibia specific examples including endangered and extinct species, threats to the ocean, statistics regarding uncontrolled mining
- One educator wanted more examples of the threats to biodiversity rather than biodiversity loss because there hasn't been biodiversity loss in Namibia yet
- After having done the first two modules, some educators said they felt "comfortable doing it now, today, with the flow"
- One of the matching questions was confusing because it seemed as though plants stop erosion control when actually plants stop erosion
- Educators with Kylie and Laura prefer to have the notes page include tabs rather than just one page of notes to scroll through
- Educators with Will and Ajay prefer to have the notes page layout of Threats where there are no tabs or subsections because it eliminates the repetitiveness of the other modules
- Educators want the layout of the assessments tab to stay consistent

Some feedback on the three modules collectively includes:

- The content was fair enough
- The order of topics (types, ecosystem services, threats) was good
- Hard copies of the modules or a downloadable PDF or word version would be beneficial for distribution to teachers and educators without internet access
- Games should be put throughout the notes section with corresponding topics instead of on their own tab