Renewable Energy SMART Lessons: An Educational Approach to Energy Independence in Namibia

An Interactive Qualifying Project
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Chapter 1: Introduction

The strict rule of South Africa over Namibia before their independence barred most of the population from equal educational opportunities. In 1990, Namibia gained independence from South Africa and began its reform towards becoming a self-sustaining nation. Countries typically run into several challenges in regards to providing equal education to all citizens. The Namibian education system specifically faces a lack of resources, informed teachers, and a diverse population. The Ministry of Education in Namibia is designing a curriculum that is sufficient for both urban and rural school children. To develop as a nation towards complete independence, education must be one of the highest priorities (Kandpal, Broman, 2014).

Along with the education barriers in the country, Namibia is reliant on other nations for electricity and power. The nation is consistently working to improve its self-sufficiency. Non-renewable energy affects the economy, environment, and livelihoods of the citizens. To battle this problem, the government created *Vision 2030*: a plan to integrate renewable energy, improve education, and promote environmental protection. Solar, wind, and a form of biomass, called Bush to Energy, are ideal candidates for the nation's power sources because of their potential to improve the economy, create jobs, and reduce climate change effects.

Vision 2030 aims to educate the Namibian population on renewable energy and improve the overall education system in Namibia. EduVentures Trust, a nonprofit organization, will implement renewable energy lesson plans in their solar-powered mobile classroom as a form of supplementary education. EduVentures' mission is to further educate rural Namibian children on environmental topics, such as renewable energy and biodiversity. There is a large disproportionality of funds directed to "successful" urban schools than to rural schools. However, this divide between rural and urban schools is not unique to Namibia. The government of Jordan implemented a program to study renewable energy education in rural and urban students. The facilitators found that rural students knew significantly less than urban students in regards to renewable energy. Additionally, per a study conducted in Kenya in 2010, the prime age for environmental education is middle to high school age students. However, Namibia's curriculum only offers environmental education programs in grades 1-4. The "learners", which is the Namibian equivalent to "student" in American terminology, are too early in their education to use this new information towards future job opportunities, such as technicians, engineers, or designers. The targeted age group is a massive impedance for learners because retention rates in Grades 1-4 are noticeably low. EduVentures acknowledges this mismatch in the curriculum, and only targets middle to high school age learners.

EduVentures is the only organization in Namibia delivering mobile education to rural schools throughout the country, which causes the company to overstretch itself. EduVentures currently focuses solely on biodiversity, but wants to expand their program to include renewable energy curriculums. The purpose of this project is to assist EduVentures in developing four renewable energy modules to minimize the massive workload of the company and to aid in the expansion of their program. The modules are: Introduction to Renewable Energy, Wind Energy, Solar Energy, and Bush to Energy. The success of this project depends on the fusion of environmental education techniques, and the needs of Namibian learners. The project team will interview several different stakeholders in the country such as: local high school teachers, government officials, EduVentures employees, and high school learners. Simultaneously, this study includes observing local high school settings to observe: structure, lesson plans, and teaching techniques. The group will then compile the information collected into informative and interactive lessons. The lessons will consist of PowerPoints, SMART technology, games, activities, and quizzes. The EduMobile classroom will then implement the modules, and the team will adjust the modules based on observations, quiz results and feedback from a student evaluation.

Chapter 2: Background

This chapter provides educational approaches for increasing understanding and awareness of renewable energy in rural Namibian youth. The Namibian government hopes to eliminate international energy dependency by the year 2030. This chapter will further examine:

- Namibian Education
- EduVentures Trust
- Climate Change and Renewable Energy Initiatives in Namibia
- Effective Environmental Education Techniques
- Experiential Learning and Curriculum Building
- Renewable Energy Topics

2.1 Education in Namibia

After gaining independence in 1990, Namibia's Ministry of Education overcame many obstacles. The apartheid rule that South Africa enforced on the citizens of Namibia led to severe disparities in the quality of education in Namibia between the various ethnic groups. The colonial education system did not satisfy the needs or goals of the newly independent Namibian people, as the content, teaching methods, and assessments were not up to date (Chin, n. d.). To satisfy these new standards, the Ministry of Education undertook a comprehensive reform process to increase access, equity, quality and lifelong learning (UNESCO, 2004). In response to many issues including education, social reform, and environmental degradation, the Namibian government created a national development agenda called *Vision 2030*. In regards to education, *Vision 2030*'s plan is to create, "a fully integrated, unified and flexible education and training system, that prepares Namibian learners to take advantage of a rapidly changing environment and contributes to the economic, moral, cultural, and social development of the citizens throughout their lives" (National Planning Commission, Section 4.3.3, 2004).

The Ministry of Education implemented several changes already, with new curricula introduced in all grade levels, an increased effort to improve teacher qualifications, and improvements to scholastic infrastructure (National Planning Commission, Section 4.3.3, 2004). The new infrastructure follows a tiered learning process, with three main levels of learning each split into two sublevels (see Figure 2. 1. 1).

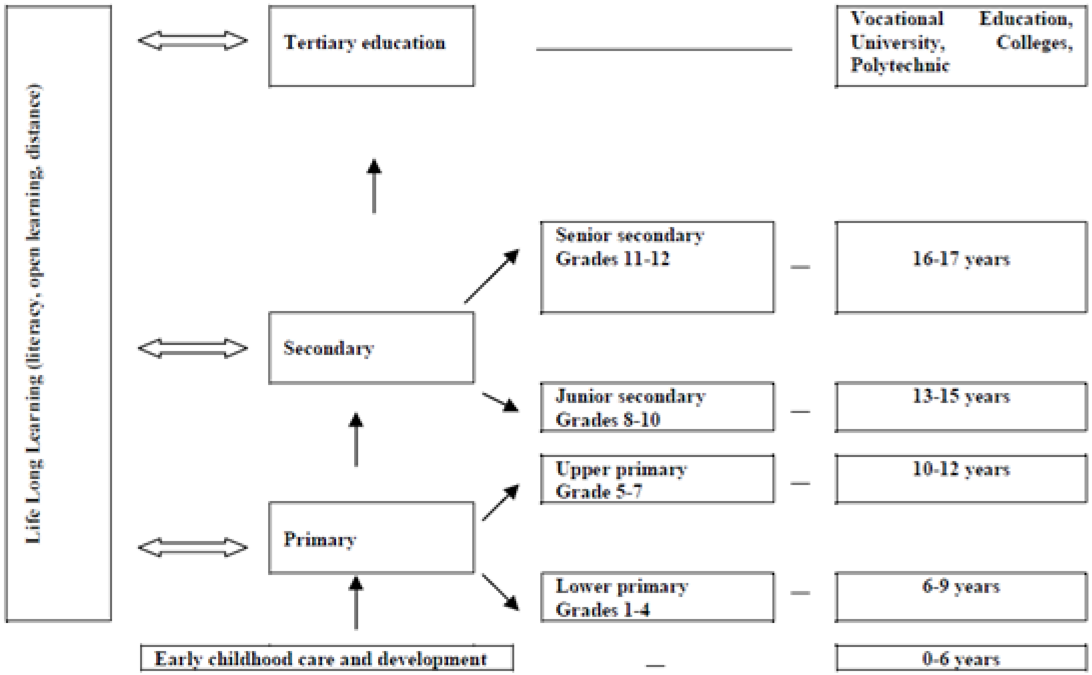

Figure 2. 1. 1: Structure of Namibian Education System (Chin, n. d.)

Primary education lasts seven years, divided into lower primary and upper primary levels. A learner begins grade one at the age of six, and completes their lower primary education in grade four, where they will proceed to upper primary education, grades five through seven (Ministry of Education, 2011). Once the learners complete their primary education, they move on to secondary education, which is split into junior secondary and senior secondary school. Junior secondary school comprises of grades 8-10. At the end of 10th grade, learners take an external examination to obtain the Junior Secondary Certificate (JSC) (Ministry of Education, 2011). This phase marks the end of required formal education in Namibia. Learners may continue to senior secondary level of education, which occurs in grades 10-12. Learners must take an additional examination of their competence, the National Senior Secondary Certificate examination at either the Ordinary level (NSSCO) or the Higher Level (NSSCH). Upon the completion of these examinations, learners receive certificates of recognition of completion of primary education and may proceed to university-level education (Ministry of Education, 2011). Learners must apply to university should they decide to continue their education at a higher level. Once enrolled at a university, the "learner" becomes a "student", and they complete their degree in a specific topic (Ministry of Education, 2011).

While all schools in Namibia follow this tiered learning system, there are drastic differences between urban and rural school systems. Most rural schools lack qualified staff because most young educators prefer to teach in urban districts. Urban schooling also tends to have better managerial approaches, as they have the funds to send their principals and head staff to management workshops. Rural schools have poor managerial systems due to minimal government funding (The Namibian, 2007). Most the rural schools are also ill-equipped with necessary school supplies and technology. South African governance developed most of the urban schools while Namibia was a colony. This results in urban schools having more opportunity to become equipped with necessary supplies and technologies. Urban schools have access to the internet and other technologies, which provide significantly better access to information centers (The Namibian, 2007). Another problem in most rural schools is a lack of access to information and little exposure to modern civilization. To fix this educational divide in Namibia, the following steps must take place:

- Reintroduction of incentives, such as reduced taxes for teachers, must occur to attract younger professionals to rural school districts
- Budget allocations for schools must consider the physical state of the schools, as well as the location of the school districts
- The government should provide internet access and subsidize computers for schools nationwide
- Regional offices must organize school tours (known as field trips), as some schools do not have the necessary funds
- The government should make it mandatory for all school administrators to undergo training to learn proper management skills.

If the Ministry of Education can implement these steps, rural learners have the potential to obtain a comparable education to urban learners (The Namibian, 2007). The government of Namibia has several plans drafted to implement these changes in the future in the educational reform section of *Vision 2030,* as mentioned above (National Planning Commission, Section 4.3.3, 2004).

2.2 EduVentures Trust

EduVentures Trust is a nonprofit organization that works in conjunction with the National Museum of Namibia and the National Institute of Educational Development. The mission of these organizations is to "... provide environmental experiences for mainly disadvantaged Namibian youth whilst simultaneously contributing to the continued expansion of Namibian scientific knowledge and deepening the collective understanding of its natural and cultural heritage..." (EduVentures, 2008). According to the Merriam-Webster dictionary "disadvantaged" refers to those who do not have access to some of the necessities of life such as proper housing, educational opportunities, and adequate medical care. EduVentures educates disadvantaged Namibian youths, grades 8-12, on a variety of educational subjects, specifically biodiversity and renewable energy. EduVentures Trust provides several learning opportunities, such as: web-expeditions, hands-on expeditions, fieldwork, individual projects, museum activities, and lessons in the mobile classroom.

EduVentures bridges the gap between rural and urban learner exposure by providing fun, educational programs that cover a variety of topics in their mobile classroom. The goal of EduVentures is to inspire children from rural areas to pursue further education or careers in STEM fields.

2.3 Climate Change and Renewable Energy Initiatives in Namibia

Namibia is one of the few countries in the world with the potential to become entirely powered by renewable energy (Munyayi, Ileka & Chiguvare, 2015). Specifically, Namibia is an ideal candidate for the implementation of wind energy, solar energy, and bush-to-energy initiatives. With the significant effects of climate change that the country battles daily, preparing Namibian citizens to transition to renewable energy for power will have several positive effects nationwide. This transition would not only enable the country to better counteract the effects of climate change, it would also reduce their dependence on foreign goods and promote job growth throughout Namibia.

2.3.1 Climate Change in Namibia

According to Namibia's House of Democracy, climate change is, "a change over long periods of time of temperature, precipitation, atmospheric pressure, and wind patterns on a global scale," (Lubinda, 2015). The natural causes of climate change include: earth's orbit around the sun, intensity of the sun's rays, circulation of the ocean and the atmosphere, and volcanic activity. Human contributions to climate change include burning fossil fuels, cutting down forests, and developing land. As the ozone disappears, surface temperatures rise, precipitation patterns change, and drought and flooding occurrences increase. (Jackson, 2017).

Although Namibia is a small contributor of greenhouse gas emissions, the nation experiences massive climate change effects (Lubinda, 2015). Changing precipitation patterns, delay Namibian farming seasons and changing seasonal temperatures result in increased occurrences of drought and flash floods. Namibian communities whose livelihoods depend on natural resources, such as subsistent agriculturalists, undoubtedly feel the effects of these changes. Land degradation, jeopardizes agriculture, and since 70% of Namibia's population is part of an agricultural community, the government believes it is urgent to act and prepare the country for the anticipated future consequences of climate change (Lubinda, 2015).

Namibia currently imports 80% of its energy from surrounding countries, but has the potential to become a country completely powered by renewable energy (Munyayi, Ileka & Chiguvare, 2015). The Namibian government recognizes this potential and, through the Ministry of Environment and Tourism (MET), implemented several policies that address different strategies to adapt to climate change and established four within the past decade:

- 2001- Established the National Climate Change Committee (NCCC), which functions as a federal advisory committee on climate change (Benyamin & Nantanga, n. d.)
- 2011- Developed the National Climate Change Policy, which outlined a comprehensive framework on climate risk management in accordance with Namibia's development agenda (Ministry of Environment & Tourism, 2011)
- 2012- Implemented the Disaster and Risk Management Act, which established institutions for risk management to plan for disasters such as flooding and drought (Republic of Namibia, 2012)
- 2014- NCCP created the National Climate Change Strategy and Action Plan (NCCSAP), which exemplifies the goals of their organization by creating effective, efficient and

practical guiding principles that are responsive to climate change (Lubinda, 2015).

Culminating these policies have laid the groundwork for nationwide change. If Namibia can maintain the traction that these initial changes have created, the country will continue to transition smoothly and efficiently to renewable energy technologies.

2.3.2 Socio-Economic Impacts of Climate Change

As mentioned above, sustainable agriculture supports approximately 70% of Namibia's population (Chioreso & Munyayi, 2015). As such, agriculture plays a vital role in Namibia's economy. Constant drought and severe flooding due to climate change cause severe land degradation, leaving less than one-third available for agricultural purposes (Chioreso & Begbie-Clench, 2015). Since most of the population lives entirely off the land, and many suffer in poverty, this lack of usable land has become an increasingly problematic issue in Namibia (Chioreso & Begbie-Clench, 2015).

The government has already begun to act to counteract this issue. One governmental plan integrates Climate Smart Agriculture (CSA) into the economy. CSA contains three main pillars of sustainable development: economic, social, and environmental impacts. The CSA in Namibia aims to: sustainably increase agricultural productivity and income, adapt and build resilience to climate change, and reduce greenhouse gas emissions. Table 2. 3. 1 depicts the government's plans to integrate CSA into Namibia's current agriculture sector to improve current practices and the economy (Chioreso & Munyayi, 2015).

Table 2. 3. 1: Climate-smart practices useful in smallholder agricultural production (Chioreso & Munyayi, 2015)

Crop Management	Livestock management	Solid and waste management	Agro Forestry
• Intercropping with legumes • Crop rotations • New crop varieties (e.g. drought resistant) • Improved storage and processing techniques • Greater crop diversity	• Improved feeding strategies • Rotational grazing • Fodder crops • Grassland restoration and conservation • Manure treatment • Improved livestock health • Animal husbandry improvements	• Conservation agriculture (e.g. minimum tillage) • Contour planting • Terraces and bunds • Planting pits • Water storage (e.g. water pans) • Dams, pits, ridges • Improved irrigation (e.g. drip)	• Boundary trees and hedgerows • Nitrogen-fixing trees on farms • Multi - purpose trees • Improved fallow with fertiliser shrubs • Woodlots • Fruit orchards

Along with these initiatives, the Namibian government introduced several energy saving measures, such as installing solar water heaters in all government buildings, introducing independent power producer concepts, supporting the development of energy from bush encroachment, solar-diesel hybrid mini-grid systems, and wind power generation (Namibia-EEP Arica, 2015). The Namibian cabinet decided to aim for nation-wide self-sufficiency in electricity generation and to reduce dependency on foreign products in 2008. The Energy and Environment Partnership (EEP) of Southern and East Africa currently has four projects in development in Namibia:

1. Fish-based biodiesel for Namibia
2. A feasibility study for the potential of anaerobic bio-digesters to produce renewable

energy
3. Invader (encroachment) Bush to Energy
4. Innovative Technologies for Underserved Populations.

These are only EEP's current projects in Namibia. In the past, the EEP completed several successful projects that promote renewable energy in Namibia, such as the Biofuel boiler depicted in Figure 2. 3. 1 below (Namibia-EEP Africa, 2015).

Figure 2. 3. 1: EEP Thermal Biofuel Boiler (Namibia EEP-Africa, 2015)

While neither the EEP's initiatives nor the CSA's program will provide immediate solutions, both projects are working to promote environmental awareness and sustainable development in Namibia, which will cause positive long-term effects. If citizens continue to implement climate smart agriculture and the EEP maintains to implement environmentally friendly changes throughout Namibia, the effects of climate change will become less severe. This will lead to an increase in useable land, which would promote job growth and improve the economy.

2.3.3 Vision 2030

As discussed in Section 2.1, the National Planning Commission (NPC) of Namibia created *Vision 2030* to clearly define the developmental programs and strategies to improve the lives of Namibian citizens. While *Vision 2030* covers a diverse range of topics, chapter five targets the issues of developing a sustainable resource base (National Planning Commission, Preface, 2004).

Chapter five of *Vision 2030* discusses the potential of sustainable development, the current environmental issues in Namibia, and the actions the country can take to overcome these unwelcome trends. The six significant components that the NPC believes threaten sustainable development in Namibia are as follows:

- **Maintaining** people's rights, responsibilities, and authority over land and resources

- **Achieving** sustainability in the land and agricultural sectors, and the need for diversified livelihoods
- **Promoting** sustainability of the forestry sector
- **Sustaining** the coastal and marine fisheries and ecosystems
- **Optimizing** Namibia's comparative advantage in the wildlife and tourism section of the government.
- **Harvesting** the earth's bountiful minerals with minimal impacts.

Figure 2. 3. 2 depicts the interconnections between these six components and how they directly affect one another and the climate (National Planning Commission, Sustainable Resource Base, 2004).

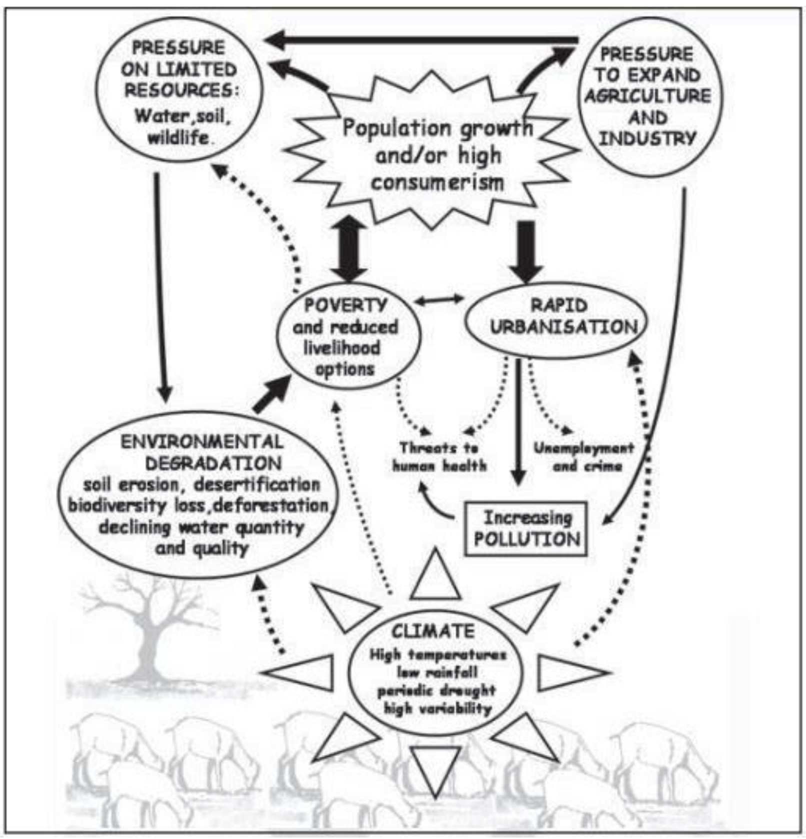

Figure 2. 3. 2 Interlinking Issues that Threaten Namibia's Potential for Sustainable Development (National Planning Commission, Sustainable Resource Base, 2004).

Surface water scarcity, minimal availability for livestock grazing, and low livestock-carrying capacity limits cultivation and commodity farming development. Soil erosion, bush encroachment, and soil salinization continue to cause economic loss and escalating poverty. Thousands of families utilize land as their only form of livelihood. While 94% of rural Namibian households identify agriculture as their main activity, the lack of available land has adverse effects on farmers' incomes (National Planning Commission, 2015).

Forests provide life-sustaining environmental services by exhaling oxygen and absorbing carbon dioxide. Forests also act as stabilizing units for ecosystems and are sources of economically valuable products. Forest ecosystems improve the livelihoods of most Namibian citizens through the supply of fuel and construction materials, as well as food, medicine, and grazing space for livestock. They also support a wealth of biodiversity and game. Unfortunately, unsustainable deforestation of natural woodland and forest areas occurs throughout the country, and is most severe in areas with high population density, especially in Northern Namibia (National Planning Commission, 2015).

Consequences of deforestation include rainfall runoff and soil erosion, as well as decreasing soil fertility, changes in Namibia's water cycle, a loss of biodiversity, and increased rates of global warming. Namibia's ecosystems play a vital role in maintaining environmental health. They promote soil stabilization and climate control, and thus hold Namibia's limited supply of hardwood timber resources. Namibia will suffer economic downfalls in the form of limited supply of hardwood and biodiversity reduction if deforestation continues to occur (National Planning Commission, 2015).

The government's plan for increasing biodiversity is another major component of *Vision 2030*. Namibia is home to many species of plants and animals which inhabit the country's different biomes. Even though only a few are directly useful to humans, all species are of ecological importance. Natural ecosystems provide vital genetic material, and indirect benefits including air, water, and productive soils.

As ecosystems lose complexity, pests and disease become more prevalent and disruption of essential ecological functions occur. Disturbances in ecosystems also increase vulnerability to drought, floods, and climate change. Biodiversity deprivation threatens food supplies, sources of wood and medicines, and the sustainment of rural communities. Without biodiversity, the environment and economy will begin to decline. Accordingly, the government implemented a conservation program to prevent biodiversity loss. Conservancies offer opportunities for communities to generate revenue and employment, and promote the protection and sustainment of wildlife (National Planning Commission, Sustainable Resource Base, 2004).

2.4 Effective Environmental Education Techniques

Education is crucial to the success of Namibia because it has the potential to produce skilled workers, enhance livelihoods, and unite the nation (Zyadin, Puhakka, et. al., 2012). The US EPA defines environmental education as, "a process that allows individuals to explore environmental issues, engage in problem-solving, and take action to improve the environment. Consequently, people develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions" (US EPA, n.d.).

2.4.1 Environmental Education Challenges

In earlier educational case studies in rural villages around the world, the main challenge faced by researchers was the student's' minimal background in renewable energy (Kioko, 2010). Although Africa is a good fit for several different branches of renewable energy, the resources to support energy generation in the desired countries are minimal. At the 2007 European Conference on Local Energy, the focus was "Education Today for Tomorrow's Energy Users"

(Sebitosi, Pillay, 2008). Even though South Africa was the ideal candidate for renewable energy initiatives, several issues arose at the conference, such as: lack of trained teachers in the subject area, strict school curricula, and lack of cooperation between private energy advisors and educational leaders (Sebitosi, Pillay, 2008).

The lack of sufficient experts in renewable energy throughout the globe is one of the reasons behind the poor expansion of renewable energy. The concept of renewable energy is a particularly hard topic for most individuals to grasp, especially children. To expand the renewable energy sector in Namibia, utilization of knowledgeable individuals is essential. In education, the instructions must be clear, engaging, and inspiring.

Namibia's curriculum currently does not support the expansion of renewable energy knowledge because the age groups targeted do not have the resources to further explore the topics. According to a study in Kenya, the prime age for renewable energy education is middle school to high school students (Kioko, 2010), however, the Namibian curriculum only provides environmental education in Grades 1 - 4 (Republic of Namibia - Ministry of Education, Arts, and Culture, 2017). If the country wants to inspire the youth to pursue careers in the energy fields, it is essential for learners to gain the knowledge when they are closer to the end of their education (Minnis, 2006). If Namibia can combat these challenges, the population will welcome renewable energy introduction throughout the country.

2.4.2 Elements of Successful Environmental Education Programs

One of the most important components in environmental education is the purpose of the lesson. According to Athman, in *Elements of effective environmental education programs*, there are five main purposes in any environmental education program: awareness, knowledge, attitude, skills, and participation. Awareness familiarizes the learners with the problem and its impact on the society, economy and environment. Knowledge provides the learners with a basic understanding of the subject and the background material. Once the learners understand the material, they can create their own opinions and attitudes about the future of the environment. Skills help learners identify and solve problems that may arise around them. Finally, participation encourages the learners to actively take part in their communities and to inform others of the problems surrounding them (Athman, 2001). Similar themes are found in *Renewable Education: A Global Status Review*; the review concludes that the following themes are key to a successful environmental education:

- **Develop student awareness** about the causes of energy related problems (climate change, economy, etc.)
- **Inform the learners** about the sources of energy: renewable and nonrenewable. Then teach the learners about outcomes of renewable energy: economic stimulation, environmental impacts, socio-cultural effects, and governmental impact
- **Motivate the learners** to pursue efforts in the renewable energy fields by stressing the various challenges the country is currently facing, and the potential positive impact of harnessing renewable energy sources
- **Work with the learners to develop values** and attitudes about renewable energy

implementation in the future (Kandpal, Broman, 2014).

This information highlights key themes of awareness, attitudes, and knowledge. If teachers fuse these themes into lesson plans, along with using other teaching techniques, the more likely that the learners will succeed (Kandpal, Broman, 2014).

2.4.3 Environmental Education Case Studies

The energy situation in Jordan nearly mimics the situation in Namibia. Jordan currently imports 90% of its total energy from Saudi Arabia, Iraq, and Egypt (Zyadin, Puhakka, et. al., 2012). Jordan is hoping to combat this problem by educating their youth to create informed, future consumers. This case study, conducted in 2012, focused on 617 learners and their current education levels and outlooks on renewable energy. The first aspect investigated by the researchers was the ability of the learners to determine the nature of energy sources, by deciding whether a resource is renewable or nonrenewable. Table 2. 4. 1 shows the responses of the learners.

Table 2. 4. 1: learners' ability to determine the nature of energy sources (Zyadin, Puhakka, et. al., 2012)

Item	Response percentages (*N* = 617)		
	Yes (%)	No (%)	Missing (%)
Renewable			
Solar	96	3	1
Wind	94	5	1
Geothermal	75	22	3
Non-renewable			
Fossil oil	15	83	2
Coal	18	80	2
Oil shale	25	74	1
Nuclear	23	74	3
N.gas	35	63	2

The misconceptions in these learners' responses are in regards to the more abstract forms of energy: natural gas, nuclear, and geothermal. To investigate the factors behind the learners' answers, the study provided the following table dividing the responses based on living area, gender, and school type (see Table 2. 4. 2).

Table 2. 4. 2: Results of area, gender, and school type variables of the learners' ability to determining the nature of energy sources (Zyadin, Puhakka, et. al., 2012)

	Responses						
	Area (%)		Gender (%)		School type (%)		
	Urban	Rural	Male	Female	Urban	Rural	Private
Ren (Yes)[a]							
Solar	99	94	97	98	96	94	99
Wind	96	93	93	97	97	93	95
Geothermal	81	70	78	76	80	70	82
NonRen (No)[b]							
Fossil oil	87	81	81	90	89	81	84
Coal	83	79	77	87	84	79	82
Oil shale	75	75	73	76	75	75	74
Nuclear	78	75	71	81	81	75	71
N.gas	64	67	62	67	64	67	63

The study stated: "While identification of non-renewable sources generally showed no significant variation by residence, there was some significant indication of better urban awareness of the nature of fossil fuels" (Zyadin, Puhakka, et. al., 2012). The study expands further by testing learners on the purposes or functions of the different energy sources, Table 2. 4. 3 displays the results of these tests.

Table 2. 4. 3: Learners' level of renewable energy knowledge: summary descriptive statistics (Zyadin, Puhakka, et. al., 2012

Knowledge item	SA[a] (%)	SDA[b] (%)	DtK[c] (%)	Mode
1. Sunshine is utilized to produce electricity	76	13	11	Agree
2. Wind turbines are utilized to produce electricity	70	9	21	Agree
3. Geothermal energy is the earth's internal heat	56	13	31	Agree
4. Bioenergy is the energy produced from plant biomass	42	10	48	Don't know
5. Biodiesel is fuel produced from plant oils	28	21	51	Don't know
6. Bioethanol is fuel produced from fermenting biomass	28	10	62	Don't know

a SA: Sum of strongly agree and agree.

b SDA: Sum of strongly disagree and disagree.

c DtK: Don't know.

Learners were most knowledgeable about wind and solar energy, meanwhile 50% of the learners responded with "I Don't Know" for biomass related forms of energy. The final test surveyed the opinions on renewable energy related to the country's future. Learners in the urban schools were more likely to favor the transition to renewable energy resources than rural learners. This case study provides insight to the background of the rural Namibian learners and the outlooks that they might have on implementation of renewable energy (Zyadin, Puhakka, et. al., 2012).

A 2010 study, conducted in Kenya, tested many learners' outlooks on preservation of the surrounding land (Kioko, 2010). The Kenya Wildlife Service is working to increase the level of awareness in conservation topics through educational programs. The survey showed that 87.5% of the learners favored conservation tactics. The reasoning behind why the learners supported conservation of their surrounding environments varied; the responses included tourism, recreation, species preservation, and wildlife containment, as shown in Table 2. 4. 4.

Table 2. 4. 4: Youth's perceptions of the value of protected areas (Kioko, 2010)

Perceived value of protected areas	Percentage of respondents
Tourism/foreign exchange	35.0
Wildlife containment	12.6
Recreation/aesthetics	11.8
Species preservation/conservation	11.8
Employment	7.7
School fees/bursaries	3.6
Animal/wildlife products	3.1
Education	2.5
Helps in infrastructural development	1.5
Religious importance	1.2
Cultural value	0.6

The study also investigated the relationship between level of schooling and student conservation attitudes. The results concluded that the older the student, the higher the chance that their outlook on preservation was positive. The primary school learners responded poorly to the presented material, meanwhile the secondary school learners responded much better to the concept of conservation. Table 2. 4. 5 shows the percentage of learners who support conservation, and their stated reasoning behind implementation of conservation tactics.

Table 2. 4. 5: Relationship between level of schooling and stated reasons for wildlife conservation (Kioko, 2010)

Level of schooling	Tourism/ foreign exchange	Recreation/ aesthetics	Species preservation/ conservation	Wildlife containment
Primary lower	11.8%	4.9%	16.0%	37.5%
Primary upper	48.0%	16.7%	9.3%	4.7%
Secondary	61.5%	8.1%	10.1%	2.7%
P-value	0.0001	0.0001	0.0001	0.0001
Chi-value	244.00	60.00	70.00	92.00

The third segment of the study collected data based on involvement in wildlife and environmental clubs. It demonstrated that secondary school learners were more likely to involve themselves with environmental clubs than primary school learners, as shown in Figure 2. 4. 1.

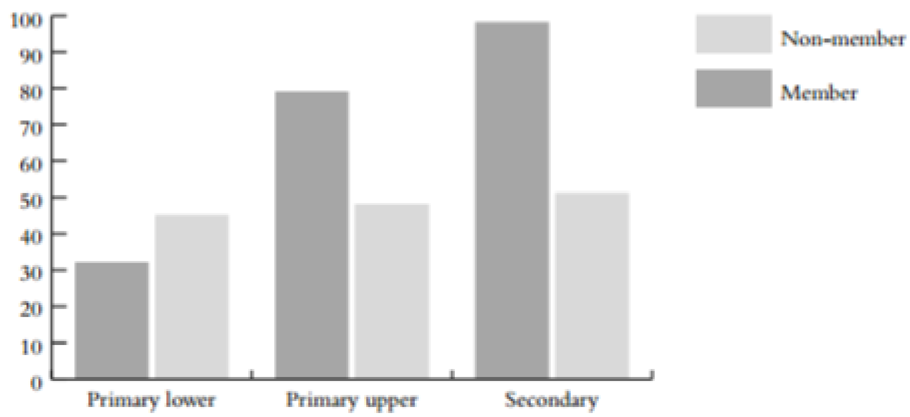

Figure 2. 4. 1: Percentage of learners enrolled in wildlife and environmental clubs (Kioko, 2010)

Once involved with one of the clubs, the learners showed a higher participation in local conservation activities. In fact, 65% of the contributors to local conservation activities were participants in wildlife clubs. Not only do these clubs increase community involvement, they also inspire members to continue their environmental learning and engage others in the conversation of surrounding environments (Kioko, 2010). This study demonstrated the effectiveness of choosing the proper age groups in environmental education and the importance of environmental club involvement after the program concludes.

2.4.4 Experiential Learning and Effective Teaching Techniques

David Kolb, a theorist specializing in education, defines experiential learning as, "learning in which the learner is directly in touch with the realities being studied" (Kolb, 2014). The emphasis is on direct sense experience and in-context action as the primary source of learning, analysis, and academic knowledge. Classrooms that implement experiential learning employ alternative educational techniques such as guided inquiry, hands-on experiments, and embedded activities that explore problem-based studies to increase learner engagement in the classroom (University of Texas at Austin, n. d.).

In his book, *Experiential Learning: Experience as the Source of Learning and Development*, David Kolb identifies four stages of this experience-focused learning style (see Figure 2. 4. 2).

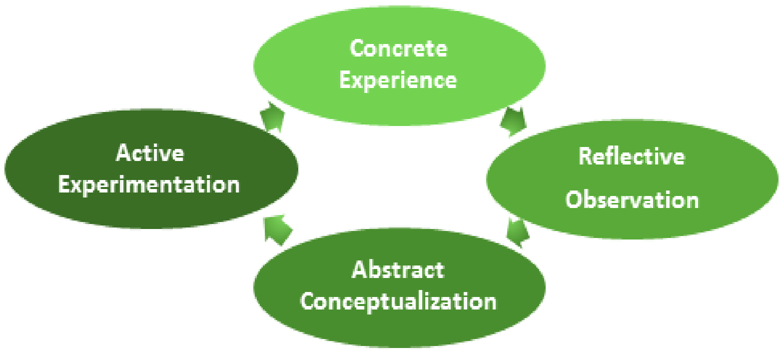

Figure 2. 4. 2: the Kolb Cycle (Altered from Kolb, 1984)

The *concrete experience* stage begins the cycle, where the teacher assigns tasks that require learners to actively participate. Kolb believes that one cannot learn simply by watching or reading about something; to learn effectively the individual or team must do something. The activities utilized to help in this stage include ice breakers, team games, problem solving activities, and debates (Kolb, 2014). After a period of time, the class enters the second stage, known as *reflective observation*. Now the class takes a step back from the tasks they are performing to review what they experienced. The expectation for this stage is that communication channels open for the class. The class will ask an array of questions and give feedback on the lesson (Kolb, 1984). The class performs *abstract conceptualization* of their task after they reflect on their experience. During this stage, the class should interpret events that occurred and provide theories about why the events happened, based on previous knowledge, and what they discovered during the concrete experience stage (Kolb, 1984). The final stage of the learning cycle, *active experimentation,* is when the learner considers how to implement their new knowledge in real-world applications.

Experiential learning has exceptional potential as an educational tool. John Dewey believed that learners develop a greater appreciation for nature and the environment if they experience it first-hand (Sayland & Blumstein, 2011). Advantages of experiential technology in environmental education include an increased interest in nature, participatory learning, flexibility, and technological integration (Dunham, Hawks, Lyles, Misera, 2015). Researchers at Comité de Valorisation de la Rivière Beauport (CSVB) agree with Dewey. They believe that experiential learning as a part of environmental education restores the relationship with natural and industrial environments. This subsequently allows learners to develop an awareness of what is transpiring in their surroundings (Par Group de recherche Littoral et vie, n.d.). The environment of the classroom is important to consider when developing lesson plans. For example, attempting to educate a class about marine life to learners who have never come in contact with the ocean is ineffective and harder than teaching them about their surrounding environment (Dunham, Hawks, Lyles, Misera, 2015). Ensuring that learners can ascertain by partaking in their surroundings increases engagement and interest in the lessons because learners have a role in their own education. Participatory learning is especially effective in rural communities, as rural learners tend to have a stronger connection to their local communities due to their isolation from surrounding communities (Dunham, Hawks, Lyles, Misera, 2015). Experiential learning similarly allows for increased flexibility in each learner's learning style and permits for a more adaptable curriculum for the school and the teachers. This is beneficial for environmental education, as it can take place in a variety of locations.

Environmentalist and artist Young Imm Kang Song commented that, "One of the most fundamental problems with environmental education is the detached, unemotional way in which it is taught," (Song, 2008). Teachers use experiential learning techniques to counteract this problem by developing engaging environmental education lesson plans to inspire moral responsibility in learners.

2.4.5 Curriculum Reform and Theory

Children growing up in a variety of environments face different challenges and require individualized attention for their needs ("John Dewey's Theories of Education", 2005). Dewey compares rural children and urban children to explain the importance of learning from experiences and the need for exposure to different activities in an educational setting. Children who grow up in an urban environment, exposed to industry, lose out on many opportunities to develop skills such as sewing, spinning, and caring for animals. While rural children develop these skills to help the family around the house ("John Dewey's Theories of Education", 2005). Education reform continues to evolve today, with the introduction of technology in classrooms. The integration of technology and computers into curriculums opens doors to new ways of teaching (Hansen, 1995). Technology aids learners' in their education because of the hands-on capabilities, such as SMART Technology.

SMART Technology utilizes interactive whiteboards, interactive flat panels, projectors, streaming devices, and software to enhance the learner's' experience in the classroom (Filigree Consulting, 2016). A report filed in 2016 by Filigree Consulting, sponsored by SMART Technology, analyzed the benefits of integrating SMART Technology into the classroom. They found that varied technologies in the classroom positively impacts the learner's success (Filigree Consulting, 2016). They also found that group activities significantly benefited the learner. Classroom settings that frequently conduct group activities observe a 23% increase in active engagement, due to student engagement in the lesson and participation in the discussion (Filigree Consulting, 2016). The report stressed that increasing the frequency of SMART technology will increase student successes. SMART Technology allows learners to create content rather than consume content (Filigree Consulting, 2016).

John Dewey introduced a curriculum theory that suggests education can share qualities of democracy; these qualities include a free form of education available to all from kindergarten through college, the learners are responsible for carrying out their education, and teachers are present for student guidance ("John Dewey's Theories of Education", 2005). From Dewey's theory, successful curriculums also depend on what to teach and how to teach, not just the teacher's ability to develop lesson plans (Hansen, 1995). Instead of drilling learners mechanically, Dewey insisted that "education should give every child the chance to grow up spontaneously, harmoniously and all-sidedly" ("John Dewey's Theories of Education", 2005). For instance, if children take up weaving, they may later inquire about the cotton process or the history of spinning because their education included hands-on learning ("John Dewey's Theories of Education", 2005). In the context of Namibia, children introduced to renewable energy in the form of a pinwheel demonstrations, may later inquire about the science behind how a wind turbine works. More generally, if learners in rural areas of Namibia experience environmental education through interactive activities, they may later inquire about the complex science and economic factors behind environmental problems in their country. When developing a curriculum, it is important that teachers pre-plan experiential learning and hands-on activities.

A curriculum refers to the entire content of a subject or topic that encompasses everything that the school teaches, not just the separate subjects or syllabus (Kelly, 2009). A curriculum should include all experiences of the learners during their educational studies (Kelly, 2009). Experiences outside of a formal curriculum, include informal curriculum or extracurricular activities and different skills and trainings. Many educational settings regard extracurricular activities as integral for the total curriculum, yet separate from the formal curriculum (Kelly, 2009). John Dewey and new educators stress the importance of experiences learned from the experiential world of the child (Deng, 2015). Dewey's theory "gets rid of the prejudicial notion that there is some gap in kind between the child's experience and the various subject-matter that make up the course of study". This supports the new educators' argument that a child's experiences are crucial to growth and development (Deng, 2015).

2.4.6 Curriculum Development

Developing a curriculum is not about determining the content. According to Kelly, a curriculum should include four dimensions - intentions of the planners, procedures for implementing those intentions, the actual experiences of the learners because of the teaching, and the 'hidden' learning by-product (Kelly, 2009). The Association of Supervision and Curriculum Development (ASCD) created a template that uses eight phases (Cunningham, 2009). Table 2. 4. 6 below outlines how to develop a lesson plan.

Table 2. 4. 6: Eight Phases of Curriculum Development (Cunningham, 2009)

Phase Number	**Purpose**
Phase 1: Introduction	Sets the goal/purpose of the lesson
Phase 2: Foundation	Checks what the students already know
Phase 3: Brain Activation	Prompts the students
Phase 4: Body of New Information	Teaches the bulk of the lesson plans
Phase 5: Clarification	Engages the students via interactive activities
Phase 6: Practice and Review	Allows students to work in smaller groups on demos or practice activities
Phase 7: Independent Practice	Prepares for future learning by completing homework tasks
Phase 8: Closure	Summarizes the lesson and how it fits in the greater picture

Although eight phases are overwhelming for a lesson plan, the time allotted to each phase is not equal. Phases one through four include the introduction and main topics for the class. Phases five through seven are central to reinforcing the student's understanding of the lessons. Phase seven is particularly important because the learners will work independently on an activity both inside and outside the classroom (Cunningham, G., 2009).

One of the challenges of developing a curriculum is determining strategies that work best for all the learners. Since learners learn differently, there is no way to develop a lesson that suits everyone's ability to learn. Mr. Pelissari, a sixth-grade history teacher from Connecticut, said "When I first started [teaching], it was more of a lecture style or read [from] the text. Now there is a lot more group work [in the lessons] rather than working out of the book". Group work and full class discussions help engage the learners and their interests in the subjects. Another way to engage the learners and their interest in the subjects is through incorporating relatable content in the lesson plan.

Mr. Pelissari also suggested that learners stay focused on the material when the lesson plan is broken down in fifteen to twenty minute sections (Pelissari, 2017). Developing lesson plans will also require integrating SMART technology. The use of SMART notebook, a software specifically designed for SMART boards, provides access to a variety of games and activities. Many of the games are interactive, such as Brain Savvy. This board game style activity splits up the learners into teams and then presents each team a question. The team has sixty seconds to brainstorm answers. Each answer given allows the student team to move their game piece a space on the board (SMART Notebook, 2009). The Game Show is another style of game that is within the Smart notebook software. The game facilitator inserts pre-made questions with information presented earlier in the lesson; then the dial is spun and the game randomly selects a question. This game allows learners to make teams and answer questions for points. This game instills a competitive atmosphere which will act as a motivating factor for the learners. SMART Notebook also has other activities such as sorting, matching, and fill-in-the-blanks. The sorting game uses monkeys with different energy resources and the learner sorts each resource into either the renewable or nonrenewable category (SMART Notebook & Brian, 2016). The fill-in-the-blank activity allows the teacher to design which section of the sentence is blank. Then, learners choose from a selection of words to fill in the sentence. Although these activities are not as interactive as the Game show, they do get the learners up and moving around, rather than sitting in their seats for the duration of the lesson.

2.5 Renewable Energy Topics

Currently, Namibia imports most its energy from the surrounding countries, the majority through the use of fossil fuels. Namibia has an opportunity to achieve independence from these countries with the implementation of renewable energy. The Namibian government is investigating the use of solar energy, wind energy, and a Namibia-specific biomass process called "bush to energy". Namibia is covered in an invasive plant species known as encroacher bush, and with the utilization of bush to energy, the country can produce energy from burning the encroacher bush as a source of biomass. EduVentures plans to use all three of this energy forms in their renewable energy program. These lessons are a method for the government to educate its population in these unfamiliar topics and prepare them for the upcoming future.

2.5.1 Wind Energy

Wind energy is a renewable energy that utilizes wind to generate electricity with a turbine. There are several classifications of wind that turbines exploit to produce electricity, depending on the type of turbine and the installation location. Utility-scale wind is a form of wind that allows for generated electricity to directly integrate into the power grid (Wind 101, n.d.). "Small" scale wind generates energy through turbines as well, but it delivers the electricity directly into homes. Offshore wind is a division of wind utilized by large-scale wind turbines located along the coast or near a body of water.

The two primary types of turbines are horizontal and vertical axis turbines (Wind Energy and Wind Power, n.d.). The designs and sizes of the horizontal and vertical turbines vary depending on the installation area and types of wind utilized. Figure 2. 5. 1 shows a comparison between these two types of wind turbines. Horizontal axis turbines typically consist of three large blades with a large pole attached to the three blades. The vertical axis turbine has blades on the top and bottom with a rotor connecting both ends (Types of Wind Turbines, 2016).

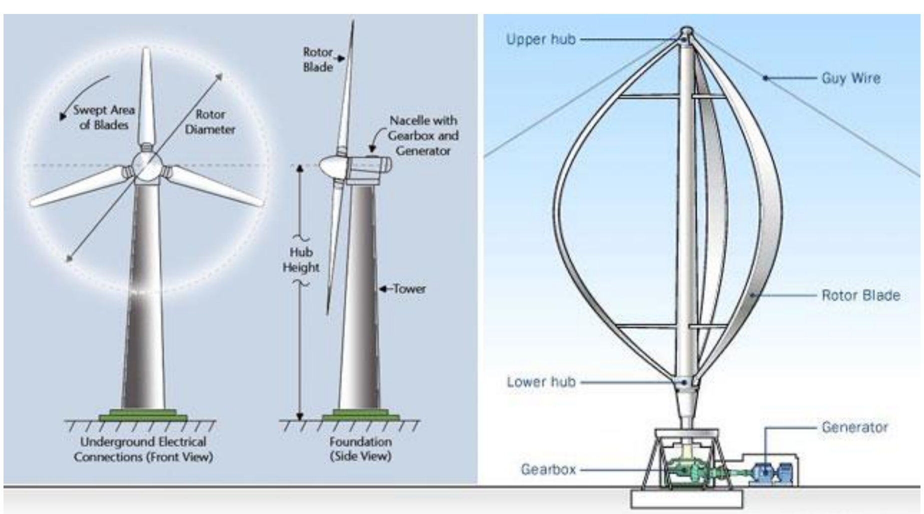

Figure 2. 5. 1: Comparison of Vertical (right) and Horizontal (left) Wind Turbines (Eco Energy, n.d.)

The type of design also affects the amount of energy that the turbines can produce, since only certain types of wind will maximize its efficiency. Wind power is delicate because the electricity generated by turbines must reach the correct voltage and frequency to enter the power grid. Specifically, in Namibia, some areas have higher wind speeds than others and this will cause energy fluctuations. Additionally, all wind turbines have an upper and lower limit of wind speed. The turbines automatically shut down at the lower limit, because of insufficient wind speed, and at the upper limit to prevent damage to the turbine (How Wind Energy Works, n.d.).

The future of wind turbines focuses on the designs and storage capabilities. Engineers throughout the globe are now designing smaller wind turbines that generate energy from breezes. Figure 2. 5. 2 depicts a prototype of a smaller wind turbine, known as “Abre a vent” or “Wind Tree” that is in testing in France (Parke, 2015). These micro turbines take on the shape of leaves, giving the appearance of a tree, and produce around 3.1 kW of energy (Johansson. A, 2016). These wind trees can produce energy for direct integration into the power grid or to power a single, family home (Wind Energy and Wind Power, n.d.).

Figure 2. 5. 2: The "Wind Tree" (Courtesy New Wind, n.d.)

However, the future of wind technology lies with improving the efficiency and physical aesthetic of wind turbines. Currently, the primary goal in wind energy is producing energy to integrate into the power grid. To further improve wind technology, engineers must design storage capabilities to provide a stable influx of energy. This technology has a variety of other applications including hydrogen production, waste management, and hydroelectric plant collaboration (Rosenberg, 2008).

Wind energy is cost-effective compared to energy produced by gas, oil, or petroleum (Wind 101, n.d.). According to The Economics of Wind Energy, the turbine, foundation, and connection to the power grid amount to around 75% of the total upfront costs of wind energy

(The European Wind Energy Association, 2009). Typically, natural gas plants' "continued" costs (operations, maintenance, and fuel) are between 40%-70%, while wind energy's operation, maintenance, and installation costs are less than 60% of the "continued" total costs for onshore turbines (The European Wind Energy Association, 2009). The offshore turbines are 50% more expensive than onshore turbines; however, this cost difference is offset by the energy output that each offshore turbine produces. The offshore turbines produce approximately four thousand full load hours per year while the onshore wind turbines supply around two thousand full load hours per year. This form of alternative energy has the possibility of creating many jobs throughout the world in design, manufacturing, installation, electrical systems, and maintenance. (Wind 101, n.d.).

Disadvantages. Wind energy can have adverse effects within the environment (Wind 101, n.d.). Depending on a variety of factors such as species, types of ecosystems, and location of the facilities, the wind turbines can have a negative effect on the surrounding ecosystem. These negative effects include noise generation, soil disruption, and erosion (Jaber, 2013). When built, these turbines cause certain species to relocate due to destroyed or altered ecosystems. Additionally, the bird and bat populations are especially at a high risk because the blades of the turbines kill aerial animals. Another major disadvantage of wind energy is the lack of storage systems. The energy generation will be entirely dependent on the wind qualities and frequencies. Wind energy is also not a reliable source as it heavily depends on wind, which is naturally intermittent (Wind, n.d.). Current wind patterns of Namibia, as well as surrounding areas, indicate that the wind speed varies between nine mph and 22 mph.

2.5.2 Solar Energy

Solar energy utilizes solar panels to harness the sun's energy to produce electricity, by absorbing photons, which, in turn, "knocks off" electrons. There are many different types of solar panels operated throughout the world and many more in development. Solar panels have two subtypes: "passive" and "active". "Active" solar panels convert the sun's light into electricity using mechanical or electrical devices. While "passive" solar panels convert the sun's light into electricity without using mechanical or electrical devices (Dhar, 2013). Figure 2. 5. 3 depicts the different technologies for generating electricity using solar panels. Solar panels are assembled from photovoltaic cells, which are composed of semiconservative material. Silicon is the primary material used in solar panels. It absorbs light from the sun to generate an electric field through the movement of electrons (Dhar, 2013). Concentrated solar power (CSP) uses mirrors to heat liquid to turn a turbine, which then produces electricity (Amatya et al., 2015).

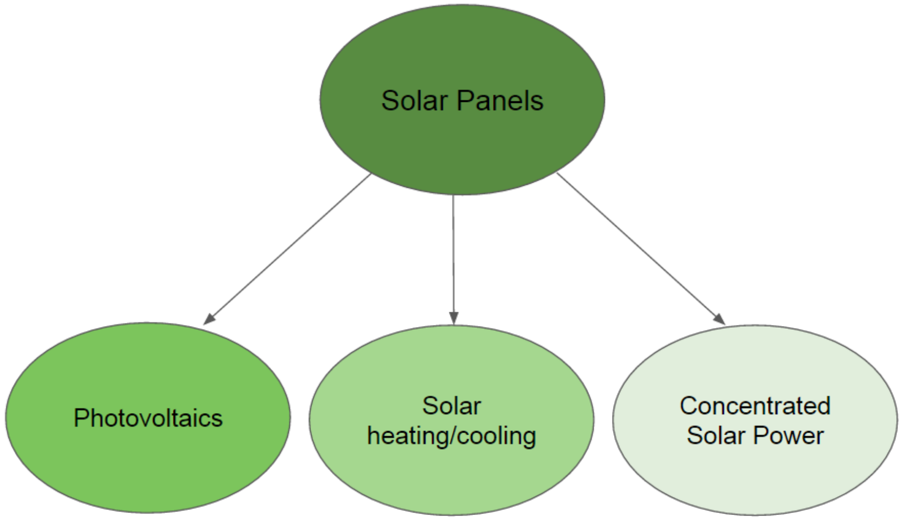

Figure 2. 5. 3: Main Types of Solar Panels

CSP technology appears in a variety designs such as the solar tower, parabolic trough, linear Fresnel, and the sterling dishes (Amatya et al., 2015). This system utilizes mirrors to gather sunlight to heat up the liquid. The mirrors in this technology allow the panels to follow the sun throughout the day, to collect the most sunlight possible. The power tower in CSP technology also contains a form of thermal storage, allowing it to store energy generated throughout the day (Concentrating Solar Power Basics, n.d.).

A priority for the current technology is to reduce production costs, the amount of silicon per watt, and the use of silver for metallization of silicon (Amatya et al., 2015). Methods to improve current Photovoltaic solar cells include: solar tracking, solar collectors, and hybrid power. Solar collectors are flat plates that collect and store solar energy (U.S. Department of Energy, 2012). Hybrid power is the use of solar energy in conjunction with another form of energy generation such as wind power or hydropower.

One of the emerging solar cells currently in development is the perovskite solar cell. The development of this cell will result in efficient and cheaper silicon-based technology. The other fields of research are dye sensitive solar cells, organic solar cells, polymer technology, porous silicon layers, mono- and polycrystalline silicon layers, cadmium telluride and cadmium sulfide solar cells. The overall purpose of current research is to create a more efficient and affordable solar cell that is available to the public (Amatya et al., 2015).

Advantages. This type of energy has limitless advantages during the day as it will absorb the sun's energy to create electricity (Amatya et al., 2015). In countries where it is sunny for most the year, such as Namibia, this type of energy can provide a sense of security. Another advantage of solar energy is job creation and growth in a variety of fields. In 2015, solar energy experienced a 20% job growth for the third year in a row and is to continue through the upcoming years. In 2015, the solar industry created 65% of new jobs throughout the globe. Implementing this technology can stimulate the economy and significantly reduce unemployment. Along with economic opportunities, the use of solar energy also builds an environmentally friendly future (Harvey, 2016).

Disadvantages. One of the major disadvantages of using solar energy as a primary source of electricity is that it is inefficient (Osman, 2015). The silicon wafer used in solar panels is a poor light absorber with an efficiency of around 10%. Additionally, solar power is expensive, in terms of installation, manufacturing, and maintenance. Installation and price of the solar panels are one-time payments, but maintenance is a continuous expense throughout the panels' lifetime. Solar panels also only generate for 12 hours, and like wind energy, most solar panels do not have a storage system (Osman, 2015).

2.5.3 Biomass and Bush to Electricity

Biomass Biomass energy production burns biological material. Plants create energy using a combustor, fan, pump, boiler, steam turbine, generator, condenser, exhaust, and a cooling tower. The burning of the biomass in a furnace produces gas, which results in the rotation of a turbine to generate electricity (Maehlum, 2013).

Two biomass processes are the fixed-bed systems and the fluidized bed systems (U.S. Department of Energy, 2016). The biomass in a fixed bed system lies on a "bed" while moving on a grate (U.S. Department of Energy, 2016). Air is blown through the grate and then ignited, causing the biomass to ignite as well. While, the fluidized bed system, burns the solid biomass as it moves through a swirling process in the tank. Both processes produce heat which transfer to a generator. Steam turbines, however, produce energy during both processes (U.S. Department of Energy, 2016).

Bush-to-energy. Bush-to-energy is specific to Namibia because an invasive species of plant, the encroacher bush, covers an extensive part of the country. The "Encroacher Bush" reduces water and nutrient retention in soil and occupies the native species' ecosystems. Over nineteen different species of encroacher bush infest more than 26 million hectares (64.3 million acres) of Namibia's Land. The remaining land does not retain enough water to sustain vegetation. Consequently, grass essential for feeding livestock cannot grow, and the livestock carrying capacity reduces (German Cooperation Deutsche Zusammenarbeit, 2015). Harvesting this bush offers great potential for the energy sector in Namibia. As the former Ministry of Trade and Industry representative in Namibia, Ben Amathlia commented, "[Bush to Energy is] a source we can use to generate our own electricity, involving the poor stricken people of our country, instead of spending close to N$3 billion annually to buy electricity from outside countries," (German Cooperation Deutsche Zusammenarbeit, 2015).

One technique of processing the bush, is to convert the wood chips from the processed bush into firewood. Namibian citizens use more than two thousand tons of firewood daily for cooking and energy needs. Developing firewood from processed bush would satisfy the national demand, and would also decrease illegal logging practices in Namibia (German Cooperation Deutsche Zusammenarbeit, 2015).

Bush energy is also ideal for establishing decentralized power supply. A five MW capacity plant could source a twenty-km radius, and a ten MW capacity plant could source a fifty-km radius. This amount of independent energy would allow for alternative ownership of power in the energy sectors. The national grid of energy has feed-in tariffs, where citizens must pay to add energy sources into the grid. Decentralized bush energy plants would allow for the establishment of mini-grids, which would reduce local dependency on government resources and decrease the cost of energy in rural communities. This would also motivate local democracies to participate in Bush-to-energy models, promote alternative local government models, and encourage development of self-sufficient communities (German Cooperation Deutsche Zusammenarbeit, 2015).

The future of Bush-to-energy lies in promoting and upscaling the process of encroacher bush. Industries will need to be competitive and reliable in their supplies of bush wood chips. Harvesting bush will also have to increase drastically to guarantee a constant supply of bush. For the bush-to-energy industry to successfully upscale, future harvesters and processors must cooperate to ensure successful operation (German Cooperation Deutsche Zusammenarbeit, 2015). Biomass energy will allow new groups to enter the market. Farmers have an opportunity to grow and sell a variety of plants to companies. These companies can utilize these plants as sources of biomass to produce the desired energy product (Gustafson, n.d.).

Advantages. Bush energy can not only save Namibia billions of dollars, but establish new jobs and counteract the negative effects of the encroacher bush (German Cooperation Deutsche Zusammenarbeit, 2015). As with the other forms of renewable energy, Bush to Energy can provide a variety of jobs for unemployed Namibians (Ferroukhi et. al., 2016). Bush-to-energy requires both skilled and unskilled workers to collect these plants for the power plants (BioPact, 2007). In addition, the use of this form of renewable energy allows for the ecosystem to grow, as more desirable plants will grow in the bush's place and animals will migrate to these restored areas (Ben-Shahar, 1992). Herbivore activity will increase because of the removal of the encroacher bush because new, native plant species will flourish (Ben-Shahar, 1992).

Disadvantages. If the process uses the wrong source of biomass, adverse effects occur in the ecosystem, thus affecting both plants and animals. Consequently, if implemented in Namibia, the country's total greenhouse gas emissions will increase because carbon dioxide is a byproduct of burning biomass (How BioPower Works, n.d.). Also, Namibia currently lacks the guidelines in regards to harvesting the encroacher bush. The government must place a limit on the types and amounts of each plant harvested (Gustafson, n.d.). The government must prioritize these issues before proceeding with bush to energy ("Utilisation of Namibian Encroacher Bush", 2015).

2.6 Summary

Namibia is a country that imports most its energy, but strives to increase its energy production through the implementation of renewable energy sources. The different candidates for renewable energy in Namibia include: wind, solar, and Bush-to-energy. The Namibian government want to educate the Namibian youth on renewable energy to ensure future consumers and technical employees. The goal of this project is to assist in the education of disadvantaged Namibian youth by providing good educational practices using interactive and engaging lessons.

Chapter 3: Methodology

This project aims to assist EduVentures Trust in developing interactive SMART lesson modules to further educate rural high school learners on renewable energy topics for implementation in the Ombombo mobile classroom. The team will work on this project from March 13th, 2017 to May 5th, 2017. The development of the modules will follow the process presented in Figure 3. 1 below.

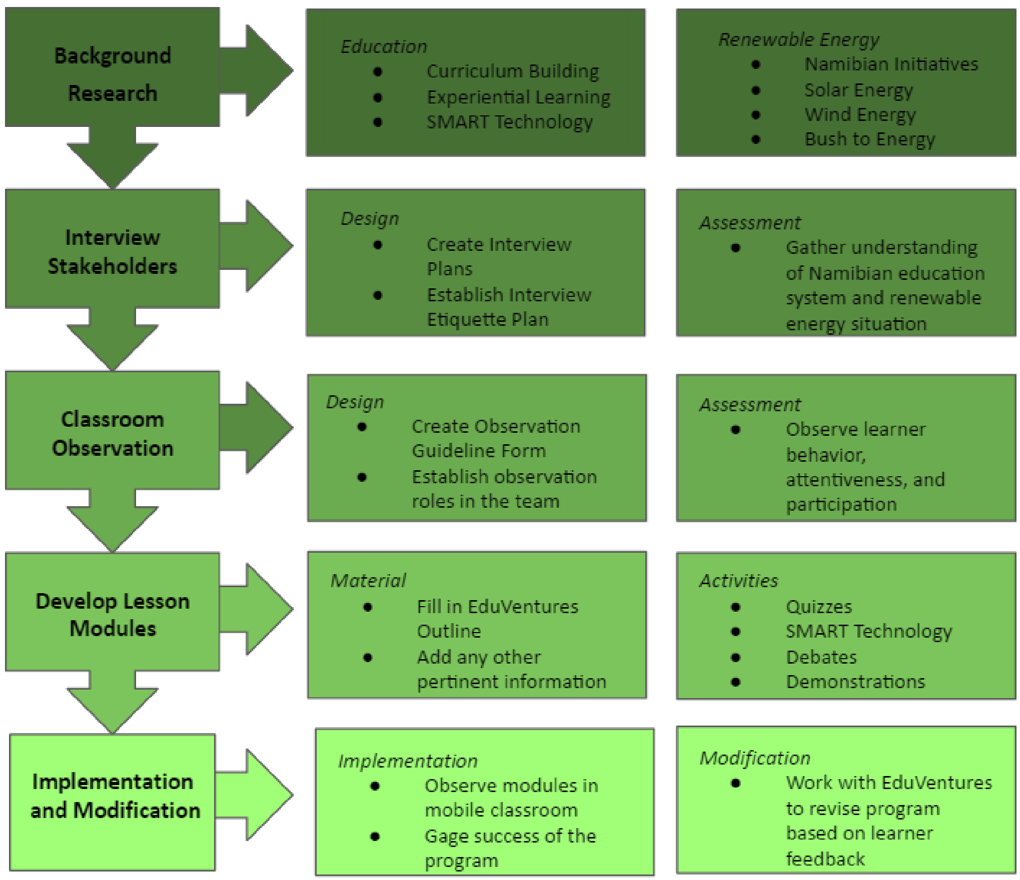

Figure 3. 1: Map of Objectives

The project timeline for accomplishing the team’s goals is listed in Table 3. 1.

Table 3. 1: Anticipated Timeline of the Project

<table>
<tr><th>Project Goals</th><th>Task</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th></tr>
<tr><td rowspan="3">Research of Namibian Education and Curriculum</td><td>Interview Stakeholders</td><td style="background:#6aa84f"></td><td style="background:#6aa84f"></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Observe Classroom</td><td style="background:#6aa84f"></td><td style="background:#6aa84f"></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Analyze gathered data</td><td></td><td style="background:#6aa84f"></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Design of Modules on Renewable Energy</td><td>Create Lesson Plans</td><td></td><td style="background:#6aa84f"></td><td style="background:#6aa84f"></td><td style="background:#6aa84f"></td><td></td><td></td><td></td></tr>
<tr><td>Create Learning Activities</td><td></td><td></td><td style="background:#6aa84f"></td><td style="background:#6aa84f"></td><td></td><td></td><td></td></tr>
<tr><td>Finalize Modules</td><td></td><td></td><td></td><td></td><td></td><td></td><td style="background:#6aa84f"></td></tr>
<tr><td rowspan="3">Implementation and Modification of Modules into Mobile Classroom</td><td>Implement Modules</td><td></td><td></td><td></td><td></td><td style="background:#6aa84f"></td><td></td><td></td></tr>
<tr><td>Observe Modules</td><td></td><td></td><td></td><td></td><td style="background:#6aa84f"></td><td></td><td></td></tr>
<tr><td>Modify Modules</td><td></td><td></td><td></td><td></td><td style="background:#6aa84f"></td><td style="background:#6aa84f"></td><td></td></tr>
<tr><td rowspan="2">Evaluation and Recommendations of Modules to EduVentures</td><td>Evaluate</td><td></td><td></td><td></td><td></td><td></td><td style="background:#6aa84f"></td><td style="background:#6aa84f"></td></tr>
<tr><td>Create Recommendations</td><td></td><td></td><td></td><td></td><td></td><td style="background:#6aa84f"></td><td style="background:#6aa84f"></td></tr>
</table>

This project will focus on implementing renewable energy education throughout Namibia. EduVentures Trust provides supplementary education to rural villages. Supplementary education is an additional form of education located outside the learners’ primary school environment. Although the Ombombo mobile classroom is a formal education setting, EduVentures considers it as supplementary education because it is an impermanent form of education for participants. The remainder of this chapter discusses the following objectives:

- Interview stakeholders
- Observe local classrooms
- Develop lesson modules and interactive activities
- Create student evaluation
- Test lesson plans in mobile classroom

3.1 Guidelines

The team will gather information on topics regarding education and renewable energy from interviews and classroom observations. These will follow two guidelines: design and assessment, which are defined below.

- **Design**: This process will contain steps that lead to the development of four lesson modules. The team will achieve this using interviews, classroom observations, and student evaluations.
- **Assessment:** Within this process, the team will analyze the information gathered from the interviews and classroom observations for assistance when designing the

four modules.

3.1.1 Interviewing

Before developing the modules, the team will conduct interviews with stakeholders. The team developed a list of all potential stakeholders, depicted in Figure 3. 1. 1.

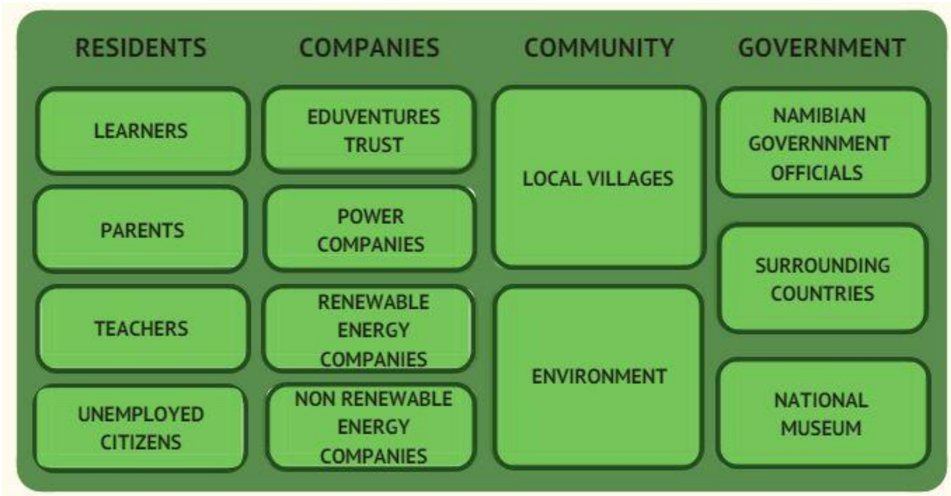

Figure 3. 1. 1: Diagram of All Potential Stakeholders

The four most relevant and accessible stakeholders include high school learners, local high school teachers, EduVentures employees, and Namibian Government officials. The team will interview three individuals from each stakeholder category, performing a total of 12 interviews over the course of the first two weeks on site. The purpose of these interviews is to gather additional background information and preliminary data about renewable energy topics, Namibian education, and learner engagement.

Design:

The team developed four complete semi-structured interview plans, provided in Appendices A-D. One interviewer and one transcriber will conduct each interview, in person when possible. The entire project team will not be present at every interview, as it may be overwhelming for the stakeholder. Each interviewer will follow Linda Ferguson's guideline to conducting a successful interview (see Table 3. 1. 1).

Table 3. 1. 1: Interview Criteria (Ferguson, 2002)

1	Approach visitors in a relaxed way with an expectation of cooperation
2	Speak with a well projected, clear, and easily understood voice
3	Listen to and understand others
4	Recognize nonverbal communication
5	Maintain a professional and friendly attitude
6	Show only polite interest with responses
7	Probe for opinions, attitudes, and emotions in a non-directive manner
8	Record all responses and information obtained
9	End by leaving the respondent feeling positive about the interview experience

Before the interview, the interviewer will read the project's goals and confidentiality statement to the interviewee. The informed consent statement articulates the following: "It is possible that any information provided may be used as a reference in our final report, which will be published on the Internet. Do you feel comfortable with this? You may ask that your name be kept private. Additionally, you do not have to answer any question that you are not comfortable with, and can choose to stop the interview at any time." Should the interviewee give consent to continue following the reading of the informed consent and project descriptions, the interviewers will ask the questions relevant to that individual. Unless the interviewee says otherwise, the transcriber will record the name of the individual. For demographics, the team has no preference in regards to the teachers, EduVentures employees, or Government officials. For the learners, however, the team wishes to interview learners in grades 8-12, which is approximately 11- 17 years of age, as this is the age of the learners that will be experiencing the team's modules. Table 3. 1. 2 below provides the complete list of all interview questions, separated by the goals that the team needs to achieve before developing the modules.

Table 3. 1. 2: Outline of interview Questions separated by overarching goal

Goal of interview	Stakeholder being interviewed	Questions
To learn about past expeditions and successes of EduVentures	EduVentures Employees	● Why do you think EduVentures' Program is so successful? ● What do learners typically remember most from these lessons and expeditions? ● What are the different types of lessons that EduVentures teaches?
To understand more about learner experience in the classroom	High school Teachers	● What is the biggest challenge that the team will face working with junior/senior secondary learners? ● Typically, when are the learners most focused during the lessons? Why do you think that is? ● Typically, when are the learners least focused during the lesson? Why do you think this at happens at this specific point in the lesson? ● What previous background in renewable energy topics can we expect from the learners? ● How do learners receive renewable energy lessons?
	Learners	● When you think of school, which activity stands out as your favorite? Why is this particular activity your favorite? ● When you think of school, which activity stands out as your least favorite?

		Why is this activity your least favorite? ● During the lesson, at what moments do you find yourself most distracted or not focused? Why do you think that is? ● Do you find demonstrations or games in class helpful? Why or why not? ● How would you define renewable energy? What is the first example that comes to mind? ● Has anything you learned in class inspired you to pursue a career?
To further develop an understanding of Namibia's renewable energy goals and initiatives	Government officials	● What is your opinion on educating Namibian youth in Renewable Energy Topics such as wind energy, solar energy, and bush to energy? ● What do you believe to be the biggest threat to the sustenance of Namibia's environment? ● How feasible do you believe it is for Namibia to become entirely self-sufficient in its energy sources? How many years do you believe it will take? Why? ● How supportive will the government be of the addition of renewable energy education into the school system, in both urban and rural districts? How much support will they provide to these schools?
To learn about successful teaching methods, curriculum building, and the integration of interactive activities	EduVentures Employees	● What teaching methods do you find most effective in the mobile classroom? ● How does EduVentures maintain variability in the types of lesson plans, to keep learners engaged in the class, even though currently only one subject is taught? ● Personally, what important information do you think we should incorporate into our renewable energy lesson modules? ● What do you hope that the learners gain from the lessons on renewable energy? ● From your experience, how do EduVentures' lesson plans differ from those taught in a more traditional classroom setting?
	High School Teachers	● What are important aspects to include in a successful science curriculum for junior/senior secondary learners? ● What is the least successful part in a science curriculum for junior/senior secondary learners? ● How do you make lessons interactive and engaging for the learners? How successful were these methods? ● What do you think we should add to our lesson modules? ● Have you heard of *Vision 2030*? Has *Vision 2030* changed how you create a lesson plan? If yes, how so?

Assessment:

Four overarching goals for these preliminary interviews are stated in Table 3. 1. 2 above: to learn about past expeditions and successes of EduVentures; to understand more about learner experience in the classroom; to further develop an understanding of Namibia's renewable energy goals and initiative; and to learn about successful teaching methods, curriculum building, and the integration of interactive activities. With additional background information on EduVentures from primary sources, the team will integrate the core values and successful techniques from past programs into the anticipated lesson modules. From interviewing local learners and using observational tactics to identify common themes, the team will gain a unique point of view on Namibian education and will use this information to tailor the lesson modules to what will engage learners the most. Interviewing government officials on the current renewable initiatives will hopefully provide the team with a broad view of the project's importance. These interviews will also present the team with additional information to implement in the "Introduction to Renewable Energy in Namibia" modules. Finally, interviewing both EduVentures staff and high school teachers will ensure more understanding on how to develop a successful curriculum in an engaging and educational fashion.

3.1.2 Classroom Observation

Gaining insight into teaching techniques and classroom behavior requires that the team contact the Windhoek High School and the St. George's Diocesan School to observe science classes. The information collected at both schools will provide information on many topics regarding education. The team selected these two schools because of their proximity to the EduVentures headquarters. Visiting more than one school allows for a larger variety of responses. One of the schools is public while the other is one private. Private schools tend to have higher standards than public schools in regards to the expectations of the learners and the depth of the material presented. The diverse information collected will allow for the exploration and implementation of multiple teaching methods in the lesson modules.

Design:

The observation form (Appendix G) is a method of data collection using a physical version of this document. It will present information on classroom organization, instructional style, clarity, learner participation, presentation of material, activities, and impact. The purposes of each section are:

- *Organization* of the observed lesson will provide both the successful and unsuccessful methods used to organize the modules
- *Instructional style observation* looks for effective teaching methods and considers different types of lecture styles
- *Clarity* observes the teacher's speech and provided explanations
- *Learner participation* observes learner engagement during the lesson
- *Presentation of material* evaluates the correlation between presented material and clear learner stimulation
- *Activities* focuses on incorporating interactive activities, such as demonstrations, in the lessons. The team will note the length of time dedicated to activities and to lecture
- *Impact* looks for learner critical thinking during the lesson.

During each observation, all four team members will be in the classroom. Each team member will have a predetermined category on the observation form. This method will allow each member to focus on their assigned categories and gather the most information possible.

Assessment:

The purpose of observation in this project is to expose the team to Namibian teaching styles and gather successful and unsuccessful teaching techniques. The team chose the categories of the observation form because they will give insightful information during module development. The applications of each of these categories are listed below:

- *Organization*
    - The team will organize the EduVentures curriculum to implement successful

aspects of the high schools' lessons

- *Instructional style observation*
    - The team will note the different lecture styles during observation and implement them into the created curriculum to ensure variability during the program
- *Clarity*
    - The team will create a teacher's guide to ensure that explanations provided to the learners are clear and correct
- *Learner participation*
    - The team will watch for disengagement of learners and note the aspect of the lesson that caused disengagement. The team will not use aspects of the lesson that caused learners to lose interest
- *Presentation of material*
    - The team will note presentations that ensured learner understanding and stimulation, and replicate them in the modules
- *Activities*
    - The team will observe the activities to see if they were successful; if successful, the team will develop similar activities to fuse into the modules
- *Impact*
    - The team will reflect on the overall impact of the lesson and use similar techniques when compiling the conclusion portion of the modules

During the process of observing the classroom and teaching styles, the team will note any similarities and differences of the current lesson plan to the Eight Phases of Curriculum Development mentioned in Section 2.4.6.

3.2 Designing the Modules

The deliverable of this project is four interactive lesson modules. These modules will balance important content about renewable energy and interactive activities. This project will develop these modules after assessing the current Namibian education system through interviews and classroom observations. The development of each module will follow a specific process:

1. Perform background research
2. Develop the modules
3. Infuse games and SMART Technology
4. Link the module to real world problems

The team aims to complete the modules by the fifth week, leaving two weeks to implement and modify the modules for future use.

Overall, this investigation will follow the Eight Phases of Curriculum Development mentioned in Section 2.4.6. At the beginning of each module, the facilitator will introduce the goal of the module and facilitate a discussion about what current knowledge the learners already possess. Next, the classroom will move into a quick "warm-up" activity to stimulate the learners before moving into the bulk of the material. After the completion of the lesson plan, activities and games will solidify the learners' new knowledge. These activities will move from large group activities for a general review of the material, to smaller group activities to facilitate discussion about the learners' attitudes. The learners will then work on a quiz or a review activity individually to gage the amount of knowledge gained from the specific module. Finally, the classroom will reconvene to summarize the lesson and discuss how the lesson fits into the "greater picture".

3.2.1 Important Considerations for Lesson Plan Development

As mentioned in the background, there are several aspects to consider when developing an environmental education program. In Athman's approach, the lesson must include the following themes: awareness, knowledge, attitude, skills, and participation. The introductory module will provide learner awareness, highlighting the problems throughout Namibia in regards to energy generation. The following three modules will provide the learners with background information on each renewable energy technology and their potential impacts in Namibia. The facilitator must then work with the participants to help develop ethic responsibility for the future of the nation. The conclusion activity will achieve this in the form of a debate or discussion. Finally, the facilitator will provide resources and contacts for the learners if they want to continue their education in the renewable energy fields, and encourage the learners to share their new knowledge in their surrounding communities (Athman, 2001).

Section 2.4.4 discusses the successful experiential techniques in environmental education which include: stimulating student interest in nature, participatory learning, flexibility, and technological integration (Dunham, Hawks, Lyles, Misera, 2015). The team's lesson plan will incorporate these successful techniques. First, the lessons will stimulate the learners' interest in nature by discussing the impacts of climate change and foreshadowing the bleak future if Namibia does not implement renewable energy. Next, learners will participate in several interactive activities and games throughout the entire program to ensure participatory learning. Experiential learning techniques provide flexibility to lesson plans because each student may participate differently. Finally, the mobile classroom, equipped with SMART Technology, will provide technological integration into the lesson plans.

3.2.2 Perform Background Research

During the seven-week preparation period, the team heavily researched background information on the four provided modules: introduction to renewable energy, wind energy, solar energy, and bush-to-energy. Creating lesson plans requires extensive knowledge in the subject material. The material researched included Namibian energy initiatives, advantages and disadvantages of the different forms of energy generation, socio-economic impacts, and the feasibility of implementation in Namibia. In addition, the research focused on strategies for developing successful lesson plans within the current education system in Namibia. Conducting research prior to arriving in Namibia enables the team to focus on interviews and observations upon arrival.

3.2.3 Module Development

Developing a lesson module means building an educational curriculum for use in a classroom setting with the intent to teach to learners. Learners in rural areas of Namibia will have the opportunity to attend classes in EduVentures mobile classroom that focus on biodiversity, sustainability, and renewable energy. The team will develop four different modules, focusing on an overall theme of renewable energy, solar energy, wind energy, and bush-to-energy. EduVentures teachers will then introduce each module in the mobile classroom as a test run. Each module will incorporate SMART technology, interactive games, activities, and demonstrations.

The EduVentures staff provided an outline, located in Appendix F, to highlight the information required for each module. Table 3. 2. 1 shows an adapted version of the outline.

Table 3. 2. 1: Brief Outline of the Modules

Introduction to Renewable Energy	● What is renewable energy ● History of renewable energy ● Climate change ● Namibian need for renewable energy ● Types of renewable energy
Wind Energy Solar Energy Bush to Energy	● What is it? ● Why should Namibia use it? ● Operation and Maintenance ● Where could it be used in Namibia? ● Advantages and disadvantages

The first module acts as the general overview of renewable energy topics. The other three modules focus on three forms of renewable energy and provide the learners with significant background on each form of energy. The team will use the background research collected to fill in the outline to include all the information EduVentures requested. Once this outline is complete, the team will integrate interactive activities and SMART technology.

3.2.4 Infuse Activities, Games, and SMART Technology

After the team develops the first draft of each module, games and activities will solidify the learners' understanding of the lesson material. The team will have access to SMART Notebook to develop each activity. Interactive games will allow the team to incorporate experiential learning techniques into the lesson plans. The program will integrate each game only once, to provide variety in the lesson plans and maintain learner engagement.

As described in Section 2.4.6, Brain Savvy is a competitive interactive board game that splits the learners into groups. The activity is most effective at the end of a lesson or the program, as the learners can brainstorm answers together in response to the question asked by the teacher. It will also help determine the effectiveness of each lesson. Another similar game is the Game show (see Figure 3. 2. 1).

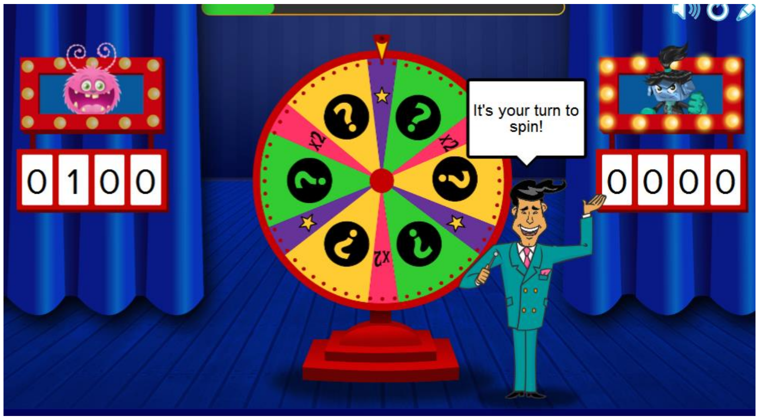

Figure 3. 2. 1: Overview of Game Show game on SMART Exchange

After a module, the learners will split up into two teams and compete against each other. The game can incorporate similar or identical questions in previous activities to convey information in different ways and improve retention. Figure 3. 2. 2 is an example of a possible question. These games will summarize the overall themes from each module.

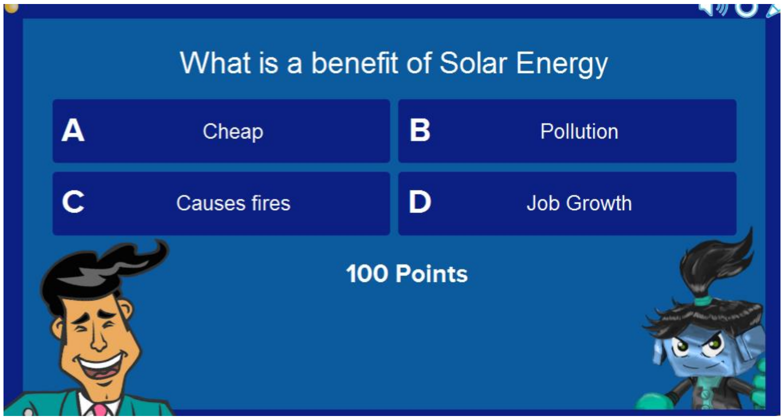

Figure 3. 2. 2: Example of a question from Game Show game

Activities developed for each lesson include matching and fill in the blanks (see Figure 3.2.3). These activities allow the learners to actively participate in the lesson without the pressure of competing with their peers. Learners can come up and interact with the SMART board while asking the teacher questions about the lesson. These activities also establish a great "warm-up" activity.

Figure 3. 2. 3: An Example of a Fill in the Blank game through SMART Exchange

An activity that would incorporate Athman's approach into the lessons would be a debate after the Renewable Energy Module. The learners will hopefully establish an ethic stance on renewable energy by participating in the debate. Preparation for the debate would also follow the steps of the Kolb's cycle, as the learners would have to be exposed to their own stance, reflect on how they want to approach the problem, conduct research and develop their argument, and then implement their stance in the actual debate. The teacher will facilitate the debate and split the learners into two groups; one group could act as the government who is "for" the transition and the other group could be energy suppliers who are "against" the transition. Questions posed during the debate could include:

- What are the advantages of renewable energy?
- How will the transition to renewable energy stimulate the work force?
- What impacts on the environment do some renewable sources have? Are they good or bad?
- Would one renewable energy with better than another? Explain.

Discussing these and similar questions above introduces ethical decisions and responsibilities to the learners

3.2.6 Connection to Real World Problems

A connection to real world problems is important because it persuades learners to establish a moral responsibility and ethic approach to the lesson. These connections will show the learners how renewable energy plays a role of both a global and local scale. The global scale will depict the effects of renewable energy implementation in other countries throughout the globe. However, the team will focus on the local effects; as the examples, will show what is at stake in Namibia.

Once the teacher completes the Renewable Energy module, the learners will participate in the debate described in Section 3.2.4. The learners will provide arguments for their side of the topic and present them. Once the learners complete the debate, the teacher will hold an open discussion regarding the debate and the learners' opinions on renewable energy. This will allow open expression of personal opinions in a nonjudgmental setting alongside their peers. The modules will include facts about renewable energy, however they do not allow the learners to establish an opinion on renewable energy. By linking the problems to real world applications, the learners will hopefully establish an opinion on renewable energy that will thrust the youth towards the future.

3.3 Implementation and Modification of Lesson Modules

Implementation:

After significant development of the modules, the team will implement the program with EduVentures in the Ombombo mobile classroom. The team will tentatively depart on this expedition during beginning of the fifth week in Namibia, though exact dates are subject to change depending on EduVentures' funding. EduVentures will integrate the team's modules during their week-long program. This investigation will again use the Observation Form, discussed in Section 3.1.2, to evaluate the effectiveness of the lessons. Each team member will have predetermined aspects of the program to focus on. This will enable each member to concentrate on their respective tasks and gather the most information possible for each category. At the end of each module, the team will distribute a lesson evaluation to the learners (seen in Appendix G). This will ensure that the team obtains specific feedback for each lesson module. Teachers will distribute a series of quizzes for each lesson module to evaluate how much knowledge the learners retained from each lesson plan. The team will create the quizzes after the development of the modules.

Modification:

From the observations, evaluations, and quizzes, the team will compile and separate the data into several categories, such as positive and negative comments, proposed changes, level of retention for each module, and additional comments. The team will analyze this data in coordination with EduVentures, and revise the modules accordingly. The extent of revisions needed is dependent on learner evaluations, quizzes, and any changes encouraged by the EduVentures staff.

Chapter 4: Conclusion

The main goal of this project is to provide the EduVentures Trust with four interactive renewable energy modules to implement in their Ombombo mobile classroom. The rural learners in the program will learn about new renewable energy technologies, and the future integration of these technologies throughout their nation. The above research and proposed methodology will allow the team to meet EduVentures Trust's educational goals, and begin to combat the educational injustice in rural villages.

Bibliography

Amatya, R., Brushett, F., Campanella, A., Maurano, A., Kavlak, G., Macko, J., . . . Tuller, H. (2015). *The future of solar energy*. Cambridge, MA:

Ben-Shahar, R. (1992). The effects of bush clearance on African ungulates in a semi-arid nature reserve. *Ecological Applications, 2*(1), 95-101. doi:10.2307/1941892

Benyamin, L. T., & Nantanga, L. I. *The Namibia national climate change committee (NCCC) evaluation and the possibility of establishing the regional climate change committees (RCCCs).* (). Namibia: Ministry of Environment and Tourism (MET).

Biraimah, K. L. (2016). Moving beyond a destructive past to a decolonised and inclusive future: The role of ubuntu-style education in providing culturally relevant pedagogy for Namibia. *International Review of Education, 62*(1), 45-62. doi:10.1007/s11159-016-9541-1

Chin, L.Education in Namibia. Retrieved from http://knownamibia.weebly.com/education.html

Chioreso, E., & Begbie-Clench, B. (2015). *Think Namibia: Land degradation*. House of Democracy: Hanns Seidel Foundation of Namibia.

Chioreso, E., & Munyayi, R. (2015). *Think Namibia: Climate smart agriculture*. House of Democracy: Hanns Seidel Foundation Namibia.

Classroom observation form (2013). Retrieved from https://www.slideshare.net/SusanMurphyLCC/classroom-observation-form-27312652

Concentrating solar power (CSP) technologies. Retrieved from http://solareis.anl.gov/guide/solar/csp/

Deng, Z. (2016). Bringing curriculum theory and didactics together: A Deweyan perspective. *Pedagogy, Culture & Society, 24*(1), 75-99. doi:10.1080/14681366.2015.1083465

Erixon Arreman, I., Erixon, P., & Rehn, K. (2016). Postcolonial teacher education reform in Namibia: Travelling of policies and ideas. *European Educational Research Journal, 15*(2), 236-259. doi:10.1177/1474904115612794

Experiential learning defined. (2017). Retrieved from https://facultyinnovate.utexas.edu/teaching/strategies/overview/experiential-learning

Felby, C., & Bentsen, N. (2011). Biomass for energy in the European Union - a review of bioenergy resource assessments. *Biotechnology for Biofuels,* Retrieved from https://biotechnologyforbiofuels.biomedcentral.com/articles/10.1186/1754-6834-5-25

Ferguson, L. (2002). *Evaluation and visitor research special interest group.* ().EVRSIG Publications Committee.

Gaspar, F., Deac, T., Tutunaru, L. V. F., & Moldovanu, D. (2016). Experimental study on the sun tracking ability of a spherical solar collector. *Energy Procedia, 85*, 220-227. doi:10.1016/j.egypro.2015.12.227

Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) GmbH (Producer), & German Cooperation Deutsche Zusammenarbeit (Director). (2015). *GIZ: De-bushing Namibia.* [Video/DVD] Namibia: Federal Ministry for Economic Cooperation and Development.

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: Interviews and focus groups. *British Dental Journal, 204*(6), 291-295. doi:10.1038/bdj.2008.192

Hansen, R. E. (1995). Five principles for guiding curriculum development practice: The case of technological teacher education. *Journal of Industrial Teacher Education, 32*(2) Retrieved from https://scholar.lib.vt.edu/ejournals/JITE/v32n2/hansen.html

Integrated Southern Africa Business Advisory, (INSABA).*Development of RE in the South Africa and Namibia..*

Jackson, R. (2017). Global climate change: Effects. Retrieved from https://climate.nasa.gov/effects

John Dewey's theories of education. *International Socialist Review, 21*(1, Winter 1960) Retrieved from https://www.marxists.org/archive/novack/works/1960/x03.htm

Jong, W. d., & Ommen, J. R. v. (2014). *Biomass as a sustainable energy source for the future: Fundamentals of conversion processes* John Wiley & Sons.

Kandpal, T. C., & Broman, L. (2014). Renewable energy education: A global status review. *Renewable and Sustainable Energy Reviews, 34*, 300-324. doi:10.1016/j.rser.2014.02.039

Kelly, A. V. (2009). *The curriculum* (6th ed. ed.). GB: Sage Publications Ltd. Retrieved from https://books.google.com/books?hl=en&lr=&id=qILGb7xcXFIC&oi=fnd&pg=PP1&dq=vic+kelly+curriculum+theory&ots=MvS6tWnMmu&sig=BFbFXJrl7TiaqFVFLv7XclnSkaE#v=onepage&q=vic%20kelly%20curriculum%20theory&f=false

Kolb, D. (2014). *Experiential learning: Experience as the source of learning and development* (2nd ed.) Pearson FT Press. Retrieved from http://proquest.safaribooksonline.com/book/social-sciences/9780133892512/introduction/pre04lev1sec01_html

Ministry of Education. (2011). World data on education- Namibia. *Unesco-Ibe,* (7th edition), 6-10.

Ministry of Environment & Tourism. (2011). *National policy on climate change for Namibia.* Republic of Namibia.

Minnis, J. R. (2006). Nonformal education and informal economies in sub-saharan Africa: Finding the right match. *Adult Education Quarterly, 56*(2), 119-133. doi:10.1177/0741713605283432

Munyayi, R., Ileka, H., & Chiguvare, Z. (2015). *Think Namibia: Renewable energy*. House of Democracy: Hanns Seidel Foundation Namibia.

Namibian education system. (2012). Retrieved from http://www.classbase.com/countries/Namibia/Education-System

Namibian, T. (2007). On the rural/urban schools divide. Retrieved from http://www.namibian.com.na/index.php?page=archive-read&id=35400

National Planning Comission. (2004). *Vision 2030.*Government of the Republic of Namibia.

Oxford English Dictionary. *Definition of arid in English*

Pelissari, A. (2017). In Pelissari K. (Ed.), *Interview with a middle school history teacher*

Reinhard, K., Pogrzeba, A., Townsend, R., & Pop, C. A. (2016). A comparative study of cooperative education and workintegrated learning in Germany, South Africa, and Namibia. *Asia-Pacific Journal of Cooperative Education, 17*(3), 249-263.

Disaster and risk management act, (2012).

Republic of Namibia - Ministry of Education, Arts, and Culture. (2017). Ministry of education - Namibia. Retrieved from http://www.moe.gov.na/

Sebitosi, A. B., & Pillay, P. (2008). Renewable energy and the environment in South Africa: A way forward. *Energy Policy, 36*(9), 3312-3316. doi:10.1016/j.enpol.2008.05.013

Shwartz, M. (2016, October 20,). New perovskite solar cell design could outperform existing commercial technologies, stanford and oxford scientists report. *Stanford News* Retrieved from http://news.stanford.edu/2016/10/20/perovskite-solar-cell-design-shows-promise/

SMART Notebook. (2009). *Brain savvy teaching tool*. SMART Exchange:

SMART Notebook, & Brian. (2016). *Sort renewable and non- renewable energy*. SMART Exchange:

Song, Y. I. K. (2008). Exploring connections between environmental education and ecological public art. *Childhood Education, 85*(1)

TEACHING, TECHNOLOGY, AND LEARNING: Understanding the interconnection. (2016). SMART Technologies: Filigree Consulting.

The Solar Foundation. (2015). National solar job census. Retrieved from http://www.thesolarfoundation.org/national/

U.S. Department of Energy. (2012). *Sunshot vision study*

U.S. Department of Energy Federal Energy Management Program (FEMP). (2016). Biomass for electricity generation. Retrieved from https://www.wbdg.org/resources/biomass-electricity-generation

UNESCO. (2004). *National report on the development of education in Namibia*.

US EPA, O. A.What is environmental education? Retrieved from https://www.epa.gov/education/what-environmental-education

Utilisation of Namibian encroacher bush. (2015).

Zyadin, A., Puhakka, A., Ahponen, P., Cronberg, T., & Pelkonen, P. (2012). School students' knowledge, perceptions, and attitudes toward renewable energy in jordan. *Renewable Energy, 45*, 78-85. doi:10.1016/j.renene.2012.02.002

Appendix A: EduVentures Employee Interview Plan

Stakeholder Category: EduVentures Employees
Interviewer:
Transcriber:
Interviewee name & Position (if permission is granted):
Date:
Time:
Location:
Project Description and Goal: We are a team of four learners from Worcester Polytechnic Institute, working in conjunction with EduVentures Trust i to produce four modules on renewable energy. To achieve this goal, we would like to interview you on information regarding past projects at EduVentures and your opinions regarding them.
Confidentiality Statement: It is possible that any information provided may be used as a reference in our final report, which will be published on the internet. Do you feel comfortable with this? You may ask that your name be kept private. Also, you do not have to answer any question that you are not comfortable with, and can choose to stop the interview at any time.
Q: What do you hope the learners gain from the lessons on renewable energy? A:
Q: Why do you think EduVentures' program is so successful? A:
Q: What do learners typically take away most from these lessons and expeditions? A:
Q: What teaching methods are most effective in the mobile classroom? A:
Q: From your experience, how do EduVentures' lesson plans differ from lesson plans taught in a more traditional classroom setting? A:
Q: What are the different types of lessons that EduVentures teaches? How does EduVentures ensure that there is variety in the types of lesson plans so that learners remain engaged? A:
Q: Personally, what do you think that we should incorporate into our lesson modules? A:
Additional Comments:

Appendix B: High School Learner Interview Plan

Stakeholder Category: Local (Windhoek) High School Learners
Interviewer:
Transcriber:
Date & Time:
Location:
Project Description and Goal: We are a team of four learners from Worcester Polytechnic Institute, working in conjunction with EduVentures Trust to produce four modules on renewable energy. To achieve this goal, we would like to interview you on information regarding educational techniques and information presented to you during lessons.
Confidentiality Statement: It is possible that any information provided may be used as a reference in our final report, which will be published on the internet. Do you feel comfortable with this? You may ask that your name be kept private. Also, you do not have to answer any question that you are not comfortable with, and can choose to stop the interview at any time.
Interviewee name:
Grade level:
Q: When you think of school, which activity stands out as your favorite? Why is this particular activity your favorite? A:
Q: When you think of school, which activity stands out as your least favorite? Why is this particular activity your least favorite? A:
Q: During the lesson, at what moments do you find yourself most distracted or not focused? Why do you think that is? A:
Q: Do you find demonstrations or games that are performed in class helpful? Why or Why not? A:
Q: How would you define renewable energy? What is the first example that comes to mind? A:
Q: Has anything you learned in class inspired you to pursue a career? A:
Additional Comments:

Appendix C: High School Teacher Interview Plan

Stakeholder Category: Local (Windhoek) Teachers
Interviewer name:
Transcriber:
Interviewee name (if permission was granted):
Date & Time of Interview:
Location:
Project Description and Goal: We are a team of four learners from Worcester Polytechnic Institute, working in conjunction with EduVentures Trust to produce four modules on renewable energy. To achieve this goal, we would like to interview you on information regarding educational techniques and curriculum building.
Confidentiality Statement: It is possible that any information provided may be used as a reference in our final report, which will be published on the internet. Do you feel comfortable with this? You may ask that your name be kept private. Also, you do not have to answer any question that you are not comfortable with, and can choose to stop the interview at any time.
Q: What is the biggest challenge that the team will face working with junior/senior secondary learners? A:
Q:What are important aspects to include in a successful science curriculum for junior/senior secondary learners? A:
Q: What is the least successful part in a science curriculum for junior/senior secondary learners? A:
Q: Typically, when are the learners most focused during the lessons? Why do you think that is? Typically, when are the learners least focused during the lesson? Why do you think that is? A:
Q: How do you make lessons interactive and engaging for the learners? How successful were these methods? A:
Q: What previous background in renewable energy topics can we expect from the learners? A:
Q: How do learners receive renewable energy lessons? A:
Q: What do you think we should add to our lesson modules? A:
Q: Have you heard of *Vision 2030*? Has *Vision 2030* changed how you create a lesson plan? If yes, how so? A:
Additional Comments:

Appendix D: Namibian Government Official Interview Plan

Stakeholder Category: Government Officials
Interviewer:
Transcriber:
Interviewee Name/Position (if permission was granted):
Date & Time of Interview:
Location:
Project Description and Goal: We are a team of four learners from Worcester Polytechnic Institute, working in conjunction with EduVentures Trust to produce four modules on renewable energy. To achieve this goal, we would like to interview you on information regarding renewable energy education and initiatives.
Confidentiality Statement: It is possible that any information provided may be used as a reference in our final report, which will be published on the internet. Do you feel comfortable with this? You may ask that your name be kept private. Also, you do not have to answer any question that you are not comfortable with, and can choose to stop the interview at any time.
Q: What is your opinion on educating Namibian youth in Renewable Energy Topics such as wind energy, solar energy, and bush to energy? A:
Q: Do you have any ideas for improving the guidelines of processing harvested bush? If so, what are they? A:
Q: What do you believe to be the biggest threat to the sustenance of Namibia's environment? A:
Q: How feasible do you believe it is for Namibia to become entirely self-sufficient in its energy sources? How many years do you believe it will take for this to occur? Why? A:
Q: How supportive will the government be of the addition of renewable energy education into the school system, in both urban and rural districts? How much support will they provide to these schools? A:
Q: Do you think it will be possible for the public schools to implement a required course on renewable energy with the government's help? A:
Additional Comments:

Appendix E: Classroom Observation Forms (Modified from Murphy, 2013)

Observer(s):	Date:	Time:
Teacher:	Subject:	Grade level:
Area of lesson:	Observation:	Additional Comments:
Organization		
Instructional style		
Clarity		
Learner Participation		
Presentation of material		
Activities		
Impact		

Appendix F: Course Outline provided by EduVentures

Table of Content for SMART lesson on renewable energy in Namibia **SMART Lesson 1*: Renewable energy in Namibia*** - What is renewable energy - Discovery of fossil fuel (The Industrial revolution) - The link to Climate change - The path to renewable energy ***The need for renewable energy – A case study from Namibian*** - Combine social, environmental and economic aspects which calls for a need to use renewable energy in Namibia - Group activities on how to solve community problem ***Renewable energy sources*** - Mention all renewable energy sources worldwide - Biogas, sun, wind, nuclear, geothermal, wave, bush to energy - What are the opportunities for renewable energy in Namibia ● Solar ● Wind ● Bush to energy
SMART lesson 2*: Solar* - What is Solar power - Why solar power in Namibia - Solar power operation and maintenance - Where in Namibia - Advantages and disadvantages of Solar power - Activities and games
SMART lesson 3*: Wind* - What is Wind power - Why wind power in Namibia - Wind power operation and maintenance - Where in Namibia - Advantages and disadvantages of wind power - Activities and games
SMART lesson 4*:Bush to energy* - What is bush to energy - Why Bush to energy power in Namibia - Bush to energy power operation and maintenance - Where in Namibia - Advantages and disadvantages of Bush to energy power - Activities and games

Appendix G: End of Day Survey

Name: Date:

Was the information easy to understand?
What have you learned from this program?
What was the most interesting topic to learn about?
What was not interesting to learn about?
Did you find the games and activities fun? If not, please explain.
What would you change about this module?
Would you participate in a similar program if you had the opportunity?
Additional Comments: