Perceptions of Teachers’ Knowledge and Attitudes Towards Environmental Issues in Science Education – Case of Namibian Science Teachers.

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In many countries people are familiar with environmental issues while concern and threats continue. Since 1948 to date environmental issues have drawn more international and national attention meanwhile school through science education is seen as significant role player towards environmental education. Environmental issues cause hostile effect to the natural environment. In Namibian primary and secondary science education, environmental issues are thematically placed. Although science teachers have satisfactory knowledge about environmental issues, there are still some misconceptions and lack of knowledge in some cases while attitudes keep changing in different situations. Thus, the main aim of the study is to create awareness and sensitize environmental issues among science teachers by identifying such issues in science education curriculum.

In this case-study, mixed methods research was used. Semi-structured interviews with eight (8) participants was carried out in Spring 2018 while quantitative entries \( N=88 \) were recorded via an electronic questionnaire. In both cases expert purposive sampling of science teachers was applied.

Results show that science teachers perceive science education provides skills and knowledge as well as create awareness and sensitize pupils about environmental issues. In addition, knowledge about environmental issues among science teachers is satisfactory, especially in specific science subjects. Regarding science teaching strategies, teachers mainly use group work, technology and discussion while assessment is conducted through formative and summative assessment strategies. Overall, the perceptions of science teachers’ attitude towards the environment is positive.

**Avainsanat – Keywords** Environmental issues, Environmental Education, Knowledge, Attitude, Perceptions, Science education.
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<table>
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<th>Acronym</th>
<th>Description</th>
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<tr>
<td>EI</td>
<td>Environmental Issues</td>
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<td>EE</td>
<td>Environmental Education</td>
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<td>SE</td>
<td>Science Education</td>
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<td>UNAM</td>
<td>University of Namibia</td>
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<td>UN</td>
<td>United Nations</td>
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<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
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<td>ANOVA</td>
<td>Analysis of Variance</td>
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<td>PCK</td>
<td>Pedagogical Content Knowledge</td>
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<td>IBT</td>
<td>Inquiry-Based Teaching</td>
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<td>CITES</td>
<td>Convention for International Trade in Endangered Species</td>
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<td>IFCCC</td>
<td>International Framework Convention on Climate Change</td>
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<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
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1. INTRODUCTION

1.1 Context of the study

"I live in..., I school at... are some basic human experiences and association with certain environments, one such early formal environment is a school because” place matters in education, it always has, and it always will” (Thornburg, 2014, p. 1). School activities are environmentally bound while teachers and learners act within its boundaries. The concept environment has social, economic, ecological and political dimensions. In this study the focus is on natural (ecological/biophysical) environment which includes living and non-living things found in the environment. It is important to note that local, national and international economies practice different aspects of development including science teaching within and on the environment.

Since the beginning, people have worked on the environment to sustain daily needs and wants while the 20th century marked high negative environmental results, hence scholars in several disciplines and working at United Nations (UN), governments, private sector as well as civil organizations are all entangled in discussions regarding environmental issues. “Various actors have begun discussions and acting on transitions in favor of sustainable practices due to impact from environmental issues” (Van, 2012, p. 117). Thus, it calls for “global understanding of environmental/climatic change that covers various areas, arguing for action and resilience of affected local people” (Seely et al. 2008).

Adverse effects are experienced at all levels of society while future generations are at the center of sustainable development programs. In this scenario science teachers and schools are no exceptions and have an obligatory national duty to cultivate adequate scientific knowledge and skills about aspects of the environment among pupils. Their role is both individually as well as collective and need continuous creativity in teaching-assessment strategies coupled with technology.
1.2 **Historical perspectives of environmental issues and environmental education (EE)**

This section presents how environmental issues have shaped environmental education discipline to date. Moreover, a variety of definitions are given to elucidate the multifaceted nature of environmental issues, causes and potential solutions that interest science education in the school. Although, environmental education discipline is young in the context of the study, environmental issues are common and continue to pose threat to people.

Several concepts are used to describe environmental issues and have emerged ever since 1972 (UN conference on human environment, Stockholm) and 1992 (Earth summit, Rio de Janeiro, Brazil). Since then numerous themes have been discussed and shifted over time. The results are changes in the language regarding environmental concerns. ”As first envisioned in 1948 and 1978 environmental education promotes awareness and capabilities for sharing ideas so that active involvement can be realized” (Leicht, Heiss, & Byun. 2018) since then, the school became an important center for this role and environmental education discipline was established. ”More than the name change that happened from environmental protection to rhetoric sustainable development focused on economic growth. Other changes took place in science and development” (Fulton, De Silva, & Anton. 2012, p. 93 & 98). In other words, manufacturing industries, technology increased causing more pollutants in the environment.

![Figure 1. Old social problems and new sustainability challenges](image)

Adapted from (Jerneck, 2011, p. 71)
Individual context-based conceptions of environmental issues occur in every corner of the world. In this study environmental issues in Namibia are similar to those studied on international level which allow for common understanding. However, the most pressing environmental issue in an area may influence differences. These same environmental issues coded with different concepts (as illustrated in fig.3 above) are all over the world due to influence of media technology.

**TABLE 1. Contextualized definitions of environmental issues**

<table>
<thead>
<tr>
<th>Definition</th>
<th>Context</th>
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<tbody>
<tr>
<td>i  Environmental issue means” occurrences which threaten human living conditions caused by natural species (e.g. mosquito invasion in a local areas)” (Lidskog, 2013).</td>
<td>Social</td>
</tr>
<tr>
<td>ii Environment issue is” when human activities cause adverse effects on other species within a natural environment (e.g. spraying pesticide)” (Lidskog, 2013).</td>
<td>Agriculture</td>
</tr>
<tr>
<td>iii Environmental issue is” the loss of soil nutrients especially in arid areas due to human-economic activities and climatic variations” (Rasmussen, 2016).</td>
<td>Biological productivity, Economic productivity, Ecosystem complexity</td>
</tr>
<tr>
<td>iv Environmental issue is” causing damage/harm or adverse change to the sustainable use of biodiversity” (Sanvido, 2011).</td>
<td>Agriculture, Economic productivity</td>
</tr>
<tr>
<td>v Environmental issues are defined as problems caused by human interference with the earth’s air, water and soil systems. <a href="http://www.yourdictionary.com/environmental-issues">http://www.yourdictionary.com/environmental-issues</a></td>
<td>Ecological</td>
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Since environmental issues occurs in” surrounding areas we live, the influence affect the life of all organisms, environment education therefore is learning about the environment” (De, & De, 2004). In abstract way EE means” recognizing values and make clear concepts to develop skills and attitudes in order to comprehend the relationship between man, his culture and nature” (Palmer, & Neal, 1994). The nature of people on other hand is to develop (change and growth) in all sectors of modern society (Mweti,
& Van, 2009). Schools are involved in various development thus potential producers of waste especially where the use of paper is still the main source for pupils’ notes. “In the context of ecological crisis, science education about environmental issues and preservation of the world’s environment have become important across the globe. Among various school subjects taught internationally in primary and secondary, science education is often perceived as one that can make a significant contribution to environmental education.” (Ko, 2003, p. 187). Conceptualizing environmental issues is simple and complex at the same time. It is one common theme across many school subjects but the absent coherence in implementation among science teachers make it challenging to fully understand. However, many examples classified as “old social problems and new sustainability challenges” (Jerneck, 2011, p. 71) make it complex to limit the definitions. Perhaps, the reason Namibia and many other countries aim for increased scientific literate societies.

Environmental issues concepts are quite familiar for scholars and educators in general, however, each one might have association to own knowledge and experiences. These names circulate around the following but not limited to ecological issues (Ko, 2003), Socio-scientific issues (Pelch, & McConnell, 2017), Sustainability challenges (Jerneck, 2011). In most cases, such issues are described as not having a single or concrete solution. They are, a result of related multiple household and industrial activities causing environmental damage (De, & De, 2004) and sometimes natural occurrences also contribute towards this effect.

1.3 Development of environmental education

The academic discipline established primarily to curb environment related issues and problems is what is known today as “environmental education”, it developed through international organizations such as UNESCO which promotes environmental protection since 1948 (Leicht, Heiss, & Byun. 2018, Russ, & Krasny, 2017). The timeline below illustrates major conferences and agreements about environment which laid foundation for environmental education to date.

**Figure 2. Timeline for the development of environmental education**

Environmental issues has received much attention in news in modern days, featuring main themes in headlines” (Lidskog, 2013, p. 127), This follow publications about international conferences like the just ended Paris climate summit, France, (2017), World summit on sustainable development in Johannesburg, (2002), The Rio de Janeiro Earth summit, Brazil, (1992). The Brundtland conference/our common future, (1987), The Earth summit in Stockholm Sweden, (1972). Thus, the history of environmental issues dates long ago. In all these conferences, the concern for protection of natural environment and development in various languages and concepts are common themes. Some of the themes include” urban challenges, food security, energy, industries, ecosystems (oceans), conflicts and population growth” (Oxford, 1987. and UNESCO, 1987). Most themes at international summits focus on basic human needs and because population growth is such a critical issue, food provision, adequate housing etc. are linked to the sources of environmental issues (manufacturing industries). Opportunities to effect change for individual nations remains each country’s responsibility and often conferences reappear after decades. Committing to such international treaties and statutes offer little influence at community level. “After Rio earth summit, attention was high for environmental issues but suddenly declined indicating less interest at local level” (Castrechini, 2014, p, 219).

*The quest for food security alone is one key factor discussed at*

*International conferences and”aquaculture production to that effect has increased from 650 thousand tons to 67 million tons since 1950s,*

*while marine catch increased from 20 million to 80 million tons in the same period (UNEP, 2014, p. 19).*
Human understanding of environmental issues should shape perceptions, knowledge and attitudes in building up international community for resilience situations. Although, according to Castrechini, (2014) “environmental issues discourse has shifted from scientific to political over the years” (p. 219). Taking advantage of the situation, environmental education in general and science education in particular are responsible for informing future adults than politicians thus the impact on young people is a potential human resource to be pursued.

EE emphasize environmental conservation by all population groups. When all people have adequate knowledge to shape behaviors and attitudes about environmental aspects, this ideal can be achieved and people will understand their decision-making roles in everyday life. In such an endeavor, the school is a tool for introduction and reinforcement of knowledge and understanding, skills and attitudes (Palmer, & Neal, 1994). In addition, awareness and other essentials are increased (Leicht, Heiss, & Byun, 2018) not only for pupils but entire community. This offer solutions for local environmental issues since big conferences offer less for a layperson. School may not necessarily offer all solutions for environmental issues in local area instead Palmer & Neal (1994) suggest for inclusion of the following learning areas: (climate, soil, energy, water, people and community, building, industrialization, water, plants, animals as well as material and resources” among other. In Namibian school curriculum these topics are evident in science education (see appendix L).

1.4 Environmental issues in Namibia

In as much as Namibians watch news reports about environmental issues elsewhere, at times several environmental issues occur somewhere in Namibia too. Thus, it might seem insignificant to focus on past environmental issues while one can argue that Namibia never existed until 1990. Two years after independence “first consultative workshops were held in 1992 which acknowledged pollution (air, water, land and noise), drought or low rainfall, reduced biodiversity, environmental degradation and fires among others” (Tarr, & Figueira, 1999, p. 8 & 10). Meanwhile, practices such as “anthropogenic fires were common in early years and intended for good vegetation dynamics by livestock herders” (Sheuyange, & Weladji, 2005, p, 189). Among the mentioned environmental issues, most prominent is drought or low rainfall as might be the influence of Namib (West) and Kalahari deserts (East).
Confirming Namibia’s environmental history today involves people’s lived experiences as well as how such contribute to resilience approaches. The Republic of Namibia like most advancing nations wish to limit adverse effects caused by environmental issues. Generally, people claim natural resources were abundant than today, henceforth, the decline can be linked to population growth rates. Looking at natural resources claimed above, fish stock for instance have been reported as health or successful (Environmental Performance Index, 2012) while a recent scientific study conducted show that” fish stock are under pressure” (Sjöstedt, & Sundström, 2015, p. 82). Analysis and links between fish stock and variations in climatic conditions are clear by (Kolding et al. 2016). Water bodies that were previously suitable fishery grounds have changed temperatures and general conditions. In most cases dry conditions make Namibia vulnerable and observing from studies the general history predicts increasing trends. Consolidating most of these claims into a coherent history of environmental issues in Namibia, a study from 1961-2000 reveals “an increase in frequency of extremely hot days and nights recorded at 8.2 and 8.6 degrees per decade. In addition, temperature range also increase across greater part of Namibia” (New et al. 2006).

School curriculum in Namibia have included most environmental issues, especially in science subjects. Young people therefore are aware of the previous claims of abundant natural resources told by elders. Common generational stories occur as part of tradition and norm of the people of Namibia and includes significant issues of the environment. Understanding environmental issues at household level is more crucial and meaningful since it contributes to science education as pupils bring such experiences to lessons.

1.5 Science teachers’ conceptions for environmental issues in Namibia

Like elsewhere, Namibian science teachers comprehend environmental crisis not only through experience in their local areas/country but from the call by international conventions such as listed in the timeline above. To this effect, Namibia has membership to international conventions such as the International Framework Convention on Climate Change (IFCCC), Convention of Biological Biodiversity, The Vienna Convention on the Law of treaties, The Convention for International Trade in Endangered Species (CITES) etc. (Fröhlich, 2006). Involvement in global environmental issues has influenced education to take action in the process. Moreover, local constitution, NDP5 and other policies such as education curriculum say the following.
”There is no atmospheric, land and water pollution from croplands and rangelands or mines, and minimal pollution from urban and industrial areas. Farms and natural ecosystems are productive and sustainable socially, economically and ecologically.

There is high quality, low-impact tourism. Average family size is small, and there is food security.” (Namibia. 2016).

Considering above quotation and the following literature (Anyolo, 2015, Kanyimba, 2014, Tshiningayamwe, 2011, Loubser, & Simalumba. 2016). It can be said, that science teachers’ understanding for environmental issues come from national responsibility and academic perspectives. These undertakings and curriculum requirements indicate how the education sector (science teachers included) take serious the problem of environmental issues. Although, each study focused on different aspects of environmental education, all contribute to building up EE conceptions for Namibia.

Science teachers know of environmental issues and share these in many ways. According to Kanyimba (2014) participants in the study had knowledge of the role of different orientation for teaching EE content, they have participated in some environmental actions. Moreover, Anyolo (2015) found that teachers define environment education by linking it with environmental issues topics they teach in different subjects while their mixed understandings causes uncertainty for whether they teach accordingly. This anxiety can be linked to what Nyambe, & Wilmot, (2015) described as discrepancies outlined in previous teacher education program. Teachers on one hand may use own available support in this case because UNAM undertakes regular follow-up on their graduates to determine continuous professional development needs” (Dishena, & Mokoena. 2016, p. 337). In addition,” majority of UNAM lectures like to mentor/work with their students and see them achieving their goals” (Taukeni, 2014, p. 620). The positive matter is that teachers accept environmental issues to be part of the subjects they teach but still they are affected by own perceptions, knowledge and attitudes. In fact, accepting subject policies does not guarantee effective teaching. Their conception of the national duty implies that implementation is ongoing at various degrees.

Science teachers must take a wider perspective of the concept environment for background knowledge. Although, according to Loubser (2008) Environmental education has mainly been associated with ecological environmental and not social, economic or political which is reckoned in Namibian
conception as observed by (Anyolo, 2015) that during the lesson the teacher spent more time on drought which affects agriculture, floods, tourism, nature conservation than social or economic dimensions.

Since science teachers understand environmental issues as part of their different subjects, “sustainability questions are critical since research advocates for paradigm shift for integration of subjects” (Young, Longboat, & Kulnieks. 2013). There are no longer boundaries to prevent integration because the impact to environment brings professionals together that’s why EE seem to be implemented as cross curricular theme (or embedded) in various contexts (see Hyseni, 2014, Jeronen, Jeronen, & Raustia. 2009). In so doing research from elsewhere suggest the main thing is that “science teachers need to understand causes and consequences of environmental problems” (Dawson, 2012). In addition, a good knowledge of environmental issues originate from exploration of environment especially for contextualizing the topics as Hogan (2008) and Loubser & Simalumba (2016) found that indigenous knowledge support teaching though building up knowledge from community. Learning in environments is fun for pupils as well as teacher. If well planned, it has potential for revitalizing the observed lost desire for science education among school pupils in modern generations. Thornburg argues that “learning must be an exciting activity and not a dread chore” (2014, p. 3). Traditional classrooms (including teaching practices) have become uninteresting while” strategies such as experimental learning in nature go beyond information provision in libraries” (Young, Longboat, & Kulnieks. 2013, p. 10).

Even if science teachers have positive conceptions as indicated above, “it is not possible to solve all environmental issues by only attending to some of them “(Guler, & Afacan, 2012, p. 226). Challenges persist in implementation process especially that some activities science teachers would like are not taking place. The approach to understand holistic EE application means teachers must plan for actions well with others. Teaching strategies focusing on imparting information are overtaken by social constructivism and learner centered (Tshiningayamwe, 2011). This idea is supported by Kanyimba, (2014) who found that participants preferred behavioral, liberal-progressive and social critical ways of teaching, but in the main, all orientations support the change in facilitating environmental topics. In other words science teachers are aware of the importance of applying relevant teaching strategies for environmental issues.

To address lack of content knowledge among science teachers, the school ought to play its social role and use the environment around to teach environment issues since” it’s not only beneficial for science achievement but also motivation for learning other subjects. Pupils through natural environment also
form connection to nature for social and cognitive development” (Kimonen, & Nevalainen, 2017, p. 68 & 69). Although content knowledge is built during university training and it’s always grounded in theory” there is need to move teacher education to go out into public school” (NCATE, 2010) where practice and solving daily challenges such as integrating environmental issues in subject teaching is can be exercised. A teacher need to be assertive to cope with professional and subject content matters by associating with other teachers in department or school. A novice teacher professional identity sharpens up with time through reflection and interpretation of what’s happening in the classroom” (Sutherland, Howard, & Markauskaite. 2010). Even though, a teacher cannot be master of everything pupils ask on daily basis thus teaching environmental issues means constant discovery in a social set up. Challenges in teacher education and integrating environmental issues cannot be single teacher responsibility because pedagogical content knowledge in one subject influence another subject. Whether a teacher is more content focused or methodological oriented a combination of both is far better than any one of them.

1.6 Implementation and challenges of EE in Namibian science curriculum

Although EE has been implemented as government initiative in schools, the responsibility for successful teaching depend on science teachers. As observed above that the understanding for environmental issues come as national duty embedded in the different subjects taught in primary and secondary phases, the specific science subjects contain much of the content (see appendix L). From elsewhere, reports show that environmental education in science education have been taught to primary pupils (Hamalosmanoglua, 2012). There are many learning areas that cater for EE as Loubser, & Simalumba, (2016) studied EE in geography while Tshiningayamwe, 2011 investigated it in biology, and lastly Kanyimba, 2009 indicated it is evident in physical science, social studies and agriculture. All these subjects are offered in Namibian science curriculum. From elsewhere Hyseni (2014) in the curriculum of Kosovo also found the same subject including chemistry, and civic education as integrating environmental issues and EE just like in Namibia.

Environmental learning is a cross-curricular theme in which all the topics (identified in appendix L) fall. It is therefore incorporated in other subjects together with other cross-curricular themes (Kanyimba, 2009). Each theme has its distinct objectives per grade and slightly different in content. In In Home ecology for instance, fifth graders already learn about the importance of waste management in
household. In Agriculture pupils learn to understand the effect of soil erosion to the environment. Natural science and health education provide knowledge on ecosystems and their importance to humans while social studies help understand the physical features of Africa and relationships (see appendix L). Meanwhile, combined objectives in senior primary science education serve “to developing science skills as building blocks for scientific literacy” (Mkandawire, 2009, p. 25). In junior secondary phase it’s just a continuation for topics covered in primary phase.

Regarding amount of time for science education subjects, in the context of this study (Namibia, MoE, 2016) standard time allocated and considered in this study (senior primary=around 12 hours out of 27 hours/5-day week or and junior secondary=around 17 hours out of 37 hours over 7-day cycle). Through learner centered education principle which advocates for “shared productive process of making sense of teaching-learning process, learning environmental issues should be interactive, productive process of discovering and exploring in our different social and physical environment” (Namibia, MoE, 2003). In addition, science education in Namibia is guided by national policy on science, research and technology (Namibia, 1999) and national, science and technology Act (Namibia, 2004) which aims for the following.

- Promotion and development of science and research
- Promote common ground for research in science, technology and thinking across disciplines.
- Advocate for training that provide quality content
- Demand for exposed, skilled teaching staff for science education
- Science teachers who are innovative, research and technically oriented

Considering the above aims for science education, school teaching of environmental issues in science education is included and thus a challenging task. Henceforth, pedagogical content knowledge and teaching strategies need to be improved from primary through to university level.

Environmental education in Namibia has received considerable attention as several projects have been well established. Some of the projects include Support Environmental Education in Namibia (SEEN, 2005) which instilled skills and value for informed decision making in life. The Life science project which helped in developing teaching-learning resources for formal education (Kristensen & Andersen, 2001). Another project is the Enviroteach which helped to incorporate EE in formal education (Enviroteach, 1998). Since then its influence on education sector is not only in development of resources,
in-service trainings for teachers but has found a ground for research to continue exposing how the process has been.

Meanwhile, a steadily growing research body is evident and point to some barriers encountered thus far. As stated earlier, some scholars in the field of EE have identified barriers such as lack of EE specialized teachers and lack of collaboration among departments” (Kanyimba, 2009) while Anyolo, (2015) found the same issues including lack of teaching-learning materials, lack of time for finishing lessons properly and limited content. The list of barriers is endless thus not important for this study rather how science teachers turn these barriers into opportunities for strengthening EE is important. The studies have in the same manner reported that participants were able to advice for effective teaching methods and environmental actions for greening the university spaces for instance and not only in curriculum (Kanyimba, 2014). Even though this idea is limited by time allocated for each subject Dube (2012) science teachers should keep on making all lesson plans work accordingly.

1.7 Organization of chapters

This thesis has seven (7) independent chapters which coherently discuss environmental issues in science education. In chapter 1, an introduction of the study context is made, focusing on environmental issues, definitions and development of environmental education. It slightly starts to bring in science education. Chapter 2 presents reports of studies conducted for EE and environmental issues in science education in various contexts. In the same chapter, a focus on EE models, teaching and assessment practices are presented as well. Next is chapter 3 which deals with perceptions of teachers’ knowledge and attitudes about environmental issues and environmental education. A proposed model for perceptions, knowledge and attitude is very significant in this chapter.

Then, research methodology in chapter 5, explains how mixed methods research paradigms have been applied for studying environmental issues in science education (SE), including samples and data collection methods. Meanwhile, results fall in chapter 6) and lastly, a combination of discussion and conclusion (chapter 7). Here a critical summary of results and limitations of the study are presented while highlighting suggestions for further research in the end.
2 ENVIRONMENTAL EDUCATION IN SCIENCE EDUCATION

2.1 The context of environmental issues in science education

Science education is contains much of environmental learning issues from primary through to university level. According to Wals (2014) science education and environmental education are competitive and further apart, because they generally posit different educational aims. While science education (SE) emphasize knowledge, environmental education (EE) on other hand promote positive attitude and behavior change among humans. Meanwhile education in general promotes sustainability to show relationship between science and society (Laws et al. 2004). Therefore, environmental issues threatens the society for which science education offer solutions, meaning the two (SE and EE) support each other than compete. Thus, in this chapter, the study reports on relevant literature across different contexts.

The topic of environmental issues and environmental education discipline dates many years ago as seen in figure 2, which means it is globally well researched considering the state of natural world. In the case of science education, Singh (2011) undertook research on developing thinking among pupils through oral assessment and identified environmental topics such as air pollution, global warming, seeds, eutrophication, informal settlement etc. as relevant for developing community thinking. These topics are similar to Hyseni (2014) who reported evidence of environmental protection, global change, environmental pollution, society and environment, deforestation and forest protection and energy consumption. In addition, other topics investigated in nature schools and outdoor education are energy, animals and plant species, food webs, habitats for birds and water ecosystems, landscapes and land use (Jeronen, Jeronen, & Raustia, 2009, Kimonen, & Nevalainen, 2014). Moreover, Russ, & Krasny (2017) suggests seven key areas to gain necessary environmental knowledge, such as climate, soil, water, people and community, buildings and industrialization including waste, plants and animals, materials, resources including energy.

In pursuit of the above topics, researchers indicate various reasons for studying the topics which mainly point to the causes and effects, action and solutions for the specific issues Singh (2011) whereas general environmental awareness and sensitivity aims were reported by (Jeronen, Jeronen, & Raustia 2009). In support of this idea, Maltese & Tai (2010) say when pupils are still young it is ideal to pursue sensitivity
because interest in science education is high. On the opposite note, Murphy & Beggs (2003) reported that actually the interest reduce as pupils move to secondary education. This indicates to this study that science teachers also have various reasons for their choices of environmental topics to foster pupil knowledge by using what is already known to them (Kang, 2018). Meanwhile, a reasonable answer to this idea is given by Lee, (2009) who studied reasons for teaching environmental issues and reported that, teachers do so for personal reasons such as showing pupils the reality and meanings thereof. There is a need for science teachers to seek relevance in teaching environmental issues in science education. In that way, they will be able to reach their goals with less barriers encountered. Although, the topics cover a wide range of environment and occurs in various areas (Dawson, 2012, Hlobil, 2010) advocates for science teachers’ understanding and action towards environment issues in their respective schools.

Energy is one of the environmental topics that is widely investigated especially among teachers to determine the level of thoughts and understandings. A study by Zyadin, (2014) on renewable energy indicated that science teachers had limited knowledge, neutral perceptions and positive attitudes. On the same topic Spiropoulou, (2007) reports misconceptions among teachers in different context while Liu (2015) reports a national survey that satisfactory knowledge on general environmental aspects among teachers is present. Various influences interact to produce these results, such as gender, level of education etc., in this case male had better knowledge about renewable energy while female posed favorable attitudes for renewable energy Zyadin, (2014). A result of favorable attitude among females is supported by (Barthwal, & Mathur, 2012) although this was regarding conservation of wild animals. Regardless of the nature of environmental topic, it seems women are more emphatic towards environment issues than men. This trend is generally even more evident when they have attained postgraduate qualifications (Zyadin, 2014, Badola et al. 2012). Although the above studies bring such conclusions, it is often that people will agree with statements in their favor during research Stern (1992) while everyday activities show exactly the opposite according to Bamberg (2003).

Regarding the complexity or simplicity of environmental issues in science education, studies continue to indicate that science teachers have sound knowledge of climate change by looking at links between greenhouse effect and temperature Dawson (2012). A clear understanding of pollution in space is one difficult thing for many people because we do not live there but rather regard atmosphere as life support provider. In general life is more inclined to the good state of the atmosphere thus according to Aksan (2013) the opposite indicates that without proper orientation on climate change science we may conclude
the false cause-effect relationship between environmental issues such as ozone depletion, acid rain etc. To avoid this misunderstanding teachers are encouraged to ensure that science education provides skills and knowledge that pupils must own forever because this is the main goal of the discipline (Zivanovic, 2008).

In addition to environmental issues in space, Lane (2016) reports different understandings for tropical cyclones, their distribution and explanations among prospective primary teachers. Environmental issues such as strong winds are interesting topics because their sources and effect areas in most cases are quite distant from one another. It might start for instance in eastern Africa and affect weather in the western part of the continent hence to show clearly how this occurs during science lessons it is crucial for understanding. Tropical cyclones are influenced by global warming, another misunderstood concept by teachers as it has multiple origins (Ocal, 2011). Most results (Zyadin, 2014, Loubser, & Simalumba, 2016) indicate this type of misconceptions and it’s important to evaluate the sources of knowledge most used to access information about environmental issues. Observations of weather patterns across the globe are mainly accessible on the web however, the transfer of this information to local media outlets pose another challenge for authenticity especially for geography teachers who may use it frequently.

A subject such as biology has lots of environmental topics and knowledge provided is connected to other subjects e.g. geography. A topic for biodiversity was studied and results indicate that the concept is familiar among teachers while related concepts such as sustainable use, ecosystem diversity and genetic diversity were not adequately answered (Dikmenli, 2010). Understanding concepts in the case of environmental issues connects this study to other methods teachers can use to explore together in ways that construct knowledge. This idea was studied by Howes (2004) and results indicate that science teachers planned a field trip. By means of discussion and reflections they were able to form new conceptions about the variety of plants species, invertebrates’ densities etc., showing the ubiquity and infinite of life (Howes, 2004). Phenomena such as biodiversity or environmental issues may seem complicated in general while science education has much potential to educate future generations and public at large. Biodiversity as an environmental issue has features of indigenous knowledge to enrich the work of professionals hence teachers are presented an opportunity to teach and learn at the same time. Using local school grounds for teaching helps to achieve competence in the lesson and familiarize with the ecology of the school environments.
2.2 Models of environmental education (EE)

Environmental education is an integrated aspect of Namibian school curriculum (Namibia, MoE. 2016, Kanyimba, 2009) as in Kosovo (Hyseni, 2014), and Israel (Tal, 2005) and other countries/subjects (Hua, 2004). Understanding environmental issues in science education therefore require consideration of the philosophical orientations taken during planning and even implementation of such curriculum. Moreover, science education is called to offer a holistic approach with ecological dimension as prerequisite aim (Anderson, 2004, Hart, 2002). Meanwhile, environmental education substantiates science education with various local understanding for pupils (Dillon, 2002). Among other aims, environmental education seeks to create” awareness and knowledge” about environment Mckeown-Ice, 2009, to”empower people with complex understanding for taking informed action strategies for the environment resulting from attitudes and values” (Hungerford & Volk 1990, Roczen et al. 2014). In countries offering environmental education (EE) curriculum planners have to align this important aspect to the EE models because there is decline in environmentally oriented action among schools (Twenge, Campbell & Freeman. 2012). Regarding EE models, Namibian curriculum has some features aligned to environmental behavior model (Hungerford & Volk 1990), the tree model (Palmer, 1998) the house model (Jeronen & Kaikkonen, 2002) and the model of education for sustainable development (Åhlberg, 2005).

Environmental behavior model has three (entry-level, ownership and empowerment) variables which” emphasize sensitivity in first level” (Hungerford & Volk 1990), especially at childhood level. During this crucial stage feelings for the environment grow (Jeronen & Kaikkonen, 2001). Through sensitivity young people become empathetic to issues such as litter and potentially nurture positive attitude and practices for the environment. Moreover, they grow to be active citizens who can invest in the environment. In ownership variables knowledge is necessarily for one to be responsible citizen which is the general aim of education. This in-depth knowledge about environmental issues leads to responsible strategic actions” (Hungerford & Volk, 1990) and performed successfully. However, Dewey (1993) argue that “knowledge (from experience) does not necessarily mean learning”. Empowerment variable is cornerstone in EE” (Hungerford & Volk 1990) and strategic actions employed here are genuinely out of feeling (developed over long period of time) for the environment.
"Education for the environment, education about the environment and education in or from the environment” (Palmer, 1998) are the three interlinked components for the tree model. Among them, education about the environment is the most associated with Namibian curriculum since lot of information is provided (Hungerford & Volk 1990) in textbooks and technology. Meanwhile, teachers do not take advantage or use local environment to create real experiences for pupils (education in environment) and in some cases ongoing assessments are lacking (Loubser, & Simalumba. 2016, Tal, 2005). This assertion certainly results from negative environmental attitudes, behaviors and related variables thus causes unpleasant environment.

Other models such as the house model emphasize development of senses and emotions to seek solutions for environmental issues (Jeronen & Kaikkonen, 2002). Like a real house the foundation (represent childhood while roof represent adulthood) and evaluation of EE content should be varied accordingly. To do it successfully it requires participation of all stakeholders at the house top (Jeronen and Kaikkonen, 2001). Implications of environmental education go beyond classrooms and have impact on the society. Meanwhile, the onion model builds on behavior model and focus on personal experiences for meaning (the person is at the core of the model) (Kapyla, 2005). This assertion is further described by (Jeronen et al. 2002) as taking account for individual differences in pupil. Experience is likely to be different even in the same context because environmental knowledge, attitude and values are personal traits. On other hand, the model of education for sustainable development is a global response to deteriorating state of natural environments.” It seeks to promote sustainable development by protecting biodiversity and understand environmental problems” (Åhlberg, 2005). As can be observed, onion model builds on behavior model of human toward environment while the model for sustainable development builds on the tree model. This means that environmental education models” use different approaches to achieve one goal of active citizenship in the end” (Jeronen et al. 2002). Although the Namibian curriculum has features of different environmental education models, because of common environmental challenges it aims to empower citizens to act responsible. The curriculum has various science subjects and aim to foster a holistic environmental education.
2.3 General science education strategies for environmental education

The art of teaching encompasses techniques to ensure the flow of ideas to the audience happens in most efficient way. Both the teacher and the audience need to exercise some necessary behaviors during the lesson. This call for either teacher to be more active than the pupils or vice-versa. According to (Kimonen, & Nevalainen, 2014, p. 48) the two ways of teaching divides into teacher centered and learner centered strategies. Learner centered strategies include among others inquiry-based learning, discussion, use of relevant topics (Kang, 2018) while Martín (2017) applied the technology strategy. Moreover, Gawe et al. (2004) lists experimental learning, problem solving, role play and discussion as learner centered strategies while list expository, textbook strategies as examples of teacher centered. In this work focus is on effective strategies applicable for teaching environmental issues are given attention. These are generally some of the most desired strategies in science education.

Environmental issues are part of the science subjects as indicated earlier, this means teaching occurs within a specific subject and therefore it demands innovation and transitions for the teacher. The challenge and most important thing are whether the science teacher can recognize environmental aspects in order to choice the teaching strategy from the curriculum, since “36% of geography teachers indicated that they were unsure about environmental challenges (Loubser, & Simalumba, 2016, p. 56). The perception, attitude and knowledge of the science teacher is at play in this case. S/he should link curriculum to the context to familiarize the pupils to the sites (Boric, 2014). Each science teacher should be able to identify environmental aspects from textbooks and curriculum for implementation and ensure the best experiences are achieved.

On other hand, teaching of environmental issues depends on individual teacher personal reasons (Lee, 2009). This idea indicates to this study, that chances exist for science teachers to leave out some environmental topics they may not like. In the same study (Loubser, & Simalumba, 2016)” (89%) of geography teachers were most confident to teach environmental issues and at the same time least confident in using the local environment for doing practical activities. This practice is detrimental towards the education for the environment and its people because it denies pupil the opportunity to better understand the phenomena. In support of this idea, Auer (2010) states that environmental education is incorporated in school curriculum to enrich science education and must practice outdoor teaching. These
significant studies above show to what extent teaching strategies matter in the teaching of environmental education and the responsibility science teachers have.

Generally, science teachers use different teaching strategies, but not all are fully utilized for the benefit of teaching environmental issues for reasons stated earlier. However, science education particularly is based on inquiry-based learning as well as fieldwork and experiments or laboratory” (Bell, Lewenstein, Shouse, & Feder, 2009, Carrier, 2013, Jeronen and Kaikkonen, 2005). For science education to effectively teach environmental issues, teachers should capitalize the early interests in science” (Bulunuz, & Jarrett. 2010) because young people are curious and continue using their traditional teaching methods since they are most suitable for local schools (Carrier, 2013). Although learner centered education is a major teaching approach it is a broad concept involving lots of teaching strategies for implementation. To this effect, questioning and answer, experimental, inquiry-learning are incorporated. For instance, (Mkandawire, 2009) used group work in physical science to develop questions for process skills learning tool and is categorized as learner centered since pupils were actively involved during the study. This means, there are different perspectives of how LCE is practiced in the context of the study. This leave an accountable gap for pedagogical decisions undertaken by science teachers. However, LCE is a desirable general framework for science teachers to apply in choosing appropriate environmental teaching strategies.

2.3.1 Effective science teaching strategies for environmental education

For meaningful science teaching, the key aspect involves switching from traditional ways of teaching to active student teaching strategies (Callahan, & Dopico, 2016). Since there are many obstacles identified in implementing environmental issues in the context of the study. Science teachers “should always refine their teaching strategies and clarify how their own experiences formed their understanding of how to teach science of environmental issues” (Callahan, & Dopico, 2016). To unpack such teaching strategies teachers must speak out of their personal experiences as well as those of their (professional) communities for departure into further teaching. In other words, teaching science especially environmental topics cannot rely on textbooks, words or teacher alone but rather “use inquiry-based learning, technology, experimental learning for better understanding as widely recommended (NRC, 2011, Klosterman, 2012, Mandler, 2014, Jeronen and Kaikkonen, 2005). The following teaching strategies; inquiry-based
teaching, discussion, technology, outdoor education are examples for effective teaching of environmental issues in science education.

Traditionally the role of a teacher is seen as conveying knowledge to pupil as if it’s a tangible object which is typical teacher centered way of understanding. For the entire time constructivism which promote discovery learning has breathed what is now well-known as inquiry-based learning strategy in science education (Kang, 2018). Although it’s generally well known, it’s rather young in terms of implementation for most developing countries. Therefore, it’s a pedagogical means of learning in which pupil explanations, propositions, evidence etc. are evaluated against scientific principles just as professional scientist study the natural world. Thus, it enhances pupil interest and performance” (NRC, 1996, PRIMAS, 2011). In another way inquiry is the practice whereby pupils plan activities, conduct those activities for gathering data and make justified interpretations and more importantly communicate findings obtained (Teig, 2018). In both definitions, it is clear that pupils’ role is huge compared to the teacher although s/he is the planner. Thus, inquiry can be applied to investigate environmental issues and yield results for school or community to solve local problems e.g. on water or pollution issues. The strategy is among those making OECD countries to receive much attention on international scale for high achievement in science education assessment reports. (PRIMAS, 2011; OECD, 2016). On the contrary, Teig (2018) found out that”a curvilinear pattern exists between inquiry based teaching and pupil performance. In addition the relationship rather positively correlated until optimum value was reached which this study assume is opposite of what conventional understanding of the two items by many science educators.

Researcher believe that science teaching strategies in the countries listed above have certainly shifted to inquiry based and experimental hence produce such good results on international level. On other hand, it might be that the instructional approaches currently used by teachers especially in developing countries are those from their own science experiences” (Tsai, 2002). On the contrary, inquiry according (Hammerman, 2006; NRC, 1996, p. 23) has many activities for pupils such as asking questions, making observations, checking information from different sources for what is already known, designing investigations, using scientific tools to gather, analyze and interpret data etc. These activities are then incorporated in frameworks such as one adapted by Teig (2018) which consists of conceptual, investigation, and conclusion and discussion phases. Meanwhile, the amount of freedom pupil and teacher have in pursuing above activities describes whether an inquiry is student-centered open inquiry,
guided inquiry or teacher-directed structured inquiry (NRC, 2000). Although, according to Bell et al. (2005) teacher directed inquiry is not considered inquiry as the focus in inquiry learning rests on pupil making meaning from investigations and not the teacher. This is a good indicator for this study that when science teachers plan an inquiry lesson for environmental issues their role must be less.

Among these forms of inquiries, open inquiry is reported to be the most challenging since it’s based on pupil initiatives throughout the project. Thus, the science teacher only offer minimum guidance (Martin-Hansen, 2002). Judging from the two forms of inquiries, guided inquiry can always be an option as it take features from both open and structured especially for controversial issues such environmental issues. In the end, science teachers are cautioned by Jiang, & McComas, (2015) who categorized pupils into five levels according to autonomy given for conducting inquiry activities, drawing conclusions, designing projects and posing questions. Results indicate that not all levels of inquiry are suitable for science lessons, instead an evaluation for the purpose of inquiry and selection for the right level of inquiry must be made.

Most often when people are seen talking to each other, they are busy with casual discussion about a certain topic. In the same manner, for science education to cater for environmental issues teachers must be “innovative in persuading reflection and reflexive discussions which produce solutions for environmental issues” (Anyolo, 2015, p. 31). Discussion strategy have been reported by, (Day, 2011, Loubser, & Simalumba, 2016, Ko, 2003, Gawe et al. 2004) and it means comparative way in which members exchange and share justified ideas for a purpose (Shemwell and Furtak 2010, p. 223; Gawe et al. 2004, p. 176). A study by (Day, 2011) indicated that science teachers seldomly use discussion strategy during lesson because they feel uncomfortable to talk about socio-scientific issues with their pupils. In addition, different disciplines use the strategy for different purpose and depends on years of teaching experience as (Day 2011) found that humanities and science teachers easily mentioned the strategy but science ones were not confident enough to explain the application. The above result is like (Ko, 2003) who found out that discussion was only used sometimes in integrated science education lessons. Suitability of this strategy in science education depends on the purpose for which it is used. Research continue to indicate that social skills, new perspectives as well as logical skills were mentioned by teachers in different fields of study including science education (Day, 2011). Curriculum subjects are sometimes seen to be more oriented towards argumentative (e.g. Social studies) while others apply problem solving through new ways of thinking about environmental issues.
Discussion strategy is applicable for environmental issues however the teacher must be selective and tactical to use it effectively for intended goal. According to (Shemwell and Furtak 2010, p. 223, Gawe et al. 2004, p. 176) discussion strategy can take place in many forms such as constructing grounded arguments for scientific theories, policy discussion for which a viewpoint is taken, explaining discussion and predicting discussion. Discussion is important as described by (Shemwell and Furtak 2010, p. 10) because internalization of scientific concepts is achieved in socio-cultural theory because during the process participants engage in meaning making of environmental issues by checking own understanding against established ideas on the social plane. Moreover, participants gain knowledge and improve communication skills (Gawe et al. 2004, p. 177).

In the main, discussion strategy will critically stimulate reasoning that can impact the community as argued that important learning related to curriculum extend beyond the walls of classroom and involve parents” (Loubser, & Simalumba, 2016, p. 53). Once environmental issues are discussed away from initial learning sites, it is hoped that all are being sensitized and made aware. Meanwhile, the role of the teacher especially inside the classroom is crucial to prevent disagreements, waste of time or discussion beyond or out of the topic (Gawe et al. 2004, p. 177).

It’s interesting that science teachers are sometimes compelled to discuss controversial environmental topics with pupils since during the process teachers are affected by perceptions, knowledge and attitude in effectively teaching environmental issues. In fact, research indicate that many science teachers taught when they have favorable attitudes and skills to do so (Ko, 2003). Such instances allow the teacher to challenge own principles and beliefs. Since discussion may take place between teacher-pupil and pupil-pupil ways it for selecting appropriate views and concepts to use before their pupils, especially in teacher-pupil case.

Regarding discussion in social interaction situations involving teachers and pupils or pupil-pupil, science teachers need to know that all learning is social, children learn through interactions with others” (Vygotsky in Smidt, 2009, p, 76). Environmental learning topics must be discussed either between teachers, learners or both. Teacher-pupil (teacher mediated) discussion can be a good strategy for high order thinking because teacher ask questions to stimulate pupils’ thinking in certain direction for deeper meanings to be achieved (Day, 2011). It is crucial that the teacher maintains his/her role in the dialogue to allow free expression for pupils. So, choosing discussion teaching method is a critical decision for the teacher.
Another discussion takes the form of peer interaction about the topic and pupil imagery or self-conception is built. The teacher observes and prevent domination by one child over the others and all other group dynamics. Observation by the teacher however remains active as moderator for posing questions towards lesson objectives (Day, 2011). Peer-peer interaction allows pupil to think and analyze the reasoning of each other and respond accordingly. This practice according to (Havu, 2000, p. 125) is an opportunity for learning to inform and express their thoughts aloud on a topic such as environmental issues. Science education can benefit from strategies such as discussion of environmental issues especially in developing countries because such aspects are daily experiences and affect pupils’ lives. As (Callahan, & Dopico, 2016) clearly put it that” meaningful learning require meaningful teaching strategies and experiences are good when pupils address science content from own experiences”.

Science teaching in the 21st century must educate citizens who are able to interact with technology and because pupils have little independent opportunities to move around and learn (Malone, 2008). Ideally, the use of various technologies offers practical and experimental solutions for such a problem, pupils can be sited down and explore the environment. A handful of studies indicate that technologies such as tablet computers, mass media publications, and smartphones are very much applicable for science teaching, especially for facilitating environmental content such as laws of nature (motion, speed, time) in physical science (Klein, 2014, Martín-Ramos, 2017, Klosterman, 2012). These technologies are more interactive for searching information regarding environmental issues. In addition, technologies allow freedom to think how best to answer real societal problems in a more smart and relaxed manner than traditional method of teaching (Klein, 2014). Moreover, Klosterman, (2012) in a study of science teachers’ use of media and technology reported that although they use it to explore socioscientific issues their knowledge is limited. On the other hand, Kolsto (2001) found the opposite, that teachers are able to evaluate news regarding environmental issues. Although teacher’s knowledge might be limited, if they are more skilled in using appliances they may become carried away by the gadgets and still not critically make proper assessment on time. On other hand, science teacher can only pay careful attention if they evaluate their pupils. According to Klosterman (2012) when teachers are prompted, they look for author’s credibility and accuracy of information. Application of media and technology in teaching environmental issues can be summarized into accessing information, analyzing, evaluating and creation according to (Klosterman, 2012). Created materials or projects can be published on blogs for public use for more inputs.
Society in general use different means of information dissemination to reach its members and nowadays platforms such as newspapers, leaflets, magazines, and internet have become more accessible. Science education teachers are reported to often acquire (search and download) environmental information from these sources for teaching purpose than the textbooks (Reis, & Galvao, 2004, Zyadin, 2014). Meanwhile, according to Klosterman (2012) caution need to be exercised as there are risks involved in this practice because technology, especially mass media is non-instructional, and its news coverage is beyond the needs of education in general. It is obvious the media reports for general audience including science education and therefore in using these technologies science teachers save time and resources. Moreover, topics that demand measurements, conversions, light, position, motion etc. are easily captured but ability to discriminate useful information is important.

Another teaching strategy science teachers may use is outdoor education which is the direct interaction between teachers, pupils and reality (Kimonen, & Nevalainen, 2017, p. 311). There are many advantages of outdoor education including field trips and excursions in the following literature (Kimonen, & Nevalainen, 2017, Nadelson, 2012, Larsen et al. 2017, Bell et al. 2009 & Bas et al. 2011). From pupil increased interest and motivation for learning especially science education to problem solving skills because pupil get involved in organizing such exercises. And moreover, interact in groups to make meaning and success of their project. Environmental issues are mainly observed outside classroom and pupils will get firsthand experience which can be recalled even after school years.

Outdoor education take place inside the school yard for safety reasons, but also, undertaking trips to museums, science centers is exciting for pupils however, information is limited to these places alone (Nadelson, 2012). More natural settings such as forests, rivers and lakes, gardens, and game parks offer open information as pupils observe through bringing to classroom rich data for interpretation. During such occasions, science teaching aim for deep factual, conceptual, procedural and metacognitive knowledge is attained (Callahan & Dopico, 2016). Primary experiences influence perception and attitude about environment. Such activity is informed by learning in the environment component and achieve some objectives as highlighted by environmental education tree model and model for sustainable development. In nature pupils do inquiry for self-discovery and will develop pro-environmental behavior.

Although, research show that practicing outdoor education is difficult due to time limit and curriculum demands (Carrier, 2013). It should not discourage science teachers from exploring and experimenting
in the natural world since according to (Boric, 2014, Smurr, 2009, Alvarez-Garcia, 2018 & Hlobil, 2010) it’s another way to familiarize and help pupils to express about the sites so they can learn to protect nature. Generally, most parents would give reasons for high costs of field trips and or excursions. On one hand it’s quiet reasonably, however, benefits are exceeding the measure of money because time spent for excursion is life time memory. Education in which pupils can participate and reflect is not often inside classroom. Research show that there is much interest in outdoor education because knowledge is gained when teaching occurs in proper context (Wilhelmsson, 2012).

There are many science teaching strategies which have not been elaborated in the study, such as place-based, demonstrations, debate, team teaching, gaming, role play, discovery etc. which are also very relevant for teaching environmental issues. Such strategies should be applied considering the purpose and ways for application. All teaching strategies are relevant and serve a purpose, however, the teacher have choice to make in the end. Expert decision making is highly valuable in choosing the strategies. Broad approaches such as learner centered education incorporates most other strategies and are applicable for teaching environmental issues as well.

2.4 Assessment strategies for environmental education

The practice of teaching alone does not yield results, because it’s merely discussion, demonstrating or experimenting stuff in laboratory while assessment bring out results. In the context of the study, assessment is an “ongoing component of the national curriculum for evaluation of teaching process and to keep record of continuous progress in the learning process. Moreover, this assessment is conducted using formative and summative strategies. (Namibia, MoE. 2017, p. 3). This means that there is not a special way for assessment of environmental issues nonetheless integral part of general assessment frameworks in science education. On the other hand, the nature of EE vary across subjects and education systems, especially the formative assessment part (Tal et al. 2000, Heimlich, 1999). To this end, subject teacher content knowledge and many other factors play a hypercritical role for incorporation.

Formative assessment therefore is another dimension of teaching which make it more goal orientated. It is therefore defined as a process, “where a teacher use evidence of learning in order to transform teaching to meet immediate learning needs, minute by minute and day by day” (Wylie, 2015) while according to Sabel (2015) it’s a “classroom practice during teaching and learning that places students
ideas and thinking as basis for instruction”. And lastly, “teacher recognizing and responding to student learning in order to enhance learning during the lesson” (Cowie, 1999).

Definitions above provides stepping blocks to understanding the key words about the purpose of teaching and learning process. Most lessons do not move smoothly as planned by teacher alone since learners play a part too, meaning different conceptions, ideas need to be evident, recognized and responded by the planner/teacher. Engaging formative assessment “increases significant gain in pupil science learning” (Ruiz-Primo & Furtak, 2006) but since pupils read or experience a lot about environmental issues from various sources, a teacher need to respond clearly through” interactive formative assessment techniques to individual or small groups” (Cowie, 1999).

In order to include environmental issues in assessment the teacher should employ formative assessment strategies which engage the pupils. For instance,” clarifying misconceptions, evoke discussions, give feedback and empower students to own the learning process and use them as instructional resources” (Wylie, 2015). Since lessons should not necessarily be smoothly, through formative assessment the teacher must exercise the above strategies because learning is meant for pupils. The main task of the teacher then, is to make known the pupil’s ideas, evaluate them and craft next steps for helping pupil to learn” (Sabel, 2015). However, the teacher should view this process as teaching-learning by listening or recognizing pupil and respond in appropriate manner because the focus is on the learning process. In order to evaluate and give pupil direction of environmental issues for instance, teachers would have to be knowledgeable about such issues as studies argue that” teacher subject matter knowledge allowed them to be productive” (Sabel, 2015).

Formative assessment takes the form of questioning, brainstorming and even writing pre-exercise to determine level of understanding. It is evident in numerous studies that formative assessment takes different strategies such as questioning, listening, oral assessment, interactions, and reflections are among common practices” (Mckeown-Ice, 2009, Singh, 2011, Mortari, 2003, Tal, 2005). In addition, in Physical science of Namibia syllabus, teachers ought to observe general participation in practical and investigations to determine further areas of need” (Namibia, MoE. 2015). Formative assessment strategy may take different forms which might be informal or formal as Cowie (1999) describe “planned formative assessment focuses on how information is collected and interpreted while interactive formative assessment does notice, recognize and responds to pupils”. The later, take place right during the lesson for immediate need while the former has formal assessment characteristics since it determines
real issues e.g. identify slow learner and seek intervention. To identifying a slow learner thereof require some evidence for more professional counselling services to be offered which make planned formative assessment to be formal thus differ from the genuine formative features.

On other hand, summative assessment as mentioned earlier is commonly known as “end of year examinations or test which produces promotional marks and is always norm referenced” (Reddy in Gawe et al. 2004, Namibia, MoE. 2014). The form of assessment such as test or examination (local, national, international assessments) differ significantly in various context and grades. In the case of Physical science in Namibia it forms 60% of overall weighted marks” (Namibia, MoE. 2015). Teachers conduct this form of assessment by way of recorded orals, but often in written formats and typical example are national examinations for matric or high school conducted in various countries. According to (Dori, 2003, ASE, 2006) this type of assessment is too standardized and require accountability which interferes with assessment towards student centered”. In addition, it’s criticized for limiting student learning and demotivate pupils in science education. On the opposite note, summative assessment evaluate overall student performance in the subject (ASE, 2006). Although it evaluates overall student performance it is most influenced and affected by socioeconomic status of individual school/pupil. Supporting this idea, OECD (2016) which is a large scale assessment type, schools with high social and economic infrastructure performed well compared to those with low.

In both assessment strategies, the objectives is mastery of “specific competencies in terms of knowledge, skills and attitudes” (Namibia, MoE. 2017). Some other assessment strategies such as diagnostic assessment fall under formative while formal assessment is part of summative assessment. However, the well-known continuous assessment in Namibia education system has features of formative and summative assessment” (Namibia, MoE. 2017, Namibia, MoE. 2014). In all cases environmental education includes many science subjects, therefore teaching and assessment strategies must encourage pupils to care about where they live and act to improve their environments” (Tal, 2005, Tal, Dori, & Lazarowitz, 2000). Only when pupils solve real world problems will they appreciate the relevance of learning about environment issues in their lives.
3 SCIENCE TEACHERS’ PERCEPTIONS, KNOWLEDGE AND ATTITUDES FOR ENVIRONMENTAL EDUCATION

3.1 Psychological perspectives for environmental issues

This study is situated in multiple disciplines namely; environmental education, science education and environmental psychology. All converge to make a contribution for analysis of teachers’ perceived knowledge and attitudes of environmental issues. As detailed explained later in this chapter, perception is the understanding a person forms about the world, people or object” (DeLamater, 2015) while knowledge is information a person acquires for protecting the deteriorating natural environment, however, knowledge is unquantifiable thus the skills we practice form part of it. Knowledge is most useful when threats approach and it is applied to remedy the problem, in this case, environmental issues have been recognized as threat to the world and it is hoped that the knowledge will help (Burke et al. 2006).

This study proposes a model for environmental perception, knowledge and attitude to link the three concepts together. Analyzing environmental issues in science education involves psychological lens because it involves human beings in the form of science teachers. Science teachers have ability to sense the environment and accordingly develop a potential attitude which simply means a response. The concepts are interlinked in multiple ways as (Murray, 1887) indicated that “knowledge grasps over and above perception in particular situations but not as separate from it while in good (intimate) relationship with one another”. However, attitude on one hand come in as a concern and potential behaviors towards environmental issues in everyday life. In the study, no experimental or observation of science teachers’ actual attitudes were done, instead, responses were imaginary and reflections. In fact perception is not passive attitude (DeLamater, 2015). In other words, it is present even before an attitude is performed. For instance a science teacher corrects the misconception about erosion for pupils, so, the basis upon which the correction is presented is the perception made by the teacher about the pupils’ understanding. Hence, a teacher perceive and responds by observing” (DeLamater, 2015, Ajzen, 1982).
At least some studies point that when “people are more knowledgeable, they are more likely to respond/behave correctly since knowledge and attitude strengthen each other (Pagiaslis, 2014, & Bamberg, 2003) while (Vlaardingerbroek 2007 & Grob, 1995) found out that, increased knowledge also lead to low environmental attitudes and vice-versa. In fact, more knowledge increases the subjective attitude as one demand surety about anything s/he does. A good character for a science teacher to poses. The proposed model has three components and each component help researcher to identify features of this study in clear manner. The knowledge component features environmental awareness and identification of environmental issues” (Grob, 1995). In addition, Kaiser (2003) identified the following forms of knowledge “declarative, procedural, effective social”. Moreover, Capraro, et al. (2003) divides the knowledge into objective referring to actual knowledge about something e.g. environmental issues) and subjective knowledge as perceived. A human brain have the capacity and necessary knowledge to perceive unlike other animals, thus perception is informed by knowledge and also vice-versa because people can use all the concepts to sense environmental issues as Murray (1887) argues that both are receptors in mysterious manner. To go back to human verses animal story, Human knowledge help us to decide appropriately, otherwise, the line can be thin if people do not exercise these powers. According to Grob (1995) who demonstrated that “before people can show attitude towards environmental issues first they need knowledge while at the same time knowledge is influenced by current attitude”. The

Figure 3. The model for perception, knowledge and attitude

![Figure 3. The model for perception, knowledge and attitude](image-url)
researcher then assumes, attitude is uncertain and allows the operations of procedural and effective forms of knowledge to make it certain about environmental issues.

In addition, attitude is a factor leading to a persons’ behavior (Guler, & Afacan, 2012). It is described as positive or negative depending on the reasons behind (Kaiser et al. 2007). In case of environmental issues such as pollution, it is positive or good attitude to launch a protest for the municipality to act while its equally negative attitude to protest and damage properties for instance. In other words attitude can be planned and sometimes incidental. Science teachers have more opportunity to plan their attitudes towards teaching environmental issues before the lesson while trying to control their existing attitudes if necessary to prevent biased practice. According to Halpenny (2010) attitude may change because of various motives such as costs and values attached to the object.

Regarding perceptions, it is often made based on present schema held about something hence is the basis for either wrong or right perception while DeLamater (2015) describes perception in terms of bias due to deficiencies in the schema. As it can be concluded, perception is comprised of information/schema, bias and stereotypes especially if based on unfounded knowledge claims. In case of environmental issues, this is an important factor to consider since media and entire global society produces information about the topic. For science teachers, it calls for ability to discriminate relevant information for teaching purpose.

For the purpose of this study, the explanations and proposed model shed introductory perspectives about how to differently look at environmental issues in science education. Therefore, researcher believes that when we practice science education both as humans and professionals the impact can be significant because a person is not separate from the job s/he is doing. Our daily experiences influence our professional identity. Although, many times people try to show different personalities between work and community. Science education must not only focus on pupil academic achievement but contribute to building resilience towards environmental threats in society.

3.2 Environmental knowledge for science teachers

Developmental activities nowadays have heightened environmental issues which now concerns many people, to this effect “environmental knowledge is important for science teachers to understand the mechanisms and consequences thereof” (Dawson, 2012). The term environmental knowledge means
awareness of environmental issues and possible solutions for the problems (Zsóka, 2013). The state of awareness or knowing about environmental problems is not enough since the main aim of education is to change pupil into better citizens. Moreover, in the context of science education solutions for environmental issues should be practical for it to be meaningful for pupils. Meanwhile, according to (Kollmuss & Agyeman 2002) knowledge does not guarantee improved attitude since not many studies confirm it.

The forms of knowledge identified help this study to understand the aims of science education results later in chapter 6. Declarative knowledge is learning about the causes and consequences of environmental issues in general but factual way. However, not necessarily that one has absolute knowledge about the subject. Procedural knowledge means the behavior we do to achieve our environmental goals. In addition, effective knowledge is ability to make an assessment of environmental issues and take informed decisions which are pro-environmental for instance buying an environmentally friendly product even if the cost is high than a cheap product that is environmentally unfriendly. In fact Gardner, & Stern, (1996) suggest making a choice in environmental list of things in order to changing one’s attitude.

On other hand, social knowledge is more conventional as it stem from the prevailing norms and intentions (attitude and perceptions) in the community. Thus, pro-environmental attitude is beyond scientific skills such as declarative, procedural and effectiveness skills and involves social (Ernst, 1994, Schultz, Oskamp, & Mainieri, 1995, Spada & Ernst, 1992). Such knowledge provokes human reasons for engaging in environmental activities as observed from community. Forms of knowledge according to Kaiser (2003) must work together to enhance pro-environmental attitude because it is the strength that matter than the acquired amount of knowledge”. That explains why Schahn (1996) and Zyadin (2014) reported procedural and declarative knowledge do not imply positive attitude for the environment.

Environmental knowledge is acquired through EE which encompasses five interlinked content areas (nature, the built, aesthetic, social and ethical environments) which need to be taught in line with environmental education (EE) models” (Jeronen, Jeronen, & Raustia. 2009) (see chapter 2). Nevertheless, in the context of the study, learner centered approach clearly state that “science teachers (and general) should be aware and value the experiences of learners as starting point” (Namibia, MoE, 2003, p. 10). For teachers as facilitators of knowledge about environmental issues in science education,
it become a duty to consider the holistic pupil. A science teacher ought to have sound knowledge to the required level for him/her to assist pupils. In most developing countries, the role of the teacher is seen as a source of knowledge especially in rural areas. Even in urban areas because not all pupils have access to appropriate technologies or modern learning materials. On other hand, access to modern teaching and learning materials alone is not adequate. Instead, discussing environmental issues in multicultural setting improves one’s knowledge because personal values and beliefs which come before knowledge are explicit leading to new knowledge. According to a study conducted by Boon, (2010) “participants admitted that school is crucial source of knowledge” about the physical world in which they live. In other words, the teachers and learners discuss environmental issues within the science curriculum.

Considering that knowledge about environmental issues is not guaranteed, science teachers need to have ability to recognize and critically evaluate appropriate teaching and assessment strategies for environmental issues. In addition, conversant in issues like climate change, water, energy, floods, deforestation, drought etc. in scientific perspective. They should contextualize environmental issues in local knowledge/language for pupils to understand, which make the task easier for the science teacher. According to Walter (2008) and Luketic (2012) knowledge is “understanding of subject (environmental issues) through outdoor experience and study to higher levels of education such as master’s degree”. On one hand, experience amounts to indigenous knowledge which Van (2004) concurs as a system of skills and practices identifiable through certain characteristics which make people aware of environmental issues. Whether environmental knowledge is traditional or scientific the premise is that “it should produce solutions to the question of environmental issues. Environmental scientists alone cannot unpack the question about environmental issues or simply cannot reach certain interest territories for research without help from local people who own such knowledge (custodians of indigenous knowledge). Meanwhile, the most recognized paradigm for acquiring environmental knowledge is science education offered in school and universities (Kimmerer, 2012).

Science education curriculum enrich environmental knowledge from both traditional and scientific perspectives. Efforts for the incorporation of indigenous environmental knowledge helps contextualize and deepen the teaching thereof” (Kimmerer, 2012, Breidlid, 2003) as “it uncovers and recovers the lost or marginalized information over decades” (O’Donoghue, & Neluvhalani, 2002, Asafo-Adjei, 2004). Although science teachers know much about local knowledge which might enrich science education, summative assessment have less value for this type of knowledge and inclusion may just affect pupil’s
performance. On other hand, science teachers should be selective for inclusion of indigenous science knowledge for lessons. EE content has many facets that call for social inquiry as Van (2004) argues that a considerable amount of ecological knowledge texts that has rationality in scientific discourse were extracted via indigenous means. To this end science teachers as members of society that have many facets, need to balance their emotional intelligence for choices regarding teaching and assessment strategies in science education content for environmental learning.

Although teachers have the obligation to teach environmental issues, not all teachers are adequately executing this duty in a successful manner because of reasonable grounds (hindrances) in education policies. This study advance the question of pedagogical content knowledge (PCK) about environmental issues and methodologies applied during lessons, whether science teachers’ knowledge and attitudes about environmental issues are adequate considering their specific subjects. There are plenty of studies indicating good level of environmental knowledge and lack of knowledge among teachers (including science teachers) in various countries (Alvarez-Garcia, 2018, Sondergeld, 2014, Halder et al, 2012, Vlaardingerbroek, 2007, Hlobil, 2010, Anyolo, 2015, Yilmaz-Tuzun, Tuncer, & Aydemir, 2008, Summers, 2001). Nevertheless, only few concentrates on general environmental issues. At least a study conducted by Yilmaz-Tuzun, et al. 2008 reported science teacher having basic knowledge of air pollutants and negative results such as CO2 and SO2 but lacked in-depth knowledge of the issues. In the same study, science teachers showed good knowledge about renewable energy.

In most cases teachers are trained based on the needs of pupils and education than advanced level for industrial work or pure scientist. On the opposite side, a professional development program reported 100% agree and strongly agree, that teachers (20% were science teachers) have learned new concepts, definitions and facts while 94% learned instructional approaches (Sondergeld, 2014). In both cases teachers’ own experience of science education/environmental issues and training for teachers come into play because teaching environmental issues require negotiation with pupils and norms of society. Teaching environmental issues go beyond content to appropriate teaching strategies as illustrated above. Moreover, handling the issues with others who may hold different conceptions is the task of a teacher. Although environmental cognitive knowledge (facts) is the basis for perceptions and attitudes. Science teachers need both knowledge and good attitudes to be able to genuinely teach environmental issues with less barriers. To this effect, researcher argue that outdoor activities enhance the development of
positive environmental perceptions and attitudes necessary for improving knowledge about environmental issues in science education.

Similarly, “teachers have a sound knowledge of climate change science, with ability to recognize the importance of greenhouse effect for living things and the relationship with temperature” (Dawson, 2012). Meanwhile, knowledge about global environmental issues lagged among teachers in Lebanon compared to Australian counterparts (Vlaardingerbroek, 2007). Environmental cognitive knowledge seems better reported in a satisfactory way for developed countries while studies in developing countries indicate the Lebanese trend. Environmental cognitive knowledge stem from proper initial teacher training which studies indicate as not up to standard in terms of “theoretical and practical in some cases” (Alvarez-Garcia, 2018, Hlobil, 2010, Spiropoulou, 2007, p. 447) supported by various other studies (Karameris, Ragou & Papanikolaou, 2006, Vassala & Georgiadou, 2006). The implementation and teaching of environmental issues in the study context seems to be a personal endeavor as some little attention is given and only in some selected subjects. It is possible that often citizens are unaware of environmental aspects within the country’s borders or even province.

Observing from the studies above, environmental knowledge is quite important, however, it changes with age and context as reported by Braun (2018) that 10-12, 13-15 and 16-18 years old scored better than those aged 7-9 years olds while rural dwellers scored much higher than urban dwellers in a comparative study. It seems that this assessment was more likely to produce this result since one group was too young for testing on environmental issues although age is certainly a significant age factor.

### 3.3 Environmental perception for science teachers

There are various perceptions science teachers hold about environmental issues as they listen, watch and read or experience these events. As defined (in this chapter) perceptions are the “views, beliefs and awareness of environmental issues through senses, especially sight” (Walter, 2008). Such beliefs and views according to Bamberg (2003) differentiates perceptions from those who are highly concerned to the low concerned science teachers. Thus, in the context of science education what teachers perceive about environmental issues greatly influence their teaching, and this study hope that messages of hopelessness are well evaluated before dissemination. This scenario may frighten not only pupils but teachers to think such issues are not necessarily part of the curriculum. Moreover, they will feel more
burdened to share these with pupils while they are vital for future generation of leaders. When teachers do not know what to do about environmental issues, they simply say it is the sole responsibility of subject teachers with direct environmental topics. Whereas team teaching easily finds solutions for content or instructional strategies if one is stuck. Science teachers’ views may differ regarding curriculum environmental topics that qualify for environment depending on their perception, knowledge and attitudes.

Considering some studies focusing on environmental education, teachers face numerous obstacles such as unable to identify environmental issues curriculum, unable to use appropriate strategies in line with EE and difficult to motivate learners. Thus, result of the study indicate that science teachers perceive the importance of conserving the fragile environment for the future” (Anyolo, 2015). This positive perception act as good starting point for deeper meanings and understanding of environmental issues since according to Sondergeld et al. (2014) in introduction, when science teachers understands their local environment, they certainly will care about environmental issues in distant places. In addition, if the environment is fragile, then science education must “emphasize critical thinking, problem solving and decision making through action toward the environment” (Anyolo, 2015). Other dimensions such as education for the environment and education in the environment ought to feature in science education as well. Meanwhile, pupils are the vital agents to be exposed to teaching approaches for different perspectives. The role of science teachers here is to plan and guide pupils to discover knowledge. According to Van (2011) EE content areas focus on “participation and self-assessment among stakeholders to bring along their cultural, social and historical meanings” which influence perception.

More interesting, a study on lectures’ perceptions of EE indicated that they perceived “environmental education activities as forced in curriculum for teacher training because it placed extra work. And only involved few staff members” (Van, 2011). Although, this study does not focus on science teachers, the same perceptions are more likely among prospective teachers under such guidance. And since geographical proximity between the context of this study and context of report is very close (bordering countries), some teachers might find employment in other country as foreign experts and share similar wrong perceptions.

Teachers’ perception of environmental issues elsewhere shows that, “teaching environmental issues is more individual because such teachers feel and believe these issues are important based on their own ideals, philosophies or personal concerns and without much contact with educational reforms” (Lee,
Although, general monitoring of teaching progress is a practice in most educations systems. It is clear indication that teaching environmental issues is not firmly monitored since individual teachers’ personal commitment play a major role. Relying on personal commitment of few teachers alone will not advance the solutions for environmental issues. A collective effort is better because even at international level lack of commitment has shown to reduce the level of motivation for reducing pollutants in atmosphere. In addition, “another study indicated that teachers regard environmental education as an important area of work, this indicator is even higher among female teachers and those with postgraduate qualifications” (Yanniris, 2015, p. 154) while (Hailu, 2016) say “variable gender produced no statistically significant results towards environment”. Researcher agrees with Yanniris, (2015) that female postgraduates show good perceptions of environment because the other study employed mainly first year students with intention that university education must not influence results. Higher education which also equate knowledge is linked to shaping levels of awareness for possible sharing with pupil. If a teacher is not well informed, it is more likely that most pupil will be unaware about environmental issues, especially in the context of developing countries.

Gender orientations is an important factor here because in general male and female perspectives vary significantly in many areas. This become evident when engaged in discussions and explaining concepts and illustrating environmental issues with real life examples. Primary teachers are environmental education experts since their training and nature of primary pupils is more oriented towards experiencing physical world objects. Although result above indicate no statistical difference in gender, generally more female teachers are employed in lower and primary education thus their perception about environment might be different. Even those specializing in science subjects according (Aksan, 2013). The type of training in primary teacher education may help improve teachers’ perceptions towards environmental issues.

Many studies conducted about perception focus on different environmental subjects, indirectly show the differences in understanding, beliefs and views science teachers hold. In one study for instance “pre-service (science, primary, and social science) teachers perceive differently the fact that urban waste is source of greenhouse effect and acid rain will not cause greenhouse effect”. (Aksan, 2013). In addition, another study reported that based on their perceptions (that renewable energy was very expensive) they strongly supported the use of nuclear energy (Zyadin, 2014). As mention (in previous section) that perception is informed by right or wrong existing schema which proves the perception report above.
Science teaching experiences has potential to develop right perceptions among science teachers regarding local and global environmental issues. Investigations should be conducted even on small scale to bring out relevant conceptions which can inform communities. This ideal however face tough competition against stereotype information from media causing panic and misunderstanding. Hence, the role of media for “teachers’ perceptions of ozone depletion was found to be influenced by television and other external sources” (Çokadar, 2013). Disseminated information about environmental issues is not validated for scientific purpose because it depends on the understanding of the journalist and the funders but not the general public.

3.4 Environmental attitude for science teachers

Most human beings have an attachment for the environment, and how they perceive it describes the attitude which according to Walter (2008) “means the behavior towards something”. In the same manner Schultz et al. (2004, p. 31) describe attitude as a set of beliefs, affect and behavioral intentions a person has towards the environment. For this study it refers to how science teachers’ perceive their actions would be towards environment issues in the questionnaire. Attitude manifest itself in actions for or against the environment as visible indictors which are measurable. Actions perceived by science teachers are based on their knowledge of subject teaching. This idea of linking the two concepts is strongly connected (Zsóka, 2013). Earlier study found that the variables for “measuring attitude and behavior in whole are complex and take time to produce objective results in single study” (Hungerford & Volk. 1990, p. 263).

Studies have measured attitude in various context and have for instance found that “teachers had unfavorable attitude towards snow leopards because they prey on other animals. However, overall they held favorable attitude for conservation of wildlife” (Barthwal, 2012). In the same study, it is revealed that “ecological knowledge and experiences of livestock rearing informed teachers’ knowledge since some of them are natives”. This indicate to this study, that being in a place for long time influence both environmental knowledge and attitude. It validate the idea that knowledge influence attitude. Hungerford & Volk. (1990) emphasize ecological knowledge is pre-requisite in environmental education. Knowledge which influence attitude can either be indigenous or scientific because “older teachers tended be sources of traditional knowledge” (Barthwal, 2012). Sometimes this does not appear in modern sources of information. Another study reported “89% of teachers held positive attitude
towards installation of solar heaters at home” (Zyadin, 2014) while 57% of primary teachers contributed to environmental conservation in their everyday life” (Spiropoulou, 2007).

In the main, Science teachers must not take for granted that having acquired knowledge or concern means good attitude for environment (Zyadin, 2014). On the contrary Hailu (2016) concurs that low level of knowledge also produce favorable attitude. Moreover, even substantial knowledge which seem promising to bring positive environmental attitude in many studies is just a moderate predictor of attitude and behavior (Tuncer et al. 2009, Esa, 2010). Therefore, researcher argue, that prevalence of favorable attitudes is situational or context-based result because it changes with time and other factors. Halder et al. (2012) argues for societal support for education that will prepare future policy makers and influence development of positive attitude.

In pursing attitude, EE aims to educate people “for sensitivity, awareness, skills for participation and possible environmental protection and thus, it is reasonable because attitude relate to knowledge and vice-versa” (Hungerford & Volk. 1990, Jeronen, Jeronen, & Raustia. 2009). More important is that, knowledge, perception and attitude in this study have been used in relation to one another and separation leave a gap between them. This observation is evident in many other studies conducted in various educational research which also appear frequently in the reference list of this work. A knowledge and resource base for environmental education strategies in schools is lacking that’s why it is important to train teachers even more” (Hlobil, 2010) so that motivation is maintained for future generations. Both teachers and pupils need internal and external drivers to act explicitly in favor of environment at household and community level. This bottom up approach is an empowerment for long term environmental solutions.

Many factors influence science teachers’ attitude towards the environment and that indicates whether environment is regarded important or not. According to research women have more positive attitude than men (Ergas & York 2012, Braun, 2018) while on other hand, environmental attitude is reported to develop from early childhood (Ernst & Theimer 2011, Gifford & Sussman, 2012). Since childhood is time for play and grow, most activities remain memorable for children and natural environments are fascinating places to be forgotten. Women used the environment for food and medicine many years ago which might have impact to date whereas men might take nature for granted for obvious reasons that they have been in nature most of the time to show their care through studies.
The place one live also play a major role in shaping environmental attitude because the general culture towards environment often is silently taught or learned even by foreigners. This idea according to (Berenguer, 2005) is the same in terms of rural and urban while another study found differences (Braun, 2018). Differences in results often are possibly because studies have been conducted in different context and participants have various environmental orientations. Where no differences exist between rural and urban, then factors such as childhood experiences in outdoors, knowledge etc. are high while actions are expected to match attitude. According to Berenguer (2005) rural people exhibit high level of responsibility and protection while urban show greater responsibility but less pro-environmental attitude. Attitude change is key among other variables because the environment is under enormous pressure to support current world population” (Stratton, 2015). These differences between rural and urban are more unsafe for developing countries where rural-urban migration is high. It means such population will gradually lose their positive attitude towards nature and consequently few people to take care of the environment.

In order to change pupil’s behavior, science teachers need appropriate tools such as botanical gardens, for teaching environmental education programs at school and teachers must be familiar with these nature areas” (Tampoukou, 2014). Field trips to farms, nature reserves, flat and mountainous landscapes, advanced laboratories for experiments that impact pupil’s attitude. In addition, promote “critical thinking and provide excellent environments for constructive debates” (Borgerding, 2018). Viewing nature alone or simply experimenting stuff in quiet spaces may not conclusively build repertoire for science teachers than justifying own views before others.

3.5 Summary of the theoretical framework

The disciplines of science education and environmental education have strong potential to educate not only for academic performance instead for pupil empowerment since they generally posit similar aims. Science education provides knowledge and skills to seek solution for environmental issues in society. Through the models of EE different science teaching strategies such as inquiry-based teaching, discussion, outdoor education and technology are employed to develop sensitivity, empathetic and feelings for the environment. Once these early stage features are developed many young pupils will grow as responsible citizens displaying these features throughout life. An emphasis for education in, about and for the environment is the holistic approach to develop these necessary characters and create
experiences that impact the holistic pupil. Strategies for teaching environmental issues in science education are many and can be applied for different purposes. Strategies such as discovery, role plays, debates etc. which either fall into teacher or learner centered strategies. The models such as house model, tree model, behavior model and model for sustainable development all aim to improve individual capacity to act pro-environmental for development of favorable attitudes and perceptions.

It is suggested that EE models and teaching strategies can be linked for an effective environmental instruction in science education. Through the model for environmental knowledge, perceptions and attitude come equal reports indicating satisfactory and unsatisfactory claims of knowledge, positive and negative attitude as well as wrong and right perceptions. In all cases, results are due to interlinked influences each variable has on the other two e.g. more knowledge is only likely to produce correct response but not guaranteed. While on other hand, awareness (knowledge) may only influence right perceptions provided it is correct schema. Attitude can be observed according to action or behaviors people perform based on the internal drivers (knowledge and perceptions). Knowledge such as “declarative and procedural alone do not produce pro-environmental behavior without effective social knowledge. Thus, a science teacher should poses or consider all when facilitating environmental topics in a balanced manner for environmental and science education to be effective. Even with all the attributes a pro human must poses, pro-environmental actions are context based and can change. This allow us to develop and grow into conscious science teachers in decision making regarding environmental issues.
4 RESEARCH TASK AND QUESTIONS

4.1 Scope of the study

Since environmental issues are sought after on international level due to global concern, this study draw from perspectives of both environmental education as well as science education while contextualized for Namibia. However, environmental issues cut across imaginary boundaries and affect other territories further away which allow for applicability in another context. Therefore, this study is focused on environmental issues in Namibian science education by recognizing these issues from school curriculum and describe science teaching and assessment methods. The subjects under study include Social Studies, Natural Science and Health Education, Elementary Agriculture and Home Economics at senior primary level (grades 5-7). At junior secondary level (grade 8 & 9) subjects include Geography, Life Science, Physical Science and Agricultural Science.

4.2 Research questions

Often, appropriate research questions can only emerge after a review of relevant literature in the field of study for potential identification of gaps” (Evans, 2014, p. 68). As can be observed from the structure of this work, researcher have complied with this guideline in order to have thorough knowledge of newest insights in environmental issues as well as science education. According to Ary, research questions can either be theoretical (deal with developing or support current theories) or practical questions (deal with actual everyday problems to improve practice)” (2014, p. 37). My research questions in this study take both forms of questioning and aim to test existing theory on environmental knowledge and attitudes. Moreover, help improve the teaching of environmental issues since” institutions of higher learning, schools and teachers are now confronted with essentially ethical questions” (Callicott & Rocha, 1996, p. 75). Meanwhile the following research questions guide the study to the objectives:

RQ1. What is science teachers’ perceptions of the role of science education towards environmental issues?
**RQ2. What is the perception of science teachers’ knowledge about environmental issues?**

**RQ3. What is science teachers’ perceptions of teaching and assessment strategies for environmental issues?**

**RQ4. How is the perceptions of science teachers’ attitude towards the environment?**

### 4.3 Aim and objectives of the study

Although many objectives are listed for this study, the main aim among all is to *identify* environmental issues in the Namibian science education/curriculum and *explore* the most effective teaching and assessment strategies. These two put together help teachers widen teaching repertoire for controversial issues. Environmental issues are controversial firstly as different disciplines (science education and environmental education) have distinct goals (Wals, 2014). Secondly because environmental issues impact almost the entire society while tools such as media and technology often contain pieces of information on the subject. Meanwhile not all published content is appropriate for teaching (Klosterman, 2012). On other hand, as teachers can only motivate pupils to read often but have no mandate to control the content. This would actually contradict the role of teaching in larger context.

Because the physical environment is under serious pressure emanating from human activities and in turn make life difficult for all species. I deem it fit to study environmental issues in order to sensitize pupils as early as possible. In an international study by Halder et al. (2012) only small proportion of pupils had high level of knowledge about bioenergy whereas in Namibia some teachers are unsure about environmental issues (Loubser & Simalumba, 2016). In the main positive attitude is necessary for teaching-learning of environmental issues. Due to differences in ways of conceptions by young pupils and adult science teachers, this study is locating each at their level. Children are easily sensitized while adults learn easily, the two groups are different and should be reached at their respective levels. In the end this provide answers which point to the following aims:

- To **identify** environmental issues in Namibian science education curriculum for teachers in primary (grades 5-7) and junior secondary (grades 8 & 9).

- **Explore** effective **teaching and assessment** strategies for environmental education
• **Broaden** existing knowledge about environmental issues and teaching-assessment strategies among science teachers in Namibia.

• **Explain** relationship between environmental attitude and other variables.

• **Emphasize responsibility** among science teachers to effectively educate Namibians about the consequences associated with environment issues and seek solutions together.

• **Advance** environmental education research in the Namibian education context.
5 RESEARCH METHODOLOGY

5.1 Research paradigm

Mixed research paradigm is applied to analyze perceptions of science teacher’s knowledge and attitudes concerning environmental issues. However, interviews and questionnaire strategies have been employed since at least three areas of interest are considered under this study. Moreover, two independent components of the study were conducted. Interviews research looked at teachers’ knowledge and perceptions concerning environmental issues while questionnaire instrument measured attitude. The methods are used in a “complimentary, triangulation, development, initiation and expansion as recommended” (Creswell, 2011. p, 62) way to produce results which are comparable. Among the objectives of this study, creating awareness of environmental issues among science teachers is sought after hence need to expose them to varied approaches and aspects of environment issues.

Research paradigm choices need to be “identified for use; matching the research purpose and questions while being explicit about the reason for mixing methods” (Creswell, 2011. p, 54). This Namibian case-study used mixed research paradigm with interviews and questionnaire instrument about environmental issues. Qualitative research offered less data for attitude concerning environmental issues hence a suitable instrument was identified and adapted for this purpose. In addition, during the pilot study process it became open that interview questions on the certain section could not obtain anticipated data and valuable suggestions helped researcher to make final decision for mixed methods. Interviews were conducted one on one with science teachers and recorded while a questionnaire instrument was completed online for quantitative data however, later a printed version was also used. Mixed methods became the paradigm of choice because combining qualitative and quantitative data strengthen up the results of the study (Muijs, 2004, Evans, 2014).

Qualitative data is preferred in this case-study because it presents an opportunity for exploring environmental issues in more detail and share some fine facts experienced in science teaching which might not be included in quantitative method. Moreover, respondents are not restricted to express ways used for handling environmental issues in science education.
The quantitative paradigm in this regard was employed to offer reliable feedback to the question “how is the perception of science teachers’ attitude towards environmental issues? “Quantitative is a flexible method that can quantify data which may not necessarily suit mathematical models like attitude through design instruments” (Muijs, 2004, p. 15). Using survey or questionnaire instrument the study may generalize the results for Namibian science teachers and even beyond. In the next sub sections of this chapter, researcher give more detailed methodological choices, procedures and decisions made.

5.2 Research design

In this study, exploratory design (begins with and prioritizes data collection and analysis of qualitative data, building from the results (of study 1) it goes on to conduct quantitative (study 2) to test and generalize the findings” (Creswell, 2011, p. 71).

Figure 4. Exploratory research design

(Adapted from Creswell, 2011, p. 69).

Exploratory design uses linear forward sequence and appropriate timing of processes and procedures. This design is crucial for “assessing overall prevalence from individuals to larger samples of the population and generalization of results thereof. Also, for in-depth exploration of the dimensions of phenomena. Moreover, it is helpful for identification of variables to study in numeric style while lack of adequate theory to inform the study give valid justification for exploration” (Creswell, 2011, p. 71 &
In this case-study, semi-structured interviews (in study 1) with science teachers concerning environmental issues is typical example, preliminary analysis identified appropriate topics for inclusion in the questionnaire (for study 2). In the main, this study employed exploratory design since some of the research questions could not be adequately answered in numeric style (and vice versa). Final interpretation have aspects of the qualitative and quantitative data analysis to make robust conclusions for generalization purpose.

Studies 1 & 2 were conducted independently from one another with fresh participants in each case. Making the work to remain genuine and valid, while prevent phase 1 from informing the ways of responding to items in study 2. Other points for consideration include; “Exploratory design is easy and straightforward to explain, implement and report findings. It also makes qualitative approach more acceptable to quantitative biased audience, Furthermore, it is useful for quantitative phase because new issues emerge based on the learned initial qualitative phase. Importantly, researcher develops a new instrument for future researchers” (Creswell, 2011) although an existing environmental attitude scale is used for this study.

5.3 Relevance of research paradigms and design

Informed by the theoretical framework, research questions and study objectives, this case-study used interviews and questionnaire in a “participatory (influenced by political concern for the environment) and pragmatic (the importance of questions asked about practical implications of science education) worldviews” (Creswell, 2011) where the help is sought for how humans face injustice of living in the world of serious environmental issues caused by themselves. Among such factors, social and economic development are number one. The question hence; what is the role of science education for towards environmental issues and how it shapes perceptions, knowledge and attitudes? If well answered, science education ought to offers multiples forms of empowerment for a citizen science (literate) community that can evaluate daily decisions concerning the environment. Secondly, this study also investigates environmental issues in science education through “post-positivism (measure of selected associated variables to test hypothesis) and constructivism (participants provide meanings through individual social interactions to broad understanding) worldviews” (Creswell, 2011).
Furthermore, the epistemologies of realistic and relativistic perspectives of environmental issues in modern world are multifaceted. Science education offer more “objective measurements and observations” (Muijs, 2004) of environmental issues thus encouraged to take center stage in creating awareness and possible resilience actions for citizen science community. However, a lot of other factors come into play and are “subjective to social construct” (Creswell, 2011) of differently lived individual reality around the world. Sustainable development practices are encouraged at global and national level since natural resources are diminishing and demand ever increasing.

Lastly, the “ontology (reality of environmental issues) and epistemology (how to gain knowledge about environmental issues)” (Creswell, 2011, p. 41) is thus another focus in the study; what science teaching and assessment strategies are used for teaching environmental issues? A view of the role of values (axiology) is also studied from the instrument (quantitative) used for environmental actions among science teachers. Therefore, science teachers’ attitude towards the environment as humans is crucial and cannot be completely detached from their practice. The gap is filled by constructivism worldview in which researcher and participants interacted through individual interviews (qualitative/study 1) to make meaning about teaching environmental issues. It is relevant then to apply mixed method research paradigm to connect knowledge from science teaching practice with perceptions and attitudes prevailing in everyday life (quantitative/study 2). This allow for the study and development of knowledge which transcend from constructivism to post-positivism epistemologies of environmental issues in science education.

5.4 Participants of the study

A non-probability expert purposive sampling method was used because science teachers are best to answer the research questions about environmental issues. All science teachers who participated in the interviews were master’s degree students at the University of Eastern Finland in Joensuu. The group was ideal for two reasons: 1) they have been teaching science in Namibian schools and 2) they were immediately available for interviews than those in Namibia by the time of study 1 which became pre-request or important component for study 2 to take place.
Participants recruited in study 2 were from Erongo, Khomas and Zambezi regions of Namibia, and were sampled from general science teachers (as in study 1). The researcher found it easy to ask co-workers to complete online questionnaire through various software applications (WhatsApp, Messenger and Email). In addition, printed questionnaires were later used to increase the response rate. Participants were mainly from urban schools in the regions and very few from rural. Moreover, participants taught science subjects in primary (grades 5-7) and junior secondary phases (grades 8 & 9). In total study 2 demographic information is $N=88$, overall, female representation is $45.5\%$, $F_{40}$ while their male counterparts are $54.5\%$, $F_{48}$. Regarding subject teaching participants for Natural Science and Health Education ($33.0\%$) $F_{29}$, (Elementary) Agriculture ($9.1\%$) $F_{8}$, Social Studies/Geography ($35.2\%$) $F_{31}$, Life Science ($10.20\%$) $F_{9}$, Physical Science ($10.2\%$) $F_{9}$ and Home Economics ($2.3\%$) $F_{2}$.
Figure 5. Biographical information for participants in study 2

Figure 6. Science subjects for the study
5.5 Pilot study

When the data collection instruments were ready, a pilot study 1 (interviews) was conducted among two science teachers. The whole study took place on 14-16 March 2018 at participants’ houses and all pilot interviews were carried out during afternoons in various locations of the city of Joensuu. During this period researcher analyzed the time taken (average 35 minutes) for each interview. Moreover, a closer look at the interview questions led to minor changes in framing initial research questions. A significant change took place for questions regarding attitude/behavior which sounded more personal and led to the use of environmental scale to detect this phenomenon via a questionnaire.

For study 2 piloting included five science teachers who completed the questionnaire online. This took place in early April 2018 and in the same manner comments were valuable. The result indicated no major issues were raised as the questionnaire is a standardized scientific research tool and was slightly adapted for current study. Through this pilot study, data was being generated and participants gave positive feedback that questions were clear although instructions sounded confusing for some participants as subject choices were combined. Some participants taught more than one subject and desired to mark as such but could not be catered for.

5.6 Data collection process

By means of interviews the researcher collected qualitative data from master’s degree students who have experience as science teachers in Namibia. During the process researcher set up a schedule which was negotiated with participants regrading time and place. Most targeted science teachers agreed to participate in interviews at library study rooms. Over a period of 2 1/2 weeks eight (8) interviews were conducted. The process went smoothly because students had classes on campus and perfectly adhered to appointments. Moreover, study rooms in the university library were most conducive to avoid noise pollution in the recording.

The online questionnaire (study 2) was open for completion by participants from April to July 2018. The month of May however is covered by school holiday in Namibia and very few responded during this time. In other words, researcher considered it and rather focused on other academic commitments. A more robust data collection was done during the month of June since researcher physically visited
schools to ensure substantial number of teachers responded. To this effect, researcher realized the need for manual completion of questionnaire as some science teachers were willing to complete that way. Generally SPSS analysis requires at least 35 participants to reach conclusions. A total of three (3) education departments or regions (see appendix B, C & D) were visited. A grand total of 88 entries was recorded including online participants. In other words, manual collected forms was entered by the researcher himself and this was done in three different sets according to researcher discretion when opportunity appeared. Data collection closed on 30 July 2018.

5.7 Data analysis

Analysis for study one used content analysis which is among the main methods in qualitative analysis and often used to explain not only textual narratives, but also “transcribed talk (interviews), observation instruments and images (Bauer & Gaskell, 2000, p. 136). In addition, content analysis therefore, “is evaluated by means of grounding in the materials and its coherence with research theory” (Bauer, & Gaskell. 2000, p.133). Before and during the analysis process, researcher read and re-read the transcriptions several times to understand knowledge, thoughts, and attitudes towards environmental issues. Although transcribed texts yielded volumes of texts, the technique of coding reduced it to manageable components.

Researcher developed themes/categories through open (break down text into simple sections) and axial coding (assemble the text back together and make links between and across categories) (Ary, 2014). A total of seventeen (17) categories were produced from the data and each was accorded to respective research question and overlapped in some cases. The categories included provision of skills and knowledge, education for the environment. These were directed to research question 1. Examples of environmental issues, importance of environmental knowledge, teacher education for science education, effective science education and sources of environmental knowledge, these directed to research question 2. In addition, Science teaching for environmental issues, incorporation of environmental issues in science education, activities for environmental in science education and discussion teaching strategy which referred to research question 3. Meanwhile a sub-research question regarding assessment also was accorded assessment strategies for environmental issues, formative assessment, summative assessment, environmental topics for assessment, nature of environmental assessment in science
education and scientific skills in assessment of environmental issues. Moreover, gender, teaching experience and level of education were considered for all research questions.

To achieve the themes/categories researcher examined and re-examined transcriptions for coherent questions and answers. Also, different colors were used to separate themes/categories using Microsoft word program, it became practical to continuously separate and merge data and find relationships between them. Lastly, interpretations of all responses formed the results of the study (see chapter 6).

Study two (Quantitative) dealt with numeric data organized in variables of the research question 4-dealing with environmental attitude. A total of 32 statements in the questionnaire measured the outcome variable with Likert scale answers coded 1=strongly disagree, 2=disagree, 3=undecided, 4=agree and 5=strongly agree. Software program IBM SPSS version 24 was used to analyze the data. Internal consistency, normality tests were performed for the instrument to determine reliability. Descriptive statistics median (Mdn), mean (M), standard deviation (S) as well as analysis of variance (ANOVA) and Mann-Whitney and Kruskal-Wallis tests were performed for analysis and presentation of results.

5.8 Reliability and validity

Qualitative and quantitative research both employ different reliability and validity strategies, however, they all stress quality in the work. The former is stronger in validity aspects while the later in reliability (Creswell, 2011). In this study, reliability and validity were accounted for in various ways and inferences to each other were made throughout the process. Ary, (2014) suggests appropriateness of content, adequate standards, human traits and particular behavioral domains for reliability and validity of research work”.

Reliability is the extent to which results are free from mistakes thus describes research instrument in a way” (Muijs, 2004, Fendler, 2016). More clarity is also found in (Creswell, 2011, Ary, 2014) who emphasize truthful scores or results. On other hand validity “is questioning whether the research instrument measures what it set to measure and describe a way of reasoning” (Field, 2013, Muijs, 2004; Ary, 2014, Fendler, 2016). Generally, when research tools are reliable, results are more likely to be valid considering other influential factors (and vice versa).
For qualitative (or study 1), the researcher collected information from science teachers with experience in teaching various subjects in primary and secondary phase. The developed interview instrument was checked by a total of four researchers in Finland and Namibia, including the research supervisor. All are well conversant in both research, science education and environmental issues thus validated the interview instrument. Moreover, a pilot study was conducted. During this process, only minor changes were observed and fixed. One such issue was removal of a question on ethical and moral issues on the topic. The removed question is minor because it did not influence the current research questions at all since it was placed as last question in the interviews. To this effect, “valid content in the instrument employed is first character. Other includes criterion related evidence (asses the association with other measures of the variable of interest) and construct related evidence (measuring how well the instrument represents the construct interest)” (Ary, 2014). My study involved analyzing environmental issues to science education as well as knowledge and attitude of science teachers. Since validity is a question of finding out “whether the instrument or questions measure what is supposed to measure?” (Muijs, 2004, Ary, 2014) I have in study 1 investigated teachers’ perceived knowledge about environmental issues, teaching and assessment strategies in a way they perceive the practice. In so doing, specific questions triggered for more and more detail of environment issues as Morrow (2005) recommend looking at details in line with research questions.

During the analysis process for study 1 researcher triangulated transcribed data, disconfirming evidence as results indicate differently against established evidence and member checking (Creswell, 2011). Researcher also checked transcribed text and listened to audio for consistency with what has been said during interview. Minimal corrections of concepts or words was done to prevent misinterpretation of results. Moreover, researcher did a thorough reading and re-reading of text and grouped into various categories against research question so that results come out in clear manner. However, interviews went forward and back, and some crucial aspect were also found in other categories as the process continued.

The study results are congruent and diverge in some cases with other studies conducted in Namibia and this helped researcher to also re-establish the position/perspectives in right direction by carefully employing relevant concepts. Meanwhile, other members and experienced researchers have critiqued the study before this final work was done.

In quantitative (or study 2) researcher adapted an existing scale and it was re-tested for reliability with Cronbach’s alpha (a) .892 as a recommended practice in quantitative study is instrument test and re-test
The Cronbach’s alpha is adequate at $a=.884$ ($a>.07$ or preferable $>.8$) (Field, 2013, Muijs, 2004) indicating initial consistency for this instrument. Reliability testing with Cronbach’s alpha ($a$) was also extended to the subscales with energy saving ($a=.703$), water saving ($a=.702$), environmental publication ($a=.839$) and sustainability ($a=.824$). Moreover, Kolmogorov-Smirnov, Shapiro-Wilk tests, visual representation with histogram as well as normal Q-Q plot were used for testing normality and data was approximately normally distributed, however, some variables were not and non-parametric methods were used. The results from these tests were reasonably good enough to continue this study (see appendix M).

5.9 Ethical issues

A lot of science teachers have participated in this study and accountability for the information provided means taking absolute care. According to Tangen (2013), ethical issues in education research has three domains; “ethics in research community, protection of research participants and role and value of research in society”. Ethical issues therefore refer to values, standards and institutional schemes for guiding scientific activity” (NESH, 2006, p. 5). In this research work, ethical issues have been adhered to in planning, data collection as well as reporting the results. The extent to which the three domains described above were employed vary in degrees. In the main, ethical issues have been considered here to accord individual participants “privacy, anonymity and confidentiality as key ethical issues especially in online research” (AERA, 2011).

In study 1, the first step involved obtaining informal (oral) permission from UEF research supervisor to conduct research among Namibian science teachers who were students at the same time. This represent institutional permission that required no written permission since researcher is part of the group. In this case researcher had no overriding power in decision making for participants since all have knowledge about research ethics. Prior to conducting interviews researcher telephonically requested individual voluntary participation. This was supplemented by written statement providing information to this effect. In addition, participants signed consent forms to confirm their willingness to engage in the study (see appendix F). Interviews were recorded, and participants had knowledge about it thus conversation was conducted in” respect of professional integrity, respect for colleagues (and pupils), respect for policy makers and general research community (Tangen, 2013).
In the next stage, recorded interviews were transferred from recording device onto researcher’s personal computer secured with two different passwords. During data analysis, identifiers were immediately removed and replaced with letter” T” for teacher with random numbering according to cases i.e. T1, T2 etc. In addition, no information thus far and in future is or will be made available to any third parties or used for any other purpose than this work.

Study 2 on other hand, researcher first sought permission from Erongo, Khomas and Zambezi education departments. And upon approval, researcher also requested permission at respective schools.” These levels of permission are necessary in both qualitative and quantitative research” (Creswell, 2011, p. 175). Even though, individual participants involved did so in voluntary capacity. Information pertaining to anonymity and confidentiality was put right on top so that each participant is able to read it before attempting any question. Moreover, constant reminders about it was made including right to withdraw at any time during the process.

The online survey instrument was designed in a way that no identity of participants was required. Although a printed version of the online questionnaire was later used, participants were also informed through verbal means that identity in any form is not a requirement to participate in the study. And no incident of individual or school name writing was observed by researcher in the whole study.

On other hand, Mahon (2013) argues for online research to give a warning statement in participant information sheet as they might be potential hacking activities during the process”. Moreover,” IP addresses also act as identifiers as well as tracking links. However, even with all measures for anonymity and privacy there is still chances for breaching beyond researcher’s control” (Roberts, 2015). In my study, no incidents of hacking or tracking of devices used was experienced as this might require advanced technical knowhow. For enhancement of quality research and increase response rate researcher has maintained reasonable number of reminders for each participant and accepted that potential participant is unwilling to take part. None of the potential participants or participants directly informed the researcher s/he is unwilling. This might be ascribed to cultural issues for not openly refuse a request. Researcher also strictly maintained the use of other software applications (WhatsApp, Messenger and Email) for research work only and instead interacted more often with colleagues personally known by researcher and vice versa. Another measure for ethical issues is that each participant had to press” save” in the end in order for data to be in the system or could simply leave the web page as withdrawal from participating.
During extraction of data from elomake to excel and then SPSS system, researcher have no means to identify any participant and thus only interested in the data. These techniques are built in the elomake software program of UEF to maintain ethical issues in research.
RESULTS OF THE STUDY

In this section results are presented according to sections (6.1 to 6.4). The chronology for exploratory mixed research design is followed, meaning results for qualitative are presented first (see section 6.1 to 6.3) and thereafter, follow the results for quantitative (see section 6.4).

6.1 The role of science education towards environmental issues (EI)

According to main results, the role of science education is to provide skills and knowledge such as observing, recording, analyzing etc., help increase academic performance among pupils, motivate pupils to take up scientific professions. In addition, Science education informs pupil of human impact on environment. Moreover, educate pupil for the environment by creating awareness, sensitizing people environment issues, especially in places they live. The skills and knowledge should enable people to become responsible citizens and conserve natural resources. Gender reported 50% (1 out of 2) female influence towards the result. On other hand, teaching experience and level of education produced no differences towards the aims of science education. Thus, the perceived aims of science education by science teachers remain the same except in the case of gender. Below are the detailed results for this section.

To answer research question 1, results show that science teachers have different perceptions about the role of science education towards environmental issues. At least four respondents perceive the role of science education is to provide and develop scientific skills and knowledge. Science teachers mentioned the following skills make observations in environments, analyzing data, reporting/communicate results form own investigations. Moreover be able to conduct measurements with scientific apparatus, make assessment of the information from sources and be aware of the environmental problems and seek solutions. In addition, two respondents indicated the role is to motivate pupils to consider scientific professions (especially among girls), (female respondent remarked). While other two respondents think science education help to improve academic achievement in science subjects. To this end an extract which follow further illustrates the analysis.

T3. In science we mainly teach to develop scientific skills among learners, so... one of those is learners must be able to observe,
learners must be able to record the observations, learners must be able to synthesis what they have observed and learners must also be able to report

The skills mentioned in extract above are practical and pupils apply them in learning or finding out scientific issues within the environment. It helps them improve their understanding of results obtained in different ecosystem dynamics for instance. In addition, their interaction with nature will improve since they are aware of impacts caused by certain actions.

As some respondents mentioned more than one role of science education, At least six respondents say science is part of environment and inform people to be responsible citizens as they experience environmental issues. Three respondents also perceive the role of science education is to educate through indigenous knowledge and create awareness, sensitize people about environmental issues in local areas. This they hope help by solving household and community issues. Generally, science education also teach about human activities that impact the environment thus maintain resources for future generation. Respondents used the following concepts regarding the role of science concerning environment issues.

**TABLE 3. Science teachers’ descriptions of the role of science education for the environment**

<table>
<thead>
<tr>
<th>Human activities not be done</th>
<th>Lessons in science education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Should not create hazards for environment</td>
<td>Create awareness for environment</td>
</tr>
<tr>
<td>Do not damage the environment</td>
<td>Teach people to care/conserve resources</td>
</tr>
<tr>
<td>Should not cause negative impact on environment</td>
<td>Teach people to love the environment</td>
</tr>
<tr>
<td>Make people to be sensitive towards the environment</td>
<td>Make people to be responsible for the environment</td>
</tr>
<tr>
<td>Teach people to be responsible for the environment</td>
<td></td>
</tr>
</tbody>
</table>
Lastly, two respondents maintain that the role of science is to teach or educate science content and assess according. In addition, the content assist in dealing with scientific issues in everyday life and help in lifelong learning.

*T4 It’s quite a lot of aims when one is teaching science, but for quite most important aim for teaching science is to inform learners on how they should deal with scientific issues they come across within life in term of lifelong learning when you apply science. but when you apply on a benefit of a learner is to excel in maybe to be professional someone in science related subjects and it might become a teacher, a scientist or a doctor.*

Although science education is mainly for academic achievement in school, environmental issues appear in different ways and affect the whole society. Through continuing education pupils need to be aware of such issues. More importantly, they ought to take up professional positions to be able to influence others in society.

The variable gender had 50% (1 out of 2) influence for the results of the research question. Male and female respondents produced different results towards the role of science education. The unique response or remark is as follow

*T2. My aim is to instill the love of science education in young learners, especially in the young female learners because they believe that science is only a subject for boys and smart people since it is believed to be a difficult subject.*

The belief that science education is for some sort of people or certain gender is still common in some societies, especially in developing countries. It is important that this result recognize opportunities are for all to learn about environmental issues/science education especially at tender years.

There were differences between more experienced and less experienced respondents in the way (behavior) of responding to the questions used for this section. However, the perceived aims of science education are similar. Three (38%) more experienced respondents were observed to be more
confident/relaxed during interviews while three 38% less experienced respondents were slightly less confident. Two (25%) less experienced respondents were very confident although responses were short. In addition, more experienced respondents recorded more time (above 35 minutes for entire interview) in explaining every detail than the less experienced who responded in short. The variable level of education produced no differences between respondents in terms of the aims of science education. All respondents (100%) mentioned the relevant aims for science education.

### 6.2 Science teachers’ knowledge about environmental issues (EI)

According to main results, science teachers’ perceived knowledge about environmental issues is satisfactory. Respondents mentioned pollution (63%), deforestation (38%), climate change (25%), etc. as examples of environmental issues. In addition, (6 out of 8) 75% of science teachers perceive environmental issues are part of society and important learning area in science education. Moreover, teachers mentioned and justified environmental topics such as ecology, mining, weather etc. They perceive such environmental knowledge helps pupils to make decisions. Thus, enable them to make link between what is learnt (theory) and reality (practice). Many sources inform teachers knowledge about environmental issues, among them teacher education, collaboration with experts and media/technology are quiet significant. In the main, variables gender, teaching experience and level of education produce no differences in the result for the research question. Below are the detailed results for this section.

Overall, results show that eight (8) science teachers’ perceptions of knowledge about environmental issues is satisfactory, however, differences occur on individual environmental issues. Respondents mentioned environmental issues such as pollution of air, water and land (63%), deforestation (38%), climate change, global warming and land degradation all with (25%), while acid rain, soil erosion, depletion of ozone layer as well as drought recorded (13%). In addition, science teachers confidently elaborated each environment issue mentioned in more detail giving examples such as extinction of animals, dying aquatic animals, low rainfall figures, destruction of landscape.
TABLE 4. Frequency for examples of environmental issues

<table>
<thead>
<tr>
<th>Environmental Issues</th>
<th>Frequency</th>
<th>Percentages (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Depletion of ozone layer</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Deforestation</td>
<td>3</td>
<td>38</td>
</tr>
<tr>
<td>Pollution (air, water &amp; land)</td>
<td>5</td>
<td>63</td>
</tr>
<tr>
<td>Acid rain</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Land degradation</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>Global warming</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>Soil erosion</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Climate change</td>
<td>2</td>
<td>25</td>
</tr>
</tbody>
</table>

Regarding why science teachers perceive knowledge about environmental issues is critical aspect of science today, At least six (6) out of eight (8) science teachers perceive environmental issues are crucial part of science education and society, thus important for pupils to learn in order to have an understanding for decision making as future environmental leaders. Moreover, science teacher were able to recall environmental topics or concepts they have taught and explain how contextualized. The following justifications are given to explain it further.

T5 Environmental issues in science teaching is very important because

remember science is teaching children things around them” so you

need to teach these children in science how can they take care of themselves,

how they can act to things around them for future awareness, to prevent diseases.
Science education is meant to inform us to live better lifestyles especially in relation to our surrounding areas and personal hygiene. Health education is quiet significant in curriculum for science education (see appendix L).

**TABLE 5. Environmental topics and illustrations for relevance in science education**

<table>
<thead>
<tr>
<th>Environmental topics</th>
<th>Illustrations for relevance by science teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecology/ Ecosystems (Living and non-living things)</td>
<td>Teach relationships between people and nature</td>
</tr>
<tr>
<td>Plants and animals</td>
<td>Teach about kinds of plants and animals</td>
</tr>
<tr>
<td>Littering, plastics</td>
<td>Burning plastics causes air pollution</td>
</tr>
<tr>
<td>Oil spills</td>
<td>Aquatic animals struggle to survive</td>
</tr>
<tr>
<td>Fertilizers/Soil nutrients</td>
<td>For rural farmers to use organic fertilizers due to consequences of NPK</td>
</tr>
<tr>
<td>Weather</td>
<td>For farmers to know fluctuating weather patterns</td>
</tr>
<tr>
<td>Mining</td>
<td>It causes changes in landscapes and destroys vegetation</td>
</tr>
<tr>
<td>Energy</td>
<td>So that we conserve energy in household</td>
</tr>
<tr>
<td>Farming (crop and livestock)</td>
<td>Because most people are farmers, some farming practices are unstainable</td>
</tr>
<tr>
<td>Gases</td>
<td>Causes harm to the environment, e.g. acid rain affect the color of buildings, plants and causes diseases</td>
</tr>
<tr>
<td>Natural resources</td>
<td>Because old narratives indicate there were plenty of animals but not anymore</td>
</tr>
</tbody>
</table>

In addition, science teachers perceive knowledge about environmental issues in science education help pupils make connections between environmental theory and practice or help them implement good
practices they learn. Science education is important because it create environmental awareness, sensitize pupils to become responsible citizens with ability take necessary precautions and decision about environmental issues.

*T1 You don’t make a field close to the water cause we know the consequences” if it rains fertilizer will wash in the water and the animals are going to die. at least they should not buy because the one actually produced is more harmful than the biological ones.*

*T6 I think that we are moving in a direction where the society is more involved in science and we need to teach our learners to be able to connect what they are learning in the classroom which is theory to the practice, because it is an everyday issue that they come across or in contact with.*

Pupils acquire knowledge through education and as science teachers it’s important to understand the practical nature of the subject environment. They ought to apply what is learnt in science to everyday activities at household and community level.

Respondents have undertaken training for various qualifications such as B Ed. Science education and pursuing MA Primary education degree, including seven (7) years average teaching experiences. Five of the respondents indicated (yes) they need training on environmental issues, they emphasize that training is required on how to deliver practical environmental education lessons to pupils such as conducting fieldwork with scientific equipments and materials to assess the environment. Environmental content, material/resource development e.g. posters in science education. Moreover, trainings should be in the form of environmental conferences/workshops (in-service training) and collaboration with specialized agencies/ministries on regular basis. On other hand, two science teachers indicated (no), they do not need training since they perceive that their current knowledge is satisfactory enough regarding environmental issues and science education. They think their current masters’ degree studies is adequate to understand most content about environmental issues. And one science teacher is undecided regarding training.
In general, respondents also suggested the need for increasing environmental issues in curriculum and general environmental awareness not only for science teachers but all teachers. Regarding teaching they suggested the practice that includes inquiry based strategy, laboratory/experimental work, outdoor education/field trips and the use of technology to aid current practices. In so doing science teachers hope for increased pupil interest in science education. Meanwhile, resource/material development for teaching, projects, tours need funding and collaboration with environmental agencies and relevant ministries.

Regarding sources of knowledge for perceived environmental issues most science teachers disseminate and access information regarding environmental issues through discussions with colleagues and other experts (75%), internet (63%), textbooks (40%) while radio and television both at 25% and remain traditional means of information sharing.

_T1_ Environmental issues we always have documents, we have textbooks for example for teaching the learners we have the curriculum of course it doesn’t tell us to go beyond the curriculum of what they need to know. We have the textbook where we can get information we have newspapers, magazines. I think move magazine most of them like because there’s always something about the environment and tv they see those things e.g. what happens in those countries where for e.g. acid rain.

There was a state in USA where it’s experienced acid rain on TV if they have seen that.

those are the things I refer to.

_T6_ Yes, just by reading, reading from the textbook and other materials from the internet, sometimes we discuss it with other colleagues.

Information about environmental issues is easily found nowadays than before, thus, media and technology play a major role in facilitating teacher’s acquisition of knowledge. However, not all information reported in media is applicable for science education. Science teachers’ evaluation and
choice for content need to be exercised with diligence. Reading from multiple sources is always ideal for establishing a critical viewpoint. No differences were observed from the variable gender towards the results of this research question since examples/content and expressions of environmental issues used by male and female respondents were similar. All respondents (100%) were able to respond to all questions in the expected way.

There were differences between more experienced and less experienced respondents in the way (behavior) of responding to the questions used towards environmental knowledge. However, the perceived environmental knowledge is similar. Three (38%) more experienced respondents were observed to be more confident/relaxed during interviews while three 38% less experienced respondents were slightly less confident. Two (25%) less experienced respondents were very confident although responses were short. In addition, more experienced respondents recorded more time (above 35 minutes for entire interview) in explaining every detail than the less experienced who responded in short. The variable level of education produced no differences between respondents towards environmental knowledge. All respondents (100%) mentioned the similar examples of environmental issues.

6.3 Science teaching and assessment strategies for environmental issues (EI)

According to main results, science teachers perceive using different teaching strategies. Examples of common teaching strategies include group work, technology and discussion (50%). Inquiry and outdoor education (38%) while experimental, collaborative and demonstration (25%). Preferences for teaching strategies is based on topics, availability of resources, class size etc. including advantages and disadvantages. Science teachers applied discussion strategy for teaching topics such as water, energy and sanitation. Gender produces differences regarding teaching strategies, four out of six (67%) male science teachers prefer narrative, experimental and discussion strategies while two out of two (100%) female science teachers prefer inquiry and discussion strategies. Teaching experience and level of education produced no differences towards the result. Below are the detailed results for this section.

Science teachers perceive they use a variety of strategies for teaching environmental issues, the most common are discussion, technology and group work which account for at least 50% while outdoor/field
work, Inquiry account only 38%. Furthermore, experiment/demonstration, collaborative with 25%. And least discovery and textbook strategy with 13%.

**TABLE 6. Science teaching strategies**

<table>
<thead>
<tr>
<th>Teaching strategies</th>
<th>Frequency</th>
<th>Percentages (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group work</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>Discussion</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>Technology</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>Outdoor</td>
<td>3</td>
<td>38</td>
</tr>
<tr>
<td>Inquiry</td>
<td>3</td>
<td>38</td>
</tr>
<tr>
<td>Collaborative</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>Demonstration/Experiment</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>Discovery</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Textbook</td>
<td>1</td>
<td>13</td>
</tr>
</tbody>
</table>

The following excerpts by respondents further exemplifies responses given during interviews.

*T5 Normally I do discovery methods most of the time, when I introduce my topic the first day I normally use through discovery method and then I consider the knowledge of my learners as my point of departure.*
A science teacher need to establish the level of his/her pupils’ understand prior to presentation of new content so that all pupils understand the background of the lesson, especially in science education for scientific concepts. This process is equally important for smooth progression into the main lesson.

_T6 Okay, teaching methods, I use different teaching methods depending on the content and learning objectives so I can use teacher centered method, I can use learner centered method, I can use collaborative method, I can use more of lab-oriented method, I can use inquiry for practical related content_

Science teachers also indicated that preferences for teaching strategies are professional choices made considering the environmental topics/ lesson objectives, resources availability, the number of pupils in a classroom. In addition, individual teaching strategies do not cover all topics adequately. Associated advantages and disadvantages are used for making such choices. Individual science teaching strategies with 50% or highest rating (group work, discussion, technology) engage pupils more in the work, bring different views and motivate learners. Moreover, outdoor education and inquiry (38%) motivate pupils by exposure to real environment and increase curiosity among pupils. Lastly, collaborative and experimental (25%) improve social skills, allow finding out things by pupils. In the main, science teachers use the strategies together for diverse instruction for environmental education.
Respondents were asked to further illustrate teaching strategies. The table and some extracts below the table give explains the ideas.

**TABLE 7. Science teachers’ conceptions of teaching strategies**

<table>
<thead>
<tr>
<th>Teaching strategy</th>
<th>Conceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrative</td>
<td>Pupils tell what they know or see in local area and teacher directs them where appropriate.</td>
</tr>
<tr>
<td>Learner Centred education</td>
<td>Teacher facilitates and guide pupils, also give task in groups.</td>
</tr>
<tr>
<td>Inquiry based science education</td>
<td>Ask questions and engage in discussion, assign a project for pupils to find out and bring feedback to class for further instruction/clarity.</td>
</tr>
<tr>
<td></td>
<td>Test their understanding/knowledge by asking questions before explaining for pupils, work in groups for different views.</td>
</tr>
<tr>
<td>Experiments</td>
<td>Conduct experiment in laboratory or class, learners follow demonstration or instructions.</td>
</tr>
<tr>
<td></td>
<td>All you need are apparatus</td>
</tr>
<tr>
<td>Discovery</td>
<td>Frequent use of questions from both sides, identify things around.</td>
</tr>
<tr>
<td>Teacher centered</td>
<td>Teacher give own views, pupil open textbook and discuss, pupil take notes</td>
</tr>
<tr>
<td>Technology</td>
<td>Download videos for presentations, take notes for comments afterwards, watch tv, and take photographs.</td>
</tr>
</tbody>
</table>
Narratives, so if we say for example magnet some of the magnet they will tell you that the magnets are coming together instead of saying they are coming together, say they are attracting. It’s just the way of directing because they already know. To help them to know the scientific term explaining or saying cutting down too many trees example is probably deforestation

Social context provides platform for conversations and inquiry on topics of interest and bring up prevailing conceptions in a group. A science teacher can use it for evaluating the level of thinking and content at the same time. In the same manner, provide guidance for pupils towards subject and lesson goals.

Inquiry based learning whereby before I commence with a topic, I ask questions and engage in a discussion with learners that serves as an introduction for the topic

Generally, respondents indicated discussion and question-answer strategies about local environmental issues as an easy strategy for perceived integration of environmental education, relating subject content with pupil’s prior knowledge and further discuss and apply to everyday life. e.g. make a school garden.

Teachers were also asked for recommendations regarding ideal activities for teaching environmental issues. Generally, science teachers recommended environmental activities such as fieldtrips/outdoor education or experimental for pupils to do practical investigations, plant trees, clean the school environment, establish gardens, ponds for fish studies to deepen their knowledge.

Teachers were also asked directly whether they discuss environmental issues (water, energy and sanitation) with pupils. Result show that four (4) respondents acknowledged discussing water, energy and or sanitation topics with pupils. In addition, during these discussions respondents emphasizes the importance of these resources. One male respondent indicated that he always encourages energy conservation through practical methods such as calculating energy consumption of various appliances in physical science, showing bills and saving techniques. Meanwhile, another female respondent indicated how she uses energy topic to tell pupils not to use smaller pots on bigger plates on the stove
(and vice versa) to save energy and time. For sanitation teachers generally emphasize personal and environmental cleanliness. Moreover, water, energy and sanitation are taught as common household and generic issues.

The variable gender produced differences towards the results of this research question since examples of teaching strategies most preferred by male and female respondents were different. Four (67%) male respondents mentioned preference for narrative, experimental and discussion strategies while other two (33%) were undecided. Two (100%) females reported preference for inquiry and discussion strategies.

There were no differences between more experienced and less experienced respondents in the way (behavior) of responding to the questions used towards teaching strategies. Thus, the teaching strategies perceived were similar. Three (38%) more experienced respondents were observed to be more confident/relaxed during interviews while three 38% less experienced respondents were slightly less confident. Two (25%) less experienced respondents were very confident although responses were short. In addition, more experienced respondents recorded more time (above 35 minutes for entire interview) in explaining every detail than the less experienced who responded in short. On other hand, no differences were observed in content mentioned by more experienced respondents compared to the less experienced respondents. The variable level of education produced no differences between respondents towards teaching strategies. All respondents (100%) mentioned the similar examples of teaching strategies applicable in science education.

**6.3.1 Assessment strategies for environmental issues (EI)**

According to main results, all eight (8) science teachers’ perceptions of assessment strategies are similar and guided by formative and summative principles. While formative take the forms of question and answer strategies as well as observation of behaviors during practical work. In addition, science teachers use brainstorming exercises. Summative assessment mainly uses practical investigations, projects and examinations for promotional marks. In general assessment of environmental topics is reported to be theoretical than practical. Moreover, variables gender, teaching experience and level of education produce no difference results towards science teachers’ assessment strategies. Below are the detailed results for this section.
Overall, results show that science teachers’ have similar perceptions of assessment strategies for environmental issues, however, slight differences occur in some respects. Respondents mentioned that assessment for environmental issues in science education is guided by prescribed formal (summative) and informal (formative) assessment strategies. This is mainly done by means of projects, practical investigations and examinations which carry weighted marks for continuous assessment purpose and account towards final grade marks. Informal strategies such as questioning, observations are also applied to improve the teaching-learning process. Furthermore, science teachers perceive establishing gardens, implementing field trips are other ways of generating assessment marks. Meanwhile, among science teachers some feel and suggest more practical assessment strategies are needed. Responses by science teachers below further illustrate assessment strategies.

_T2 for practical investigations in the Natural Science syllabus, there’s a rubric which is attached at the end of it which I use to assess their skills and efforts that they have put in their work._

Generally, assessments strategies for science education just like all other disciplines follow certain guidelines, However, a teacher should be able to design assessment strategies that capture the true reflection of pupils’ performance according to his/her professional judgement. Both formative and summative assessments need to be applied for environmental issues in science education.

_T4 I don’t think I teach it special, I just assess them, like how I assess others concepts within the syllabus according to the guideline from the ministry, but more focus like the group project and can also be in some other assessments whereby they have to expect it in exams._

Results for formative ways of assessment for environmental issues indicate that four (4 out of 8) respondents perceive to apply this form of assessment through questioning and commenting between teacher and pupil. Pupils tell the teacher what they know about a topic. Three (3 out of 8) respondents apply the strategy by observing pupil behavior and commitment towards tasks such as gardening. In this way teacher gather information that may influence awarded marks at the end of a task and also for further instruction to clarify misconceptions.
Results for summative ways of assessment for environmental issues indicate that all respondents (8) perceive to apply this form of assessment. Practical investigations are carried out on certain topics over short time, topic task summarize the topic for understanding and helpful for identification of gaps and revision while projects take place for extended time. In addition, respondents show that most of the work account for continuous assessment marks which are combined with examinations for promotion grades at the end of the academic year.

Results for environmental topics assessed in science education indicate that generally, respondents perceive pollution, plants, fish, water and coastal issues are included in assessment. They also indicated that, environmental topics are done through above mentioned assessment strategies. Regarding the nature of assessment for environmental issues in science education, at least four (4 out of 8) respondents indicated that assessment for environmental issues is based on theory from textbooks and other sources while two (2 out of 8) respondents also feel it’s less or not enough. Moreover, guidelines for assessment are prescribed for each subject.

Results for possible scientific skills attained through environmental assessment, In general way, responses indicate that logical reasoning, inquiry skills, data collection skills, feedback/reporting and understanding. Meanwhile through detailed analysis (of teaching methods and assessment), other respondents mentioned more general and humanistic skills like awareness, sensitivity and responsible behaviors. The variable gender produced no differences towards the results of this research question since examples of assessment strategies most applied in science education by male and female respondents were similar. Eight (100%) male and female respondents mentioned the use of both formative and summative assessment strategies.

There were no differences between more experienced and less experienced respondents in the way (behavior) of responding to the questions used towards assessment strategies. Thus, the assessment strategies perceived were similar. Three (38%) more experienced respondents were observed to be more confident/relaxed during interviews while three 38% less experienced respondents were slightly less confident. Two (25%) less experienced respondents were very confident although responses were short. In addition, more experienced respondents recorded more time (above 35 minutes for entire interview) in explaining every detail than the less experienced who responded in short. The variable level of
education produced no differences between respondents towards assessment strategies. All respondents (100%) mentioned the similar formative and summative assessment strategies in science education.

6.4 Science teachers’ attitude towards environmental issues (EI)

According to main results, science teachers’ attitude towards environmental factors is positive, overall mean score of 3.7 is reported. In addition, one-way ANOVA and non-parametric Mann-Whitney tests were performed. Both statistical tests indicate non-statistically significant differences \( p=>.05 \) between male and female science teachers’ perceptions towards environmental issues (energy saving techniques, water saving techniques, environmental publication and environmental sustainability). Thus, returns the null hypothesis which states that” there are no differences between male and female teachers’ perceptions towards environmental issues”.

Non-parametric Kruskal-Wallis and one-way ANOVA tests were performed. Both statistical tests indicate non-statistically significant differences \( p=>.05 \) between subject teachers’ perceptions towards environmental issues (energy saving techniques, water saving techniques, environmental publication) and returns the null hypothesis which states that” there are no differences between subject teachers’ perceptions towards energy saving”.

A non-parametric Kruskal-Wallis test shows that distribution of medians \((Mdn)\) for environmental sustainability are different in some subjects, test statistic=11.634, \( p=.040. \) \( p <.05 \) is statistically significant thus rejects the null hypothesis and accept the alternative hypothesis which states that” there are differences between subject teachers’ perceptions towards environmental sustainability”.

Below are the detailed results for this section 6.4 and 6.4.1.
### Table 8. Mean scores for science teachers’ perceived environmental attitude

<table>
<thead>
<tr>
<th>Item No</th>
<th>Actual statements</th>
<th>Valid Number of Respondents</th>
<th>(M)</th>
<th>(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I prefer walking short distances than driving.</td>
<td>84</td>
<td>4.14</td>
<td>1.099</td>
</tr>
<tr>
<td>2</td>
<td>I turn off the computer if I do not intend to use it for few hours.</td>
<td>84</td>
<td>4.13</td>
<td>1.213</td>
</tr>
<tr>
<td>3</td>
<td>I use energy-efficient lamps at home.</td>
<td>84</td>
<td>3.95</td>
<td>1.084</td>
</tr>
<tr>
<td>4</td>
<td>I buy electrical appliances (phone, laptop etc.) that use less energy.</td>
<td>84</td>
<td>3.21</td>
<td>1.079</td>
</tr>
<tr>
<td>5</td>
<td>I buy battery devices that can be recharged instead of those that run on cell battery.</td>
<td>84</td>
<td>3.44</td>
<td>1.255</td>
</tr>
<tr>
<td>6</td>
<td>I do not put electrical appliances (TV, printer, etc.) on stand-by.</td>
<td>84</td>
<td>3.44</td>
<td>1.356</td>
</tr>
<tr>
<td>7</td>
<td>I do leave light on because I’m afraid to sleep in darkness.</td>
<td>84</td>
<td>2.26</td>
<td>1.569</td>
</tr>
<tr>
<td></td>
<td><strong>Grand average</strong></td>
<td><strong>3.514</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>I always close the tap properly before leaving.</td>
<td>76</td>
<td>4.74</td>
<td>0.7</td>
</tr>
<tr>
<td>9</td>
<td>I close the tap in between when teeth brushing, shower, dish washing etc.</td>
<td>76</td>
<td>4.24</td>
<td>0.992</td>
</tr>
<tr>
<td>10</td>
<td>I make effort to immediately replace leaking taps when noticed.</td>
<td>76</td>
<td>4.26</td>
<td>0.838</td>
</tr>
<tr>
<td>11</td>
<td>I inspect water pipes for possible water leakage at home and work.</td>
<td>76</td>
<td>3.62</td>
<td>1.166</td>
</tr>
<tr>
<td>12</td>
<td>I use potable water for irrigation.</td>
<td>76</td>
<td>3.39</td>
<td>1.008</td>
</tr>
<tr>
<td>13</td>
<td>I always make sure to use less water for any purpose.</td>
<td>76</td>
<td>3.92</td>
<td>0.86</td>
</tr>
<tr>
<td>14</td>
<td>I wash my clothes in the washing machine without prewashing unless they are too dirty.</td>
<td>76</td>
<td>3.64</td>
<td>1.24</td>
</tr>
<tr>
<td>15</td>
<td>I rinse my clothes or dishes only once.</td>
<td>76</td>
<td>3.61</td>
<td>1.327</td>
</tr>
<tr>
<td></td>
<td><strong>Grand average</strong></td>
<td><strong>3.928</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>I talk with my friends about environmental issues.</td>
<td>81</td>
<td>3.78</td>
<td>0.822</td>
</tr>
<tr>
<td>17</td>
<td>I do not hesitate to warn anyone who damages the environment.</td>
<td>81</td>
<td>3.8</td>
<td>0.843</td>
</tr>
<tr>
<td>18</td>
<td>I watch and listen to environmental programs on TV, radio, YouTube etc.</td>
<td>81</td>
<td>3.88</td>
<td>0.98</td>
</tr>
<tr>
<td>19</td>
<td>I forward any message or e-mail about environmental issues to my friends.</td>
<td>81</td>
<td>3.48</td>
<td>1.015</td>
</tr>
<tr>
<td>20</td>
<td>I remember warning people about their damaging behaviors towards the environment.</td>
<td>81</td>
<td>3.83</td>
<td>0.944</td>
</tr>
<tr>
<td>21</td>
<td>I follow magazines and newspapers on environmental and natural issues.</td>
<td>81</td>
<td>3.38</td>
<td>0.943</td>
</tr>
<tr>
<td>22</td>
<td>I share messages and videos about the environment on social networking sites (Facebook, WhatsApp, Twitter, Instagram, WeChat etc.).</td>
<td>81</td>
<td>3.48</td>
<td>0.976</td>
</tr>
<tr>
<td></td>
<td><strong>Grand average</strong></td>
<td><strong>3.63</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Before I buy a product, I consider whether its waste is recyclable or not.</td>
<td>79</td>
<td>2.9</td>
<td>0.982</td>
</tr>
<tr>
<td>24</td>
<td>I put empty glass bottles into recycling bins.</td>
<td>79</td>
<td>3.51</td>
<td>1.096</td>
</tr>
<tr>
<td>25</td>
<td>I divide waste into certain categories, such as paper, glass, plastic, etc.</td>
<td>79</td>
<td>3</td>
<td>1.132</td>
</tr>
<tr>
<td>26</td>
<td>I keep wrapping paper used for presents for prospective users.</td>
<td>79</td>
<td>3.53</td>
<td>1.023</td>
</tr>
<tr>
<td>27</td>
<td>I prefer to buy environmentally-friendly products even if they might be more expensive.</td>
<td>79</td>
<td>3.43</td>
<td>1.058</td>
</tr>
<tr>
<td>28</td>
<td>I buy environmentally-friendly personal care products.</td>
<td>79</td>
<td>3.53</td>
<td>0.959</td>
</tr>
<tr>
<td>29</td>
<td>I try to put what I buy during shopping into as few plastic bags as possible.</td>
<td>79</td>
<td>3.41</td>
<td>1.056</td>
</tr>
<tr>
<td>30</td>
<td>I use permanently-used glasses, plates, forks and knives rather than disposable ones.</td>
<td>79</td>
<td>4.2</td>
<td>0.992</td>
</tr>
<tr>
<td>31</td>
<td>I give away any products like furniture and clothes that I do not want to use anymore to someone who might need them.</td>
<td>79</td>
<td>4.3</td>
<td>0.882</td>
</tr>
<tr>
<td>32</td>
<td>I use both sides of paper for copying/photocopying or writing.</td>
<td>79</td>
<td>3.99</td>
<td>0.967</td>
</tr>
<tr>
<td></td>
<td><strong>Grand average</strong></td>
<td><strong>3.562</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Scores are based on 1 to 5 point scale, 1=being strongly disagree (lowest) and 5 = strongly agree (highest)

Environmental attitude in this study is measured with 32 survey statements and questions on energy saving techniques, water techniques, environmental publication and environmental sustainability. The overall mean score of **3.7** is observed for environmental attitudes concerning energy saving techniques,
water saving techniques, environmental publication as well as environmental sustainability on 1 to 5 point scale. Higher mean score of at least over 2.5 implies positive attitude towards environment issues.

Out of seven (7) statements concerning energy saving techniques, findings indicate an average of 3.5, implying positive attitude since a high number of responses agree/strongly agree with most items. Direct attitude towards environmental issues is observed in some items such as items 1; I prefer walking short distances than driving, item 3; I use energy-efficient lamps at home, item 4; I buy electrical appliances (phone, laptop etc.) that use less energy, item 6; I do not put electrical appliances (TV, printer, etc.) on stand-by. Selected items reported mean scores in the range of 3.2 to 4.1. Alternatively, a reverse statement coded as item 7; “I do leave light on because I’m afraid to sleep in darkness” recorded substantial mean score of 2.6.

Out of eight (8) statements concerning water saving techniques, findings indicate an average of 3.9, implying positive attitude since a high number of responses agree/strongly agree with most items. Direct attitude towards environmental issues is observed in some items such as items 8; I always close the tap properly before leaving. 9; I close the tap in between when teeth brushing, shower, dish washing etc., item 10; I make effort to immediately replace leaking taps when noticed, and item 13; I always make sure to use less water for any purpose. Selected items reported mean scores in the range of 3.9 to 4.7.

Out of seven (7) statements concerning environmental publication, findings indicate an average of 3.6, implying positive attitude since a high number of responses agree/strongly agree with most items. Direct attitude towards environmental issues is observed in some items such as items 17; I do not hesitate to warn anyone who damages the environment, item 19; I forward any message or e-mail about environmental issues to my friends, item 20; I remember warning people about their damaging behaviors towards the environment and item 22; I share messages and videos about the environment on social networking sites (Facebook, WhatsApp, Twitter, Instagram, WeChat etc.). Selected items reported mean scores in the range of 3.5 to 3.8.

Out of ten (10) statements concerning environmental sustainability, findings indicate an average of 3.6, implying positive attitude since a high number of responses agree/strongly agree with most items. Direct attitude towards environmental issues is observed in some items such as items 28; I buy environmentally-friendly personal care products, item 23; Before I buy a product, I consider whether its waste is recyclable or not, items 24; I put empty glass bottles into recycling bins, item 25; I divide waste
into certain categories, such as paper, glass, plastic, etc., item 26; I keep wrapping paper used for presents for prospective users, Selected items reported mean scores in the range of 2.9 to 3.5.

6.4.1 Factors of environmental issues (EI)

Differences between gender and environmental factors among science teachers.

A one-way ANOVA between male and female was performed to compare means for attitude towards energy saving. Male were 44 and female were 40. Test of homogeneity of variances are equal. There is non-statistically significant difference in energy saving between males and females science teachers (F=.140, p=.709). Thus, returns the null hypothesis which states that” there is no differences between male and female science teachers’ perception towards energy saving.

A one-way ANOVA between male and female was performed to compare means for attitude towards water saving. Male were 44 and female were 40. Test of homogeneity of variances are equal. There is non-statistically significant difference in energy saving between males and females science teachers (F=.027, p=.870). Thus, returns the null hypothesis which states that” there is no differences between male and female science teachers’ perception towards water saving”.

A one-way ANOVA between male and female was performed to compare means for attitude towards environmental publication. Male were 44 and female were 40. Test of homogeneity of variances are equal. There are non-statistically significant differences in environmental publication between male and female’s science teachers (F.027, p=.870). Thus, returns the null hypothesis which states that” there is no differences between male and female science teachers’ perception towards environmental publication”.

A non-parametric Mann-Whitney test shows that means for environmental sustainability techniques are same for males and females, U=847. 500, p=.770. p=>.05 is statistically non-significant and returns the null hypothesis which states that” there is no differences between male and female science teachers’ perception towards environmental sustainability”.

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Differences between science subject teachers and environmental factors

A non-parametric Kruskal-Wallis test shows that distribution of medians (Mdn) for energy saving techniques are the same across science subjects, test statistic=3.015, p=.698. p=>.05 is statistically non-significant and returns the null hypothesis which states that” there are no differences between subject teachers’ perceptions towards energy saving”.

A one-way ANOVA between teachers for Natural Science, Agriculture, Social Studies, Life Science, Physical Science and Home Economics was performed to compare means for attitude towards water saving. Test of homogeneity of variances are equal. “There is non-statistically significant difference in perceptions for subject teachers towards water saving (F=1.551, p=.184)” Thus, returns the null hypothesis which states that” there are no differences between subject teachers’ perceptions towards water saving”.

A one-way ANOVA between teachers for Natural Science, Agriculture, Social Studies, Life Science, Physical Science and Home Economics was performed to compare means for attitude towards environmental publication. Test of homogeneity of variances are equal. ”There are non-statistically significant differences in perceptions for subject teachers towards environmental publication (F=1.551, p=.184)” Thus, returns the null hypothesis which states that” there are no differences between subject teachers’ perceptions towards environmental publication”.

A non-parametric Kruskal-Wallis test shows that distribution of medians (Mdn) for environmental sustainability are different in some subjects, test statistic=11.634, p=.040. p <.05 is statistically significant thus rejects the null hypothesis and accept the alternative hypothesis which states that” there are differences between subject teachers’ perceptions towards environmental sustainability”.

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7 DISCUSSION AND CONCLUSION

This chapter is comprised of (section 7.1) summary of the results according to research questions. Thereafter, follows a critical discussion of key results of the study (section 7.2). Conclusion and suggestions for further research follow in section 7.3 and lastly, reliability and limitations to the study are presented in section 7.4.

7.1 Summary of the results

The main results will be discussed in regards of the research questions.

RQ1. What is science teachers’ perceptions of the role of science education towards environmental issues?

According to main results, science teachers have different perceptions about the role of science education towards environmental issues, thus mentioned various roles which sum up to provision of scientific skills and educate people for the environment.

Respondents maintained that, science education provides and develop scientific skills and knowledge, such as ability to make observation in the environment, generate data by conducting measurements with scientific apparatus and record data, analyze and report conclusions from investigations in a sound scientific manner. In addition, help improve academic performance among pupils by increasing interest for environment and science education, motivate pupils to take up scientific professions for informed decision making in favor of the environment. Moreover, science education informs pupil of the negative impacts of human activities on environment and need for conservation of natural resources.

Science education on another hand, educate pupils towards environment issues by creating awareness, sensitizing people especially in local areas through indigenous languages. The skills and knowledge should enable people to become responsible citizens and conserve natural resources. Gender reported 50% (1 out of 2) female influence towards the result. On other hand, teaching experience and level of education produced no differences among responses towards the aims of science education. Thus, the perceived aims of science education by science teachers remain the same except in the case of gender.
RQ2. What is the perceptions of science teachers’ knowledge about environmental issues?

According to main results, science teachers’ perceived knowledge about environmental issues is satisfactory. Respondents mentioned pollution (63%), deforestation (38%), climate change (25%), while acid rain, soil erosion, depletion of ozone layer as well as drought recorded (13%). These are examples of environmental issues. In addition, (6 out of 8) 75% of science teachers perceive environmental issues are part of society and important learning area in science education. Moreover, teachers mentioned and justified environmental topics such as ecology, mining, weather, farming, gases, soil nutrients, plants and animals and all natural resources. They perceive such environmental knowledge help pupils to make decisions. Thus, enable them to make link between what is learnt (theory) and reality (practice). Many sources inform teachers knowledge about environmental issues, among them teacher education, collaboration with experts (75%) and media/technology (63%) are significant. Variables gender, teaching experience and level of education produced no differences in the result for the research question.

RQ3. What is science teachers’ perceptions of teaching and assessment strategies for environmental issues?

According to main results, science teachers perceive using different teaching strategies. Examples of common teaching strategies include group work, technology and discussion (50%). Inquiry and outdoor education (38%) while experimental, collaborative and demonstration (25%). Preferences for teaching strategies is based on nature of topics, availability of resources, class size including advantages and disadvantages. Science teachers applied discussion as common strategy for teaching topics such as water, energy and sanitation. Regarding activities for effective science strategies, respondents maintained that field trips, cleaning the school environment, establishment of vegetable gardens, ponds for fish studies help pupils deepen their knowledge. Gender produced differences regarding teaching strategies, four out of six (67%) science teachers prefer narrative, experimental and discussion strategies while two out of two (100%) female science teachers prefer inquiry and discussion strategies. teaching experience and level of education produced no differences towards the result.
What is science teachers’ perceptions of assessment strategies for environmental issues?

According to main results, all eight (8) science teachers’ perceptions of assessment strategies are similar and guided by formative and summative principles. Formative assessment take the forms of question and answer strategies as well as observation of behaviors during practical work. In addition, science teachers use brainstorming to improve the teaching-learning process. On the other hand, summative assessment mainly use practical investigations, projects and examinations for promotional marks. Furthermore, science teachers perceive establishing gardens, implementing field trips are other ways of generating assessment marks. In general, assessment of environmental topics is reported to be theoretical than practical while scientific skills assessed/gained for environmental issues are similar to those already mentioned in (research question 1 of this section). Moreover, variables gender, teaching experience and level of education produced no differences towards science teachers’ assessment strategies.

RQ4. How is the perceptions of science teachers’ attitude towards environment issues?

According to main results, science teachers’ attitude towards environmental factors is positive, overall mean score of 3.7 is reported.

In addition, Statistical tests for normality of data with Kolmogorov-Smirnov, Shapiro-Wilk tests, histogram as well as normal Q-Q plot indicated that data is approximately normally distributed, however, some of the variables were not and non-parametric methods were used. Distribution of medians with simple box plot showed differences between independent variable subject and dependent variables energy saving, water saving as well as environmental sustainability where as independent variable gender and same dependent variables produced no differences.

Parametric one-way ANOVA tests and non-parametric Mann-Whitney test were performed to compare means of male and female science teachers towards energy saving, water saving, environmental publication and environmental sustainability. Results from both tests indicate statistically non-significant ($p > .05$) thus allow this study to keep the null hypothesis that no differences exist between perceptions of male and female science teachers towards outcome variables.

Parametric one-way ANOVA tests and non-parametric Kruskal-Wallis test for Natural Science, Agriculture, Social Studies, Life Science, Physical Science and Home Economics were performed to compare means towards energy saving, water saving and environmental publication. Results in both
tests indicate statistically non-significant \((p > .05)\) thus allow this study to keep the null hypothesis that no differences exist between subject teachers’ perceptions towards outcome variables. However, for environmental sustainability with non-parametric Kruskal-Wallis test, results indicate statistically significant \((\text{test statistic}=11.634, p=.040.)\) and rejects the null hypothesis. An alternative hypothesis is accepted that differences exist between subject teachers’ perceptions towards environmental sustainability.

7.2 Discussion of key results

To discuss key solutions for the results, headings will be used to allow the reader to easily follow.

7.2.1 The role of science education towards environmental issues (EI)

This study has found that the role of science education is to teach skills and knowledge such as to observe, keep accurate records and report findings generally, the role of science education is more inclined to this assertion while, Wals (2014) directly put it that “the major role of science education is provide knowledge”. In addition, Živanović (2008) concurs science education must ensure skills and knowledge provided are permanently owned by pupils. Thus, results show consistency with other studies regarding the role of science education. More often skills and knowledge are concepts used synonymously however, this study makes a distinction because skill has to do with performance. While knowledge on other hand is broad and has to do with information and cognitive issues. In other words, skill is another form of knowledge (see chapter 3).

On other hand, (Callahan, & Dopico, 2016) argue that acquisition of skills and knowledge in science education depends on factors such as age, gender and educational level of teachers as well as traditions of teaching that prevailed during their (teacher) schooling. To this end, this study cannot guarantee the claim for provision of skills and knowledge as factors above cause hindrances during knowledge acquisition. Furthermore, I would add that interest in science education, exposure to nature has impact on how teacher explain the role of science education towards environmental issues.

Skills and knowledge are further categorized into “factual (basics of something/information), conceptual (Overall view about something), procedural (techniques and methods of doing something) and
metacognition (general and own ability to do something)” (Callahan, & Dopico, 2016, Kaiser, 2003). Here, subjects like Geography/Social Studies, Life Science/Biology, Agriculture, Physics, Home Science enables science teachers/pupils not only recall information (factual and conceptual knowledge) but demonstrate ability to solve practical problems (procedural and metacognition knowledge). To this end, concepts such as observation, recording, analyze (see section 6.1) are closely related to procedural and metacognition. On other hand, humanistic forms of knowledge such as awareness and information fall into factual/conceptual knowledge. This means that there are other forms of knowledge science education should consider offering for effective role for environment education in general since the two disciplines have divergent aims (Wals, 2014). Considering respondents by science teachers and reviewed literature this study can deduce that both disciplines seek to empower us towards sustainability.

The role of science education as per findings of this study indicate going beyond classroom and grades in school as one respondent narrate that s/he “teach the content (skills and knowledge) and assess it not only for grades, instead help solve local problems”. In fact, it enables citizens to participate in environmental issues in society (Hodson, 2009, Zeidler et al. 2016, Grob, 1995). Here respondents used statements such as “science education should teach/inform people to conserve resources, create awareness etc.” This result too is consistent as can be observed that it is directed towards general environmental education aims of creating awareness and attitude change (Mckeown-Ice, 2009, Wals, 2014). Good science education must motivate pupils to take up professional (and other active) roles in society and make informed decisions about the environment as one respondent “mention life-long learning and professional someone”. In addition, respondent indicated that a “person must be able to deal with scientific issues in life”. Dealing with scientific issues in life entails many forms, one such is ability to comprehend information from media platforms (Smurr, 2009). Since science informs people about environmental issues they may launch demonstrations to prevent unsustainable human activities from happening in their communities. It is therefore important that science education inform pupils because sensitivity should be pursued in early years of education since interest in science is still high (Maltese, & Tai, 2010) so that actions manifest through to adulthood. In addition, appreciation for science education can be fully understood. Nurturing interest of young pupil should be continued as (Murphy & Beggs, 2003) argues that it decreases as pupil move to higher grades. In the main environmental issues are part of every society, as such (Stratton, 2015) encourages that science teachers should make every effort to effectively teach sustainability issues. In researcher’s view, this idea require
consideration because appropriate content for different age groups must be provided in science education. This will hopefully ensure life-long learning for environmental issues.

The variable gender produced 50% influence towards the results because one female respondent out of two perceive that the” belief” that science education is a subject for boys exist. There is no scientific evidence to directly support nor reject the idea was found by researcher. However, according to Zyadin (2014) male had good knowledge about renewable energy but females too had favorable attitudes for renewable energy. This case produces no conclusion since according to proposed model (Figure 3) knowledge without attitude is not good enough. Meanwhile, Yanniris (2015) female have high perceptions towards the environment especially if educated to postgraduate level. Perception is linked to knowledge according to the proposed model (Figure 3) thus, it seems gender is rather a motivation for girl pupils to learn science education. On the positive side, there are significant contributions and achievements by females in the field of science education to date. According to a study by Hailu (2016) gender is non-statistically significant towards the environment. This study instead, suggest more opportunities should be given for pupils (girls and boys) to pursue science education according to their interest and ability. Science teachers should encourage and provide instructions that cater for all pupils regardless of gender towards solutions for environmental issues. In addition, more conventions at international and national levels are priority thus girls and boys can play major roles in curbing environmental issues in science education. This figure is high (50%) because only two female respondents were recruited in the study.

7.2.2 Science teachers’ knowledge about environmental issues (EI)

Results indicate that science teachers perceive they have got satisfactory environmental knowledge, especially about Namibian science education curriculum. This finding is in agreement with other studies which found sufficient knowledge about environmental issues (Dawson, 2012, Anyolo, 2015, Loubser, & Simalumba, 2016). Researcher strongly believe that the sample in this study have good knowledge about environmental issues since all were at master level of education coupled with average 7 years teaching experiences. The context in which interviews were conducted helped to shape their knowledge due good environmental practices in Finland. These experiences put together have become pedagogical
content knowledge for successful environmental knowledge. Such an idea is supported by Gess-Newsome (2015) because it is particularly about environmental learning in science education.

Examples of environmental issues mentioned include drought, pollution, climate change, resources etc. (see table 4). Some of these environmental issues are also known among science teachers, as reported by Aksan (2013) about teachers perceptions about global warming and related gases while most if not all are consistent with (Hyseni 2014). In addition, (Namibia, MoE. 2010) recognizes some of these environmental issues as risks for society. Thus, such national perception is positive because it relates to science curriculum objectives (see appendix L). It means Namibia as a nation regard environmental issues as important for science education and thus teaching resources ought not to be an issue. As indicated in results for research question one, provision of skills and knowledge is crucial, however “most teaching practices only provide information” (Hyseni, 2014) (teaching about environment). Researcher argues that providing information about environmental issues is just one way for acquiring environmental knowledge and media always do that. Other ways for gaining environmental knowledge is just one way for acquiring environmental knowledge such as learning in and through the environment need to be emphasized. In light of (Loubser, & Simalumba, 2016, Anyolo, 2015) who reported “36% teacher unsure of environmental issues and lack of resources for teaching environmental education (EE)” Although these resources have been clarified, this study believe science teachers are the most important resources above other forms of resources for improving environmental knowledge. The idea of environmental knowledge is supported by Hlobil (2010) who says “informal and formal pedagogical content knowledge is the foundation for ecological science education” in 21st century.

This study reported that environmental issues are part of society and important area of work. This report agrees with Anyolo (2015) who reported that teachers link education for sustainable development to the environment and related problems. Researcher argues for reasons science teachers mentioned in report such as to minimize negative human impacts to the environment. In this case science teachers have an opportunity to use own experiences from local environment to understand the importance of knowledge about environmental issues in their practice. In the main, perceived environmental knowledge is important to sensitize, create awareness for possible attitude change in elementary and junior secondary phases. In addition, researcher argues that, when science teachers are aware of the need for environmental knowledge, they are more likely to give proper instruction in science education. Environmental knowledge is negotiable in a social way with others for it to be meaningful. This practice
help to generate more knowledge from local people about the geography of the area the school is located. Such idea is supported by (Van, 2004, Kimmerer, 2012) and has place in school. Henceforth, this study encourage basics of everyday life as foundation for environmental knowledge in science education especially in primary phase.

Basics of everyday life include topics such as ecology, soil, weather, food systems, energy, medicine, farming among others, which are known to the science teachers and their community. The topics are supported by (Russ, & Krasny, 2017). Since topics are familiar for science teachers, environmental education (EE) should not be perceived as strange avenue that require special resources and rigorous training. In fact (Jeronen, et al. 2009) summarizes EE knowledge areas into (nature, the built, aesthetic, social and ethical environments) which in end includes all topics mentioned by results (of research question 2). Perhaps a look at EE models is another item for science teachers to supplement their knowledge into practice because these provide various guidelines and actions people ought to perform. Science teachers as human resources and their role towards environment is center of EE models, including professionals in other disciplines and trades.

As five teachers indicated the will and need to be trained on environmental education, it should be noted that in other countries like the United States, OECD countries (Finland, Belgium, Poland etc.) with advanced and focused teacher education programs, student performance is one of the issues given the most attention” (NCATE, 2010, p. 14, OECD, 2016). Researcher therefore argue that training for science educators should be accorded quality environmental instruction like any other topic perceived to be important in teacher education. It is with reference to the above countries that, researcher, argue that although many studies report satisfactory knowledge in the same context, such knowledge should continuously be tracked for Namibia’s vision for knowledge-based because in above countries, at least specific subject master degree level enables one to practice as a teacher (Luketic, 2012) which is something Namibia currently only hope for.

Researcher also agree with one respondent (T1) who said “I think on that case it should start with the training colleges like the universities, like if you want someone to do something in a certain way, so if you are at a university then you also should be taught in that way”. It can be inferred that practical work is easily memorable than bulk information, thus increases science teachers’ knowledge. At the core of teacher pedagogical content knowledge, other studies support the idea that theory must be coupled with practical outside usual classroom (Alvarez-Garcia, 2018, Hlobil, 2010, Spiropoulou, 2007, NCATE.
Practical work offered at teacher education is meaningful because often teachers replicate what they have been taught.

Science teachers’ perceived knowledge come from media/technology (63%) according to the results. Thus, result is in agreement with Reis & Galvao (2004) and Zyadin (2014). Media contains lots of environmental information which is useful for science education. Even so, science teachers lack time for proper analysis of information to be used. Contrary to that, Klosterman (2012) says they (science teachers) have limited knowledge in using media. I argue that knowledge is not limited but rather time for evaluating information against the purpose. According to one respondent who indicated that “by reading from textbooks and other materials from the internet” information/knowledge is obtained. Surely, science teachers use newspapers, internet, magazines etc. for teaching environmental issues. Researcher’s argument is that, it’s just a developed belief in the advantages of using internet such as accessing more information in short time than other sources. However, most of respondents/science teachers have not realized that information obtained from the internet require even more time and effort for verification since its big volumes. In addition, internet is sometimes utilized subconsciously and information is only verified upon critique or assessment by others.

On other hand, Information from media is not necessarily translating into environmental knowledge for science teachers because it’s non-educational in the first place. Moreover, such information is always sponsored or linked to certain environmental organizations which fund the publication for own interest. This means science teachers must compare information obtained from internet with other sources for authentication. For such reasons Klosterman (2012) say information from the internet is subjective. Lastly, media corporations are profit making entities while environment is not. Equating the two is actually the cause of most environmental issues the world is experiencing.

**7.2.3 Science teaching and assessment strategies for environmental issues (EI)**

Regarding the teaching strategies, results indicate the use of various teaching strategies such as inquiry based, outdoor/fieldwork, discussion, experimental (see table 6). This result is consistent with other studies (Kang, 2018, Jeronen, et al. 2009) who applied the strategies in science education, technology was used by (Klein, 2014, Martín-Ramos, 2017, Klosterman, 2012), while traditional teacher centered strategy was used by (Reis, & Galvao, 2004). Through indirect way results show that choosing
appropriate environmental topics and teaching strategies in science education can be a successful way of teaching because Kang (2018) when content is connected to pupils’ experiences their interest and motivation in the subject is maintained.

In addition, results indicate that respondents incorporated environmental issues as local issues in narratives and discussion. This is in line with science education aims to engage citizens in solving local or daily challenges and environmental issues as embedded in the subjects, (Zeidler, 2016, Thornburg, 2014, Kimonen, & Nevalainen, 2017, Loubser, & Simalumba, 2016) the delivery of science teaching to generate desired environmental knowledge, attitudes and perceptions is crucial. Science education delivery takes in both formal and informal teaching-learning situations (Hlobil, 2010). Strategies take the form of teacher centered while others are student centered or use varying degrees of both.

Thus, other major reasons mentioned by science teachers for choosing teaching strategies include advantages and disadvantages, especially high curriculum demands to cover target topics in time. This report is consistent with Carrier (2013) who reported that teachers were constrained by time. In the context of this study (Namibia, Moe, 2016) standard time allocated for science subjects is around 12 hours for 5-day week at senior primary while junior secondary has around 17 hours over 7-day cycle. Meanwhile, researcher assume in general terms that the issue of limited time is just a mere tendency teacher always ascribe too. On other hand, what is allocated as adequate time for the task is always different in practice since extra-curricular activities in case of science teachers affect both claims.

Observing results of this study, core science education teaching strategies (inquiry based, fieldwork or outdoor education, laboratory work) account only for thirty eighty (38%) perceived use. The reason for this might be demand for innovative strategies or extra work in science education, which is generally not admired by many as “objectives of science education require teachers with good research, scientific, logical thinking skills” (Namibia, NCRST, 2004, Namibia, Ministry of Higher Education, 1999). This assertion is a global issue because other than in this context, there are institutions in different regions of the world promoting high science teaching standards. This good practice however leave out many science teachers questioning how innovative are they for the 21st century science education challenged by sustainability issues. This study argue that the low perceived use is a signal of resource constraints including lack of proper teacher training in such strategies. Meanwhile, creativity is not a teacher training
thing but rather individual trait which all science teachers poses but not fully utilized for environmental education.

On other hand, group work, technology and discussion strategies accounted for highest (50%) which is contrary to Day, & Bryce (2011) who found less use of discussion because teachers were uncomfortable. Being uncomfortable might be linked to socio-cultural norms and practices of community and perceptions. However, this study reports similar views with (Anyolo, 2015, Loubser, & Simalumba, 2016) that important topics such as environmental issues extend into community thus should be discussed. Researcher through results of this study have found out that discussion strategy in science education brings about common use of unscientific concepts in summative assessments because teachers used such examples during teaching process. Although, the social-cultural theory is behind learning through interaction, science concepts are challenging in various languages and in big classes. To agree on concepts can be easily reached but language evolves thus complicating the issues. Moreover, in context of the study and in most other settings, science teachers come from other parts of the country and unfamiliar with ethnic group language at work which make discussion to fail. Researcher suggests where it is applicable, science teachers need to gradually direct pupils to apply scientific concepts during conversation but most important in summative assessments.

Group work is another common strategy (50%) applied in science education as well as for teaching environmental issues. Its use mainly take into account the most possible way to optimize teaching and learning for the topic. However, researcher believes that in big classes it make the work of the science teacher manageable while the learning is low. This is because time is limited for successful monitoring of activities in all groups. Meanwhile in small classes it tend to optimize learning by allowing the science teacher to better facilitate the process.

Regarding the use of technology strategy (50%) in this study, this can be attributed to youthful participant’s age and level of education. Researcher believe that even if most participants are well acquainted with technology it does not mean they apply it in science teaching. The autonomy experienced by science teachers in different education systems influence the rate of application. In case of this study and most developing countries the use is rare.
To this end, the study calls for teaching strategies which attract pupils to like science education more since worst school narratives, experiences and memories are linked to traditional teaching strategies that hinder learning (Thornburg, 2014, Kimonen, & Nevalainen, 2014, Kimonen, & Nevalainen, 2017). Meanwhile, Kang (2018) indicated loss of pupil interest in science education for the same reason. A standing teacher, black board and or being loud are not effective ways of teaching environmental issues. As stated earlier, nearby landscapes, forests, gardens, nature parks etc. offer wonderful experiences for inquiry-based strategy and help create awareness and sensitivity when effectively used (Kimonen, & Nevalainen, 2014). Teaching take expose pupils to such sites is gathering ideas for the classes and allow discussions to start. Pupils have less experiences nowadays especially where technology is minimal.

In the results teachers also recommended various activities (see section 6.3) among them outdoor education, 38% perceived use which can be implemented at school level. In so doing, benefits of outdoor education can be experienced by both the science teacher and pupils as expressed by (Kimonen, & Nevalainen, 2017, Nadelson, 2012, Larsen et al. 2017, Bell et al. 2009, and Bas et al. 2011). They (science teachers) will have chance to fulfil facilitation role in multisensory ways for individual pupils and will trust they will not destroy nature when they are outside (Kimonen, & Nevalainen, 2014, Smurr, 2009). Now, teachers in Namibia seldomly use outdoor education (Anyolo, 2015, Loubser, & Simalumba, 2016). This might be due to risks that pupils may be hurt in the process. Researcher believes such risks will always be present instead outdoor activities are possible regardless of the challenges. If science teachers’ desire strong science education, then a consideration must be made because inquiry based, field work and laboratory exercises are three strategies in which science education is based (Jeronen, et al. 2009). Thus, in the context of this study there is a need to nurture this idea. In such teaching-learning environments, pupils have opportunity to explore nearby surroundings and practice their scientific skills.

As can be observed in the results that other strategies such as discovery, teacher centered indicate lowest perceived use (13%). Teacher centered strategy still exist as indicated by Carrier (2013) who reported that science teacher always resort back to it. As T6 indicate that “I use different teaching methods depending on the content and learning objectives, so I can use teacher centered method”. An assumption therefore is made by researcher, that teachers often dominate their own lessons especially when operating under pressure. Pressure may appear from constricted curriculum, regular inspections by
higher administration personnel, time limit and even community whereas in applying effective science teaching strategies suggested in this study such tendency is significantly reduced. Since discovery strategy accounts for low percentages it reminds the researcher of another strategy called learner centered education. This is a Namibian education premise incorporating strategies such as, discovery, inquiry, experimental learning etc. The strategy “advocates that pupil must be active and discover own learning process” (Namibia, MoE, 2003). Researcher think that with such low percentage for discovery strategy in this study, understanding and application of learner centered education is reduced.

Again, result of the study show that inquiry has only 38% perceived use, which is low, and the application is in the form of questions (see table 7). Researcher assume based on answers given during interview that indirect reasons such as dysfunctional laboratories and economic situation affect the strategy. In light of the PISA results it can be concluded that it is true, because schools with adequate socio-economic resources perform better than the disadvantaged ones OECD (2016) Thus, this study also acknowledge that application of some suggested effective science education strategies requires financial and other resources, especially where field trips are concerned. In the context of this study, such evidence explains perceived less use by respondents.

Lastly, variable gender reported differences (67%) male prefers narrative, experimental and discussion while 100% females prefer inquiry based science education and discussion strategies. As alluded in the beginning, successes and challenges for each determines the perceived use. In either case, researcher did not find scientific evidence for supporting nor rejecting the claims. However, researcher argue that such differences are not permanent and prone to change. The premise is that both male and female respondents depending on the need apply the relevant teaching strategies for environmental issues in science education.

7.2.3.1 Science assessment strategies for environmental issues (EI)

Forms of assessments are vary as discussed (in chapter 2) and have different purpose for the teacher. Each of them comes at different times of the academic year. In this study science teachers perceive assessment for environmental issues in science education is guided by prescribed informal (formative) and formal (summative) assessment strategies. Meaning that assessment for environmental issues take place within the guidelines of existing policies while at the same time informal strategies allow teachers’
discretion. Thus, this result is in line with literature which identify “criterion referencing, norm referencing, summative as well as formative assessments” (Reddy in Gawe, et al. 2004, Wylie, 2015, Sabel, 2015).

This study found informal strategies such as questioning, stories, and observations are perceived for improving the teaching-learning process. In my view, it is the most meaningful way for assessment of environmental issues than the rigid formal assessments because the nature of environmental topics affect all people. For this reason, seeking solutions for environmental issues through informal strategies is more appealing for pupils as they get time to internalize necessary content for accurate assessment (Wylie, 2015). A teacher also finds more opportunity for interaction and individual assessment of learning. Formative assessment is among the most (88%) used strategy according to this study while (Tal et al, 2000, Heimlich, 1999) argues that this form of assessment is not common enough in general education systems and only few EE studies look at assessment frameworks. Researchers’ view subscribes to results of this study because science teachers ask questions, recognize and rectify own ideas as well as that of pupils in every single lesson. The real problem might be the unrecognized non-routine way formative assessment unfolds during teaching-learning process and perceptions of what assessment means in different context.

As results indicate that assessment guidelines are given for projects, practical investigations and examination thus it can be concluded that environmental aspects are included in formative assessment strategies as Gawe et al. (2004) identifies norm and criterion referencing assessments which have requirements for judging teaching-learning outcomes. Regarding a project, one respondent said “I would give requirements that should be met. The plant should be put at a place with sunlight, enough air, given enough water and put in a soil fertile enough for it to grow”. Assessment requirements are mostly written for teachers to implement e.g. (Namibia, 2017. National Promotion Policy Guide for Junior and Senior Secondary School Phases) which on other hand Dori (2003), ASE, (2006), NRC 2011) do not favor. Although, summative assessment are necessary for enabling relevant statistical records for monitoring continuous progress and promotion purpose. Its application in various context is understood in different ways. Researchers viewpoint support Dori (2003) and others because environmental issues are not well represented in most curriculums. In addition, it fail to account for most indigenous knowledge which challenge or equate knowledge in science education. Thus, science teachers are forced not to allocate marks for correct answers because they mark according to grading schedules. This practice is mainly in
schools than higher education. In addition, environmental issues are best assessed in informal ways than formal because exact answers which science demands are sometimes non-existing. This is why even international conventions do not have concrete answers to contain these forever.

Teachers mentioned environmental topics such as pollution, global warming, seeds/plants/vegetation, animals etc. for assessment in individual subjects “through projects, practical investigations, examinations and continuous assessment”. These topics are consistent with Singh (2011) who suggested topics for assessment. Although respondents were able to identify these topics, the extent to which environmental aspects appear in assessment seems to vary per science subject. This idea is supported by Tal et al. (2000) because EE differ in teaching and assessment frameworks. Each of the teachers mentioned environmental topics for assessment based on subject s/he teaches. The amount of assessment for environmental issues depends entirely on inclusion in curriculum thus, if more is needed in assessment it must start with curriculum. A science teacher cannot assess new content that is not found in curriculum even if such topic is important for society. However, all these claims should take account for the needs of the pupil. An attest to this assessment notion by one respondent goes as follow “In physical science they are very direct from the syllabus because the syllabus asks some disadvantages of pollution that goes into the environment”. For more on environmental issues being assessed in the context of this study refer to (appendix L).

Regarding how assessment of environmental issues unfolds in science education, teachers mentioned that more often assessment is less and theory based. Such findings are in agreement with (Kimonen, & Nevalainen, 2017, Carrier, 2013) who reported that it’s always difficult to plan and practice such exercises. Researcher’s view is that, practical lessons involves lots of logistical arrangements prior and even after assessment. Equipments for science education are costly and demand absolute care during such undertakings. Moreover, a teacher is obliged not to leave pupils unattended during such times as it is risky. As can be observed, specific requirements must always be maintained in science education for accurate assessment, especially where preparations are done few days before actual practicals. In the main, science teachers are specialists and ought to conduct practicals as required by assessment standards.

On other hand, teachers also respondent to a question regarding what they recommend since they perceive current teaching and assessment practices are not enough in terms of practical work for general environmental education. All (8) respondents suggested the use of school environment and any other
place of interest for pupils to have a sense of what they are learning than just discussions. This recommendation has been extensively reviewed in this work and other researcher advocate for familiarizing pupils with sites (Boric, 2014, Karppinen, 2012) for improving achievement in general science education (see chapter 2). Meanwhile, according to Mckeown-Ice (2009) geography mainly aim to create awareness than practical however, researcher view is contrary because at least some topics such as weather, map work and ecology require practicals.

During assessment of environmental issues tested and gained scientific skills are the aim of science education and thus are important. The scientific skills observed under results of this category are congruent with already mentioned findings in section 7.1. This is also supported by (Kimonen, & Nevalainen, 2017, p. 51) who identified some basic skills that teachers can assess such as making inferences of why and how regarding habitat environments for instance, collect basic data and reaching simple conclusions. Therefore, due to the nature of answers given during interviews, researcher confidently presume that scientific skills under discussion are at basic level. In addition, since respondents are mainly from primary level phase, they strictly answered the question “How do you describe your learners’ science knowledge at senior primary/junior secondary level?” as it refers to their pupils. However, the scientific skills mentioned by respondents lay foundation for future scientists.

7.2.4 Science teachers’ attitudes towards environmental issues (EI)

Overall, result indicate science teachers’ perceived attitude is positive or favorable attitude (average of 3.7) towards the environment issues under consideration. This result is congruent with (Zyadin, 2014, Spiropoulou, 2007, Bamberg, 2003) who reports good attitude especially on issues of energy. Among these water saving is at average 3.9, an indication of the priority rate participants gives for water as an environmental basic need. Although there are less opportunities for recycling, participants have an advantage (of income) to make choices over environmentally friendly products in the markets if they so wish. Moreover, due to the nature of large classes in the study context (over 30 pupils in most cases) a teacher has to use educational resources such as paper and electronic appliances in most efficient way for the next school days to operate smoothly.

As can be observed in this result that participants agreed and strongly agreed with statements and according to Stern (1992) it happens when statements or questions are in the interest of the participants.
However, the instrument used in this study is balanced with four factors while some actual statements were not in the interest of participants. On other hand, since the statements refer to perceived use of the factors one agrees that these are situational responses thus participants may act differently when confronted with problems in real life (Bamberg, 2003). In my view, socio-economic factors and nature of the problems also determines the urgency participants may apply towards environmental issues. The value attached to an environment is the factor to determine the attitude, especially in view of the proposed model which considers perception, knowledge and attitude to be connected.

To verify the above positive attitude, result indicate that no differences exist between perceptions of male and female science teachers towards outcome variables (energy saving, water saving, environmental publication and environmental sustainability) which is opposite of what has been found by (Barthwal & Mathur, 2012, Zyadin, 2014) who concluded that females have higher attitude scores than male do towards conservation and energy. Although studies are different in some respects, they fall in environmental education and measured the attitude for an environmental topic. On other hand, similar to the results Zyadin (2014), McCright (2010) women are generally more emphatic towards the environment than males especially on issues such as water, energy which are basic in everyday life. Although it is important to distinguish differences or similarities between genders, the main issues are that both must consider the state of the environment for possible actions regardless of their gender.

The non-difference result among science subject teachers’ perceptions towards energy saving, water saving and environmental publication is another remarkable results because conventionally the subjects are different from one another in content, aims and theories, however, it is equally comfortable that their orientations towards environmental issues are similar since all are science education courses. No similar studies were found to compare this result about science subject teachers’ attitude towards variables in the study or related ones, however, what the study established is that teachers have reported high score on environmental knowledge but low attitude and vice versa (Vlaardingerbroek & Taylor, 2007). Moreover, this idea is also supported by Bamberg (2003) that showing concern about environmental concern does not directly translate into attitude. Thus, research assume that although no differences were found between subject teachers perceived attitude, their actions may well be informed by what they teach in their subject specialties. On other hand, although attitude is shown by behavior based on knowledge, it equally informs the knowledge contained in different subjects as well.
In the result, environmental sustainability produced results that differences exist between subject teachers’ perceptions and this is interesting because it diverges from other results in the same analysis. Researcher view this difference as unlikely that it may happen as reported because the same participants cannot change attitude towards this one factor over the others since there is not differences between water, energy and environmental sustainability as all are equally important in general. The factor environmental sustainability mainly focused on recycling of products used in everyday life (see appendix L). This different result would be more understood if it were for environmental publication which is different from the three. Thus, the nature of data set used influenced the outcome of both responses. During the analysis, not all variables had same entries. There were some differences in mean ranks as well as median distribution for environmental sustainability against gender and subjects. For gender male were 44 while female 40, subjects such as physical science, life science and home economics indicated some high and low entries. In the main, attitude is a complex psychological concept which changes and thus it is not surprising this result came out different from the rest as there are many factors attached to the variable attitude as observed in intended behavior towards environmental issues.

7.3 Conclusion and suggestions for future research

Numerous environmental issues face Namibia as a country, due to hot climatic conditions it’s described semi-arid. As a developing country, the visions is a knowledge-based country with scientific solutions against environmental challenges. Educational and environmental policies address environmental issues through various means, and science education is a promising channel for provision of necessary skills/knowledge. Humanistic attributes such as awareness, sensitivity, sustainable knowledge and attitudes about, in and for the environment are equally essential for confident and interactive science teachers.

There’s a need for science education to foster teachers’ understanding of environmental issues as educators for future policy makers. The study focused on environmental issues in science education, drawing teachers’ attention towards interdisciplinary environmental learning to the front. It’s specialty stem from international demand for conservation of the deteriorating environment for future generations. The complexity to solve environmental issues presents multiple challenges hence it’s better to draw perspectives from various science subjects such as Geography/Social Studies, Life Science/Biology,
Natural science, Physics and Agriculture, Home Economics etc. Generally, environmental issues remain part of our society and continue posing threats to our lives.

Scientific skills and development of pupils are crucial not only for academic achievement in science education instead spill over into community as pupils take up various professions, especially those linked to the environment. Thus, characters such as awareness and sensitivity enhance the practice of core scientific skills for instance generating and recording data, analyze and reporting conclusions from investigations. With much evidence of environmental issues in various education systems and science education both in the context of this study and elsewhere, it’s important to note that there are no exact answers to environmental issues from science education. It is so, because environmental issues are caused by many sources and impacts are felt at all levels (community, national and international). In fact, the entire globe is engaged in local capacity building activities so that communities become resilience. Science teaching and assessment strategies reported in the study only show to us, the relevance of science education to the current state of environmental issues. Effective teaching strategies such as inquiry-based science education, field trips or outdoor education and use of laboratories cannot be underrated since they allow continuous reflection about observations and discoveries made in surrounding areas. It is through such strategies, science education can make significant impact as pupils are intrigued by environmental phenomena. Moreover, applying informal open questions, discussions and observations are helpful for incorporating environmental issues between science teachers and pupils. The value of formative assessment in teaching environmental issues is meaningful considering the nature of topics, thus, science teachers should apply such strategies where necessary while summative play an important role for moving pupils to next grades. Considering these strategies, application of traditional teacher centered and related strategies also aid the wholeness approach towards innovative and skilled science teachers. Through opportunities and networking with other stakeholders in education for environment the practice of life-long learning and professional development can be realized, especially for promoting environmental issues.

Teachers’ knowledge and attitudes for environmental issues is a one component through which school and science education contributes to protecting the environment and its resources, thus science teachers’ education responds to the complex and dynamic environmental issues with different attitudes. Attitude changes according to situations in different context. Due to changing nature of environmental issues, science teacher’s knowledge in like manner should keep increasing through reflections on science
teaching experiences. The attitude of science teachers towards environmental issues can be positive or negative as inputs to the variable are different.

This study has shown that environmental issues are present in general but particularly in science education in Namibian primary and junior secondary phases (also elsewhere). It then points to science teacher’s knowledge of and how such ought to inform their own and pupils’ attitudes. Generally, the public (science teachers and pupils included) follow media reports about environmental issues elsewhere and little attention is given for local issues. Thus, this study suggests for future researchers and science educators and curriculum planners the points in next sentences.

Suggestion for future researchers

- Future research should focus on studying perceptions of teacher’s knowledge and or attitude for individual science subjects to ensure results are for one cohort of teachers as science education is comprised of many subjects, subject case-study would direct results only for individual subject. Such a study would generate in-depth subject data on content, aims and theories informing such subject towards environmental issues.
- A psychology of education study about perceptions, knowledge and attitude is needed to further establish the link towards environmental issues. Although these psychological concepts are interlinked, their relationship do not form a conventional linear relationship or cause-effect.
- Although a mixed research method produces results from multiple angles, making the breadth and depth quite strong, a single method (especially quantitative study) can over the same period of time provide in-depth results including many background variables such as age, educational background etc. as the nature of environmental issues is complex and dynamic in causes and consequences for various contexts.
- Studies such as action research for implementation of effective teaching strategies is needed to produce results for increasing their use in Namibian science education and beyond. This will serve a purpose for developing teachers’ efficacy in conducting genuine science education lessons which motivate or attract pupils.
- Provision for scientific skills and knowledge in primary and junior secondary phases should be studied to assess the quality of teaching activities and link to science teacher education especially
in the context of the study for development of professional courses and services for science teachers.

- Lastly, find out through long-term ethnographic observations and answer the questions of “how science teachers conduct teaching and assessment for environmental topics”, to establish whether it’s more theory as reported in this study and if so, advice the planning for practical lessons.

Suggestions for science educators and curriculum planners

- In terms of teaching and assessment strategies, science teachers should focus on application of outdoor education, inquiry-based science education and laboratory/experimental work. This will allow for more practical lessons and maintain interest for science education among pupils.
- Science teachers should provide science instruction which encourage both girls and boys to excel in science education including action towards environmental issues since the belief about science being for boys still persist.
- Curriculum planners to include more environmental learning issues and consider all parameters necessary for inclusion in specific science subject.
- Lastly, establish clarity for science teachers on concepts used in curriculum towards environmental learning theme.

7.4 Reliability and limitation to the study

This study draws on various other studies conducted among teachers in Namibia (and elsewhere) with varying degrees in scope. It thus present empirical results as presented above in surety of participant’s responses. Qualitative study employed students at master level and science teachers at the same time, meaning the sample is most suitable for providing feedback to questions of science education. This research is grounded in theory and methodology for science education to help teachers and school in general to seek innovative ways for teaching environmental issues. Interview instrument was reviewed by other experienced researchers and supervisor before commencing the study. A sample of eight (8) science teachers from various parts of the country bringing different socio-cultural and educational experiences for the study.

While conducting the study, researcher had a stretching research plan to follow. Adherence was maintained as far as possible to generate research data for present results in the academic community,
especially for Namibia. A sample of eight (8) science teachers is adequate for this study, especially that their experiences at master level of education underpin the knowledge aspect of this study. However, the use of interviews seems not the most suitable method to tap into science teachers’ knowledge of environmental issues as conversations do not necessarily produce points (numeric records) which often is the acceptable measure. Developing and conducting a written test would have yielded numeric results on various environmental issues than the current findings. This too, is a full study and would demand more time and additional logistics. Although the interview instrument was reviewed by other experienced researchers, during interviews teachers were conversant in the use of science education concepts for environmental learning aspects, instead, these were merely information words and tend to change due to prevailing experiences during interviews.

Sampling of eight (8) science teachers who were also students compromise the context of the study because during the study some of the teachers were still in employment while others not. Moreover, interviews took place in Finland and not Namibia. Henceforth, teachers’ perceptions might have changed. However, the most important aspect is that in both cases the sample has practiced as science teachers prior to the study and drew on experiences thereof. In case of those not in employment, the longest period is not more than two years since they left teaching. This means experiences are still fresh and occupy most part of their career journeys. Sampled science teachers therefore reflected and employed their knowledge at master studies level to provide quality responses for this study.

During quantitative phase the sample of $N=88$ is considered small because case-study research may generalize results to entire population of science teachers in Namibia. Meanwhile, during the analysis various kinds of statistical tests and transformations of data seemed problematic. In some respects (for instance Home Economics) entries were not adequate to give meaningful results since data was not exactly equal across variables. A big data set which is more balanced is therefore ideal for most statistical tests and would yield significant results. Background variables is a good idea that should always be maximized than this case. In addition, researcher had limited knowledge of statistical analysis as it was first time to use it. Further practice with SPSS analyses would produce better results with effect sizes to determine the strength for conclusions.
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APPENDICES

Appendix A: Permission letters from UEF

Philosophical faculty
School of Applied Education Science and Teacher Education

To Whom It May Concern

Namibian teachers, who are participating in Master’s Degree Programme in Primary Education as a part of their studies, are conducting dissertation research. These studies consist of three different parts: a) planning seminar, b) working seminar and c) research report. To be able to complete the dissertation, they have to conduct empirical data collection, which is recommended to be carried out in Namibia. As a supervisor of their master’s thesis, I ask for Your kind support for their data collection under all necessary ethical requirements.

In Joensuu, 15th November, 2017

Sari Havu-Nuutinen
Professor
Academic head of the Master’s Degree Programme in Primary Education
Supervisor of Thesis
Appendix B: Permission letters for Khomas region

[Letter content]

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Appendix C: Permission letters for Erongo region

ERONGO REGIONAL COUNCIL

DIRECTORATE OF EDUCATION, ARTS & CULTURE

OFFICE OF THE DIRECTOR

Enquiries : Mr. J. /Awaseb
Date : 22 March 2018

George Sisebo
Latolankantu 9A2
80160
JOENSUU
FINDLAND

RE: PERMISSION TO COLLECT RESEARCH DATA

Your request on the above mentioned subject has been approved with the following conditions:

1. The collecting of Data should not interfere with the normal school program.

2. The programme should be discussed with the school management and prior approval must be obtained from the principal.

3. Participation of teachers and learners should be voluntary.

Kind regards,

J. /AWASEB
REGIONAL DIRECTOR
Appendix D: Permission letters for Zambezi region

REPUBLIC OF NAMIBIA
ZAMBEZI REGIONAL COUNCIL
DIRECTORATE: EDUCATION, ARTS AND CULTURE

Tel: +26466251931
Fax: +26466253187
Enquiries: Adrenah K Mukela

George Siseho
Lateolankantu 9A2
80160
JOENSUU
Finland

Attention: Mr Siseho

RE: REQUEST FOR PERMISSION TO COLLECT RESEARCH DATA: YOURSELF

1. Your letter dated 20 May 2018 in the context above is hereby acknowledged.

2. Permission is granted to you to conduct research in schools within Katima Mulilo Circuit as per your programme, however, you are advised to ensure that your presence in such schools you intend to visit does not disrupt the normal teaching and learning in these schools.

3. Kindly communicate your proposed program to the school management so that it does not interrupt the school set program.

4. The Ministry of Education, Arts and Culture would like to request you to share your findings with the Directorate.

NB! By a copy of this notice the Inspector of Education is notified of your presence such schools.

Thank you,

MR JOSEPH J. KAWANA
ACTING REGIONAL DIRECTOR: EDUCATION, ARTS AND CULTURE

Date: 20 June 2018
Appendix E: Permission letters for Gammams Primary School

Fax: 214778
Tel: 061-212505/6
Email: gammamsprimaryschool@gmail.com

P.O. Box 10369
Khomashal
Namibia
12 JULY 2018

File No: 12/3/9/1
George Siseho
Latolankantu 9A2
80160
Joensuu- Finland

Re: Permission to collect Research Data

Permission is hereby granted to you to do research for your Master Degree of Arts, as you are in your final stages of writing your thesis.

The following conditions must be adhered to at all times:
- Teaching and learning should not be disrupted
- Teachers who will take part in the research should do so voluntarily

We trust this confirmation to be in order.

Yours in Education

Ms. B. Kaimu – School Principal

MINISTRY OF EDUCATION
GAMMAMS PRIMARY SCHOOL
12 JUL 2018
PO BOX 10369, TEL: 212505/6
KHOMASDAL, WINDHOEK
OFFICIAL
Appendix F: Signed consent form

CONSENT FORM I: INDIVIDUAL INTERVIEW

I hereby, acknowledge taking part in the individual interview(s) of this research. I am aware of my personal rights, voluntary participation or withdrawal from this exercise at any time. I grant the research anonymous excerpts of the interview.

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<th>Date</th>
<th>Name(s)</th>
<th>Signature</th>
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Compiled by George S. Siseho (Researcher)

School of Applied Educational Science and Teacher Education

Philosophical faculty

University of Eastern Finland

JOENSUU

Finland

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Appendix G: Research ethical statement

Research ethical statement

Dear participant(s)

It is your right to give or withdraw consent for attending meeting, participate in group as well as individual interviews that comes with this Master degree research in education, conducted at the University of Eastern Finland (UEF), Joensuu. The topic is titled: **Perceptions of Teachers’ Knowledge and Attitudes Concerning Environmental Issues in Science Education – Case of Namibian Science Teachers.** The research aims amongst other, to create awareness of environmental issues in Namibian education sector. Furthermore, to advance environmental education research in the Namibian context, widen the existing knowledge among science teachers about environmental issues. These all will help develop sustainable scientific practices based on Namibian context.

Therefore, involvement in this research is voluntary. Interviews of about +30 minutes in agreed places in the Joensuu city. Interview questions are not obligatory, and you may not respond where you feel uncomfortable. Remember, this interview will be recorded on tablet/mobile phone and later transferred on researcher’s personal computer for confidentiality purpose, only persons identified as research assistants may have access to this work. And no full or part of recoded interview shall be used for any purpose not mentioned here. With your permission anonymous sections of may appear in the research findings for validity of the study.

I assure you that no harm when participating in this research, this study abides with all ethical standards for researchers at UEF and international. Nonetheless it is your decision to participate or not. As a future teacher I hope you learn something from this study and to impact on science education of environmental issues in Namibia.

Your cooperation is highly appreciated

Yours in Education

George S. Siseho
Appendix H: Interview questions

INTERVIEW PROTOCOL/QUESTIONS 25.01.2018

Part A: Introduction

1. In this interview, we (interviewer and respondent) discuss Environmental Issues in Science Education.

My name is George, a master’s degree student in the school of applied education sciences and teacher education, philosophical faculty of the University of Eastern Finland, Joensuu.

2. May you please introduce yourself?

3. Tell me about your teaching career and experience so far?

Part B: Perceptions, knowledge and attitudes concerning environmental issues in Namibia

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<th>Research questions</th>
<th>Interview questions</th>
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<tr>
<td>What is the role of science teaching/education concerning environmental issues?</td>
<td>What is your aim (s) for teaching science?</td>
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<td>What examples of environmental issues feature in your science teaching?</td>
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<td>In your opinion why do environmental issues appear in science education?</td>
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<td>Describe the role as a science teaching towards environmental issues.</td>
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<td>How do you approach environmental issues in your science teaching?</td>
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<td>Do you feel the need for further training on environmental issues for you to be able to teach?</td>
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<td>What are your recommendations concerning environmental education among Namibians?</td>
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<td>Question</td>
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<td>What teaching methods, assessment practices are used to foster understanding of environmental issues?</td>
<td>May you describe your science teaching methods?</td>
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<td>How do you incorporate environmental issues in your science teaching strategies?</td>
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<td>Which of the teaching methods do you mostly use and why?</td>
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<td>Explain how the teaching methods help learners better understand environmental issues in a scientific way?</td>
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<td></td>
<td>How do you incorporate environmental issues in your assessment practices?</td>
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<td>May you please justify your assessment practices for environmental issues?</td>
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<td></td>
<td>How do you describe your learners’ science knowledge at senior primary/junior secondary level?</td>
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<td>Tell me what tasks learners do during environmental issues topics?</td>
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<td>What other activities do you suggest science teachers do for the environment?</td>
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<td>Sustainability</td>
<td>How do you teach water saving; energy saving, sanitation, development etc.</td>
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<td>What materials are used for teaching these concepts?</td>
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<td>Do you access/share information on environmental issues?</td>
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This is the end of our interview, thank you for your **time and energy**.

Have a wonderful day!!!
Appendix I: Extract of interview transcription

Interviewer: Okay, welcome to this interview in which we discuss environmental issues in science education, my name is George (Researcher) a master degree student in the school of education sciences, philosophical faculty of the university of eastern Finland, Joensuu. Aahh…May you please introduce yourself.

Interviewee: Aahh… I am……………; Maths and science teacher, teaching mainly junior secondary school. I have taught so far for almost 10 years teaching experience, teaching Life science, Physical science which comprises of Chemistry and physics plus also Agriculture and mathematics.

Interviewer: Alright, part B of this interview deal with perceptions, knowledge and attitudes concerning environmental issues in Namibia. Aahh… what is your aim of teaching science?

Interviewee: Aahh…. In science we mainly teach to develop scientific skills among learners, that’s we have specific scientific skills that each learner suppose to develop or enhance. So... one of those is learners must be able to observe, learners must be able to record the observations, learners must be able to synthesis what they have observed and learners must also be able to report. That’s to communicate the observations they have made in any set up. This ranges from different content they are learning whether is from experiments or whether is just from a mere group or class discussion.

Interviewer: Yes…Aahh…what are the examples of environmental issues that feature in your science teaching.

Interviewee: Aahh….when we teach science especially in physical science and life science we look at how we can sustain our environments that’s from made or destruction that is caused by developmental factors for example mining. So in most cases we look at those environmental factors that can come such activities. And as a result we try to come up with or teach learners environmental related issues and on how they can take care of the environment. So that at least negative effects that come through environment damage cannot really affect our communities.

Interviewer: Okay, what are examples, for example on the issue of mining, what exactly?

Interviewee: Mining causes land degradation, in the sense that vast land get damaged or get deformed that’s mining sometimes if I can give you an example of an open pit mining so a lot of land is going to be excavated.

And that leave open dams which are quite dangerous to human life and even to wild animals. So when we teach learners we tell them to say within the mining companies itself or government they need to
have regulations after excavation of the mine has taken place then that responsible company suppose to berrry all the pit holes that they have excavated so that at least the land can be given an opportunity to renew itself. Apart from that, also mining causes deforestation because in most cases some vast forest need to be cut down so that they can expropriate whatever they need to so we teach them reforestation/replanting of trees because when deforestation take place ecological problems like erosion of soil, problems like creation of unwarranted streams of water that come out because of gradients that are being formed from mining activities. The other one also is mining activities like, in Namibia we have uranium so in most cases environmental effects that come from mining substances like uranium which is quite radioactive is to teach learners to be aware on how to be in such type of environmental areas where there is radioactive substances like uranium because too much exposure to it cause mutation. Can cause unnees can cause various different types of cancer so these are some of the lessons we give learners and also the work in hand with government policies on how to handle such radioactive substances which come from the environmental degradation by mining companies.

**Interviewer:** Bringing it back… a little bit to the school context, what are the other immediate environmental issues that you teach in the science or specifically in any of the subjects.

**Interviewee:** Aaah, talking about the issues of mining we equally teach learners we teach learners about the dangers of deforestation due to such type of activities because deforestation changes the weather patterns so in most cases this is what is visible in a lot of communities that the weather patterns especially majority of the communal farmers the patterns of rain seasons are now fluctuating now and then. Apart from that also due to oxides that come from industries, like cars for example, oxides from cars. Those are some of the environmental impacts that we have, we teach learners the impacts of such they bring around what we term as acid rain. Acid rain is visible even in the school environment because after they build new building, classroom have been painted for a while the paint fades away, the paint shrinks out due to the effects of acid rain. And this does not only happen in the school building. It also affects leaves during rain season learners are capable of seeing. You take learners out in the nearest veld to inspect plant leaves and in most cases plant leaves are going to demonstrate the effect of acid rain that eats away parts of the leaves. It also affects the product of crops in the fields because due acid rain it turns the soil to be more acidic and as a result a lot of crops do well in close to neutral soil ph so because of acid rain the soil is becoming acidity and we teach learners why we use other aspects like fertilizers for example NKP which is quite common in Namibia because its an alkaline, containing substances, and its main effect is just to balance the ph level of the soil to near neutral where a lot of plants flourish well.

**Interviewer:** Taking you back to the issues of weather patterns, fertilizers and all those. How do you contextualize these with what the learners know.

**Interviewee:** Learners are experiencing different weather patterns in every environment because of the effects of global warming. And the effects of global warming affects the environment world wide so learners in classes especially junior secondary they can relate that sometimes when it rains we have flash running water which is commonly caused by different patterns, we experience unwarranted rain in
some places that use to receive adequate rainfall, they no longer receiving such type of rainfall. So these are some of the things we try to contextualize for learners to understand from environmental issues due industrialization. The issue of NPK the fertilizer that usually used in the fields we can equally use the example of ash, ash is a very practical example that we can give learners of rural areas its closer to other fertilizers like NPK because ash is a alkaline containing substances as a result it try to neutralize the soil. Actually where they through away ash crops grow, it’s a practice in rural areas, especially for me who worked in rural are, during rain season adult take ash and spread it in the fields and learners know that. Apart from that is the issue of spreading animal manure, so we take animal manure from the cow’s kraal and spread it in the fields. Why? Because that content also is high in alkaline containing substances and as a result it helps in neutralizing the soil for farming.

**Interviewer:** Now, what is the learner’s understanding of this home practices of manure and now the learning of fertilizers or NPK in the school context, how do they act when their learning these concepts?

**Interviewee:** It make learners to realize and to understand why in most cases during farming season a lot families are given fertilize their soils because when we teach them we relate the content, chemical content of NPK which is mainly comprising of nitrogen, phosphorus and also potassium. So they know these substances and their oxides so after they come to understand the oxides of these chemicals the alkalinity and we demonstrate these in classes also we perform simple demonstrations of neutralization which demonstrates what happens when an acid combines with alkaline. And also we test different samples of ph soils so that learners can know the ph soil which is acidic or alkalinity or neutral, So learners can be asked to pick soil samples and after that they bring to class and we demonstrate to them to test the ph of different soils.
Appendix J: Extract of analysis

ANALYSIS 1 20.07.2018

Q1. Aims for science teaching/education

T1. I think I should say I liked science since the beginning. It sounded so real for me during my school years. It was something very real because sometimes they will teach so locally thing find in my environment. That’s why I decided to teach science because I can teach examples I get in my local environment. Example my indigenous knowledge.

Teacher’s aim is to teach local things (local knowledge), those happening within the environment. In other words, environmental issues that occur in local areas using local (indigenous) knowledge.

T2. My Aim is to instill the love of science in young learners, especially in the young female learners because they believe that science is only a subject for boys and smart people since it is believed to be a difficult subject. It is for these reasons that some learners are only forced to do science and mathematics because they have to but not because they are motivated that it is a good thing. Another aim for me to teach science is for the good and wellness of the environment. By teaching science, I can teach the young generation how to take care of the environment and its resources to ensure that the future generations find the resources intact and in good condition.

I treat all my learners equally regardless of their gender. The boys also need to learn science for their own wellness and I intend on equipping them with problem solving skills that would not only come in handy in future but in the present too. Children do not only learn science to pass but it is a subject that is used in everyday life.

Teachers emphasize the love for science young people s that they are able to take care/conserve/maintainace of the environment and its resources for future generations.

T3. In science we mainly teach to develop scientific skills among learners, that’s we have specific scientific skills that each learner suppose to develop or enhance. So… one of those is learners must be able to observe, learners must be able to record the observations, learners must be able to synthesis what they have observed and learners must also be able to report. That’s to communicate the observations they have made in any set up. This ranges from different content they are learning whether is from experiments or whether is just from a mere group or class discussion.
Teacher aim to develop scientific skills among learners, such as observation skills, recording skills and reporting skills. To develop scientific knowledge among pupils.

T4. Its quit a lot of aims when one is learning teaching science, but for quit most important aim for teaching science is to inform learners on how they should deal with scientific issues they come across within life in term of lifelong learning when you apply science, but when you apply on a benefit of a learner is to excel in maybe to be professional someone in science related subjects and it might become a teacher, a scientist or a doctor, so it play quit variety of reason in one to teach science.

Teachers aim is to inform learners about scientific issues in life and also to develop desire for science profession.

T5. The aim for teaching science to my side is to teach learners to discover things, through observing when they calculate we normally teach science to know things around them is the important part.

Teacher aims to help pupils discover things within the environment through scientific skills such as observing.

T6. ”My aim for teaching science is because science is around us, Science is what we see, Science is what we touch, science is who we are, so this is one of my reasons why I am teaching science but my aim is to equip the Namibian learners with what is going on in the environment around them.”

Teacher aims to make pupils aware of environmental issues through science, everyday occurrences (things we see, touch etc)

T7. Well my aim as a science teacher is to teach the science content that is given by the ministry of education in the sense as stipulate in the syllabus, for the science classes that I teach that the primary aim of me teaching science and then on top of that for me to be able now to implement that I will assess how may aim of reaching the syllabus I meant by how well the kids are performing how well the outcome of the content that I am teaching them.

Teacher aim to improve pupils performance through implementing and assessing teaching practices.

T8. INTERVIEWEE: The aim of social studies is divided into three parts, depending on the level, so the 1st part is about the historical concepts especially the Namibian context and then secondary we deal with the issues of related to the environment e.g geographical area and all these things and then the 3rd part is the about civic which deals with the citizenship whereby we teach learns to know about their government, compare different types of governments and so on.

INTERVIERWER: Okay now for example when you are teaching these three different parts what is your aim with all of them?
INTERVIEWEE: The first is for the leaners to be able to know about history or the back ground of the events that happened and also the current issues or affairs and the second part has to do with the being able to locate where Namibia is situated in Africa. also, issues related to the environment for e.g how humans’ impact natural environment and also to know the structure of government. the 3rd part now the civic part, structure of government they know their ministers they know the community leaders and many others

INTERVIEWER: Now a child may ask what is the need to learning this structures of government what is the need of learning this environment how will you respond to a learner who ask like that

INTERVIEWEE: The need for knowing about the government, minister and stuff

INTERVIEWER: Yes

INTERVIEWEE: I will respond by saying as person or as a responsible citizen you need to know what is going on around you and also highlight the fact that societies the are structures within the societies and then perhaps the need for leadership and all this things to the simple terms I will just refer them to their house by home environment that there is a head and then that there are people who are having the duties and responsibilities in organising your home so they can’t be done hazadiously.

Teachers aims at creating awareness of how human impact the environment and responsible citizenship. In other words, human activities cause damage to the natural world if not done in a sustainable way.

My interpretation

Teacher’s aim is to teach local things (local knowledge), those happenings within the environment. In other words, environmental issues that occur in local areas using local (indigenous) knowledge.

Teacher aims to make pupils aware of environmental issues through science, everyday occurrences (things we see, touch etc)

Teachers aims at creating awareness of how human impact the environment and responsible citizenship. In other words human activities cause damage to the natural world if not done in a sustainable way.

Three teachers aim to make pupils aware/create awareness about environmental issues in local areas through science as well as indigenous knowledge. Also about human activities that impact the environment. They take science as everyday things pupil see and touch and should help pupils become responsible citizens.

Teachers emphasize the love for science young people so that they are able to take care/conserve/maintain the environment and its resources for future generations.

Teachers aim is to inform learners about scientific issues in life and also to develop desire for science profession.
Teacher aims to help pupils discover things within the environment through scientific skills such as observing.

Teacher aim to develop scientific skills among learners, such as observation skills, recording skills and reporting skills. To develop scientific knowledge among pupils.

Four teachers aim to develop scientific skills and knowledge such as observing, recording and reporting investigations. Moreover, pupils to desire scientific professions and take maintain natural resources by reducing the impact of environmental issues.

Teacher aim to improve pupils performance through implementing and assessing teaching practices.

One teacher aim to improve pupil performance in science subjects

FINAL INTERPRETATION

Three teachers aim to make pupils aware of environmental issues in local areas through science as well as indigenous knowledge. They take science as everyday things pupil see and touch and thus pupils should become responsible citizens. Four teachers aim to develop scientific skills and knowledge such as observing, recording and reporting investigations. Moreover, pupils to desire scientific professions and take maintain natural resources by reducing the impact of environmental issues. One teacher aim to improve pupil performance in science subjects

Science teachers have various aims for teaching science subjects in school such as to develop scientific skills and knowledge. Pupils are taught observation, recording and reporting skills to make scientific conclusions from investigations. Moreover, they consider science to be part of environment and people experience some things e.g. environmental issues and should become responsible citizens. Through science teaching, they also aim to maintain natural resources by encouraging pupil to consider science profession hence help reduce the impact of environmental issues. Lastly and more convenient, improve pupil’s academic performance in science education.
Appendix K: Extract for attitude scale

INTRODUCTION

Questionnaire: Behavior items for Environmental Issues,
Participants should note:
☐ Anonymity and confidentiality is highly sought after, thus no names are required for completing this questionnaire.
☐ You are completing this form at own will and not otherwise.
☐ Only senior primary and junior secondary science teachers should participate (Physical science, Life science, Agriculture, Home science, Geography, Social studies and Natural science).

BIOGRAPHIC INFORMATION AND EDUCATION

Gender:
Female □

Subjects (Please select from list):
Natural Science □

SCALE

How well the following statements describe you, please select the number (1-5) that best describes you.
1 2 3 4 5
Does not describe me Describe me well

ENERGY SAVING TECHNIQUES

I prefer walking short distances than driving.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree/Undecided</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I turn off the computer if I do not intend to use it for few hours.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree/Undecided</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Water Saving Techniques

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree/Undecided</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I always close the tap properly before leaving.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I close the tap in between when teeth brushing, shower, dish washing etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I make effort to immediately replace leaking taps when noticed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Environmental Publications

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree/Undecided</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I talk with my friends about environmental issues.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I do not hesitate to warn anyone who damages the environment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I watch and listen to environmental programs on TV, radio, youtube etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Sustainability, Environmentally Friendly and Recyclable Products

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree/Undecided</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before I buy a product, I consider whether its waste is recyclable or not.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I put empty glass bottles into recycling bins.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I divide waste into certain categories, such as paper, glass, plastic, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I keep wrapping paper used for presents for prospective users.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix L: Analysis for environmental learning in science education grades 5-9

<table>
<thead>
<tr>
<th>Grades</th>
<th>Environmental Learning in Senior Primary Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elementary Agriculture</td>
</tr>
<tr>
<td>5</td>
<td>Environmental problems</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Environmental problems</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Conservation</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grades</th>
<th>Environmental Learning Themes in Junior Secondary Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agriculture</td>
</tr>
<tr>
<td>8</td>
<td>Application of Nutrition</td>
</tr>
<tr>
<td></td>
<td>conservation farming for Food commodities</td>
</tr>
<tr>
<td></td>
<td>sustainable production. Resource management</td>
</tr>
<tr>
<td></td>
<td>Importance of fruits</td>
</tr>
<tr>
<td>9</td>
<td>Environmental factors and plant growth Food and Nutrition</td>
</tr>
<tr>
<td></td>
<td>Fertilising Hygienic</td>
</tr>
<tr>
<td></td>
<td>handling of handling of food</td>
</tr>
<tr>
<td>Objectives of Environmental Learning Themes in Science Subject</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Agriculture</strong></td>
<td>Grades Objectives</td>
</tr>
<tr>
<td>(Sustainable production)</td>
<td>8 acquire knowledge and skills in the management and caring of the environment</td>
</tr>
<tr>
<td>Fruits)</td>
<td>8 acquire knowledge and skills in the management and caring of the environment</td>
</tr>
<tr>
<td>8 and our natural resources through the practice of conservation farming in agriculture</td>
<td>8 and our natural resources through the practice of conservation farming in agriculture</td>
</tr>
<tr>
<td>8 understand that fruits are important to human beings</td>
<td>8 understand that fruits are important to human beings</td>
</tr>
<tr>
<td>8 acquire knowledge of the methods of planting fruit trees</td>
<td>8 acquire knowledge of the methods of planting fruit trees</td>
</tr>
<tr>
<td>9 understand the environmental factors influencing plant growth influencing plant growth</td>
<td>9 understand the environmental factors influencing plant growth influencing plant growth</td>
</tr>
<tr>
<td>9 understand the effects of fertilizers</td>
<td>9 understand the effects of fertilizers</td>
</tr>
<tr>
<td><strong>Home Economics</strong></td>
<td>8 know the following nutritional concepts e.g. balanced diet, health, malnutrition</td>
</tr>
<tr>
<td>(Food and nutrition Resource management)</td>
<td>8 recognize the effect of eating and lifestyle habits on our health</td>
</tr>
<tr>
<td>8 recognize good food choices for a healthy diet</td>
<td>8 recognize good food choices for a healthy diet</td>
</tr>
<tr>
<td>8 understand the importance and use of cereals in the diet</td>
<td>8 understand the importance and use of cereals in the diet</td>
</tr>
<tr>
<td>8 realize the importance of water in the household</td>
<td>8 realize the importance of water in the household</td>
</tr>
<tr>
<td>8 understand the proper ways of disposal of household waste</td>
<td>8 understand the proper ways of disposal of household waste</td>
</tr>
<tr>
<td>9 revise the importance of the Food and Nutritional Guidelines for Namibia</td>
<td>9 revise the importance of the Food and Nutritional Guidelines for Namibia</td>
</tr>
<tr>
<td>9 understand the effect of heat on starch</td>
<td>9 understand the effect of heat on starch</td>
</tr>
<tr>
<td>9 observe the properties and uses of white sauce</td>
<td>9 observe the properties and uses of white sauce</td>
</tr>
<tr>
<td><strong>Life Science</strong></td>
<td>8 know the concept of osmosis and its role in the absorption of water and</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>8 know the concept of osmosis and its role in the absorption of water and</td>
</tr>
<tr>
<td>(Classification of living organisms)</td>
<td>8 know the concept of osmosis and its role in the absorption of water and</td>
</tr>
<tr>
<td>8 know examples of plants that are adapted to arid environments and the</td>
<td>8 know examples of plants that are adapted to arid environments and the</td>
</tr>
<tr>
<td>8 importance of these adaptations</td>
<td>8 importance of these adaptations</td>
</tr>
<tr>
<td>8 know the structures and functions of flowers as reproductive organs in plants</td>
<td>8 know the structures and functions of flowers as reproductive organs in plants</td>
</tr>
<tr>
<td>8 know and understand the interactions in an ecosystem</td>
<td>8 know and understand the interactions in an ecosystem</td>
</tr>
<tr>
<td>9 realize the importance of taxonomy and know the major levels of classification</td>
<td>9 realize the importance of taxonomy and know the major levels of classification</td>
</tr>
<tr>
<td>9 realize that organisms are divided into five kingdoms and know diagnostic features of each group</td>
<td>9 realize that organisms are divided into five kingdoms and know diagnostic features of each group</td>
</tr>
<tr>
<td>9 understand how some gases create a greenhouse effect causing global warming</td>
<td>9 understand how some gases create a greenhouse effect causing global warming</td>
</tr>
<tr>
<td><strong>Physical Science</strong></td>
<td>8 understands elements, mixtures and compounds</td>
</tr>
<tr>
<td>(Matter)</td>
<td>8 understands elements, mixtures and compounds</td>
</tr>
<tr>
<td>(Environmental Chemistry)</td>
<td>8 understand that the world around us is made up of the elements on the Periodic Table</td>
</tr>
<tr>
<td>8 know the physical properties and reactions of oxygen</td>
<td>8 know the physical properties and reactions of oxygen</td>
</tr>
<tr>
<td>8 know that ozone is formed in the upper atmosphere and shields the Earth from harmful ultraviolet rays</td>
<td>8 know that ozone is formed in the upper atmosphere and shields the Earth from harmful ultraviolet rays</td>
</tr>
<tr>
<td>9 realize that atoms combine to form molecules or ions and that atoms, molecules and ions are the building</td>
<td>9 realize that atoms combine to form molecules or ions and that atoms, molecules and ions are the building</td>
</tr>
<tr>
<td>molecules and ions are the building blocks of all material (extension of the particle model)</td>
<td>molecules and ions are the building blocks of all material (extension of the particle model)</td>
</tr>
<tr>
<td>9 understand the different types of bonding</td>
<td>9 understand the different types of bonding</td>
</tr>
<tr>
<td><strong>Geography</strong></td>
<td>8 understand the characteristics of population such as population growth, population movement</td>
</tr>
<tr>
<td>(Population characteristic)</td>
<td>8 understand the characteristics of population such as population growth, population movement</td>
</tr>
<tr>
<td>(Deterioration of Namibian environment)</td>
<td>9 investigate the reasons for the deterioration of the environment and suggest possible solutions</td>
</tr>
<tr>
<td>9 investigate the reasons for the deterioration of the environment and suggest possible solutions</td>
<td>9 investigate the reasons for the deterioration of the environment and suggest possible solutions</td>
</tr>
</tbody>
</table>
Appendix M: SPSS outputs

Case Processing Summary for attitude instrument

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valid</td>
<td>75</td>
<td>85.2</td>
</tr>
<tr>
<td>Excluded(a)</td>
<td>13</td>
<td>14.8</td>
</tr>
<tr>
<td>Total</td>
<td>88</td>
<td>100.0</td>
</tr>
</tbody>
</table>

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics for attitude scale

<table>
<thead>
<tr>
<th>Cronbach's Alpha</th>
<th>Based on Standardized Items</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>.884</td>
<td>.892</td>
<td>32</td>
</tr>
</tbody>
</table>

![Histogram](image1)

![Histogram](image2)
## Tests of Normality for Environmental Publication

<table>
<thead>
<tr>
<th>Gender</th>
<th>Kolmogorov-Smirnov&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>df</td>
</tr>
<tr>
<td>Environmental publication</td>
<td>male</td>
<td>.100</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>.140</td>
</tr>
</tbody>
</table>

<sup>*</sup> This is a lower bound of the true significance.

<sup>a</sup>Lilliefors Significance Correction

---

**Simple Boxplot of (EST1 + EST2 + EST3 + EST4 + EST5 + EST6) by 1=Natural Science 2=Agriculture 3=Social Studies 4=Life Science 5=Physical Science 6=Home Economics**

![Boxplot](image)
Descriptives

WST1,WST2,WST3,WST4,WST5,WST6,WST7,WST8

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>44</td>
<td>3,6136</td>
<td>.70092</td>
<td>,10567</td>
<td>3,4005, 3,8267</td>
<td>1,29</td>
<td>4,86</td>
</tr>
<tr>
<td>female</td>
<td>40</td>
<td>3,6375</td>
<td>.62578</td>
<td>,09895</td>
<td>3,4374, 3,8376</td>
<td>2,00</td>
<td>5,00</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>3,6250</td>
<td>.66233</td>
<td>,07227</td>
<td>3,4813, 3,7687</td>
<td>1,29</td>
<td>5,00</td>
</tr>
</tbody>
</table>

Test of Homogeneity of Variances

<table>
<thead>
<tr>
<th></th>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WST1,WST2,WST3,WST4, WST5,WST6,WST7,WST8</td>
<td>Based on Mean</td>
<td>,230</td>
<td>1</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Based on Median</td>
<td>,234</td>
<td>1</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Based on Median and with adjusted df</td>
<td>,234</td>
<td>1</td>
<td>79,791</td>
</tr>
<tr>
<td></td>
<td>Based on trimmed mean</td>
<td>,239</td>
<td>1</td>
<td>82</td>
</tr>
</tbody>
</table>

ANOVA

WST1,WST2,WST3,WST4,WST5,WST6,WST7,WST8

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>0.012</td>
<td>1</td>
<td>,012</td>
<td>,027</td>
</tr>
<tr>
<td>Within Groups</td>
<td>36,398</td>
<td>82</td>
<td>,444</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>36,410</td>
<td>83</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis Test Summary

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Test</th>
<th>Sig.</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The distribution of MEAN(EST1,EST2,EST3,EST4,EST5,EST6,EST7) is the same across categories of Gender.</td>
<td>Independent-Samples Mann-Whitney U Test</td>
<td>770,000</td>
<td>Retain the null hypothesis.</td>
</tr>
</tbody>
</table>

Asymptotic significances are displayed. The significance level is .05.
Hypothesis Test Summary

Null Hypothesis | Test | Sig. | Decision
--- | --- | --- | ---
1. The distribution of MEAN\((EST1, EST2, EST3, EST4, EST5, EST6, EST7)\) is the same across categories of 1=Natural Science 2=Agriculture 3=Social Studies 4=Life Science 5=Physical Science 6=Home Economics . | Independent-Samples Kruskal-Wallis Test | 698,000 | Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.
Hypothesis Test Summary

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Test</th>
<th>Sig.</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>The distribution of MEAN(ES1,ES2,ES3,ES4,ES5,ES6,ES7,ES8,ES9,ES10) is the same across categories of 1=Natural Science 2=Agriculture 3=Social Studies 4=Life Science 5=Physical Science 6=Home Economics.</td>
<td>Independent-Samples Kruskal-Wallis Test</td>
<td>.040</td>
<td>Reject the null hypothesis.</td>
</tr>
</tbody>
</table>

Asymptotic significances are displayed. The significance level is .05.

1. The test statistic is adjusted for ties.
2. Multiple comparisons are not performed because the overall test does not show significant differences across samples.
Independent-Samples Kruskal-Wallis Test

<table>
<thead>
<tr>
<th>1 = Natural Science</th>
<th>2 = Agriculture</th>
<th>3 = Social Studies</th>
<th>4 = Life Science</th>
<th>5 = Physical Science</th>
<th>6 = Home Economics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N</td>
<td>95</td>
<td>Test Statistic</td>
<td>11,634</td>
<td>Degrees of Freedom</td>
<td>5</td>
</tr>
<tr>
<td>Asymptotic Sig. (2-sided test)</td>
<td>.040</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. The test statistic is adjusted for ties.