An investigation of plant conservation strategies employed in Makhanda, South Africa: an educational exploration.

by

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DECLARATION:

In accordance with Rule G5.6.3, I hereby declare that the above-mentioned treatise/ dissertation/ thesis is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

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Abstract

The school curriculum in South Africa gives educators the freedom to design and organise learning experiences according to their local circumstances and availability of resources. In that context, this study advocates conservation education through use of plants on school grounds and visits to local herbaria and botanical gardens as part of the school curriculum. Trees growing on street verges in town suburbs are also a resource that could be using for teaching.

School learners from three schools representing different areas of Makhanda (Grahamstown) participated in plant-related activities and were surveyed to determine their prior knowledge about plants and plant conservation. Learners answered a series of questions in writing using a funnel sequence and the inverted funnel sequence in questionnaire design. This motivated respondents to co-operate and fully complete a questionnaire. In addition, the non-participant observation technique was used to capture behavioural reactions to the activities in order to supplement the data generated through questionnaires and interviews. This proved to be a purposeful, systematic and a selective way of watching and listening to an interaction phenomenon as it takes place.

Interviews and questionnaires revealed that most Makhanda residents (especially in rural and township areas) use traditional medicine and medicinal plants to treat many diseases. They also use plants for cultural activities. Traditional remedies are practised among the rural and township communities because of ease of availability, convenience, and also due to social, psychological and cultural reasons. Medicinal plants have been increasingly recognized for their role not only for health care, but also for improving the economic status.

Community members and street vendors were also questioned using semi-structured interviews. Open-ended questions were used successfully to assess the person's knowledge, attitudes, opinions, beliefs and feelings. This type of interview ensures that a specific question does not lose its purpose. These interviews were used to determine how community members see, interpret and relate to nature. In the interviews, I also assessed the real needs of the local communities because there is a tendency to think that our power, knowledge and resources can give us the right to predict what communities really need without actually asking them. When our imposed initiatives fail, we often accuse these communities of a lack of interest in our issue of interest. Documents on plants and their uses kept in the Selmar Schönland Herbarium were compared with the information given by community members and street

vendors. Xhosa plant names and ethnobotanical information given by the community members and street vendors was used to augment existing information on plant use.

A further aim of this study was to investigate the potential use of plant resources provided by the street trees and gardens for education. Makhanda streets were sampled and, of the 1 435 plants that were countered from 17 streets, only 15 indigenous species were represented, while 20 alien species were recorded. These trees can be used for lessons on both alien and indigenous plants. Notable differences in tree density and species richness were evident across suburbs with the highest density and richness found in the more affluent suburbs and poor representation of trees in the township. This will affect learner perceptions and viewpoints.

The results from the analysed data revealed that use of the school grounds, botanical gardens, the local herbarium and town streets are effective in plant conservation education in schools and communities. These types of resources could be used for environmental education for future generations in South Africa and all over the world.

Dedication

This thesis is dedicated to my family who offered me unconditional love and support throughout of this entire venture.

Acknowledgements

I would like to thank my supervisor, Prof. Eileen Campbell for her support, motivating intellectual guidance and advice throughout the research journey; my Selmar Schönland Herbarium colleague Tony Dold from Rhodes University Botany Department for assisting in plant identification; all Nelson Mandela University Botany Department staff and Albany Museum staff for their time whenever needed; the Makhanda schools; community members and street vendors for their participation in the research study. Finally, I would like to thank the Department of Sport, Recreation, Arts and Culture and National Research Foundation for funding this research study and conference travelling expenses.

The ethics clearance reference number is **H11-SciBot-011**.

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Abbreviations

AC-ERE	Advisory Committee for Environmental Research and Education
AMNH	American Museum of Natural History
AQD	Aquaculture Department
BODASTA	Botanical Database of Southern Africa
CAPS	Assessment Policy Statement
CARA	Conservation of Agricultural Resources Act
CBD	Convention on Biological Diversity
CBNRM	community-based natural resource management
COP	Conference of the Parties
CREW	custodians of rare and endangered wildflowers
DEAT	Department of Environmental Affairs and Tourism
DLA	Department of Land Affairs
FET	Further Education and Training
GBIF	Global Biological Information Facility
GDP	Growth and Development Plan
GET	General Education and Training
IAP	Invasive alien plants
IP	Indigenous plants
IUCN	International Union for Conservation of Nature
NAAEE	North American Association for Environmental Education
NEMBA	National Environmental Management: Biodiversity Act
NSF	National Science Foundation
PGDP	Provincial Growth and Development Plan
SANBI	South African National Biodiversity Institute
SAPIA	Southern African Plant Invaders Atlas
SCBD	Secretariat of the Convention on Biological Diversity
SENCER	Science Education for New Civic Engagements and Responsibilities
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WWF	World Wide Fund

1. General Introduction

According to Statistics South Africa (2003) the population of the Makana Municipality (City of Makhanda previously known as Grahamstown) in 2003 was 124 758 of which 77.4% were African, 11.8% Coloured, 10% White, and 0.7% Asian. The racial divide is still significant in Makhanda even though now people are free to stay in any area. They are also free to attend school in any area of their choice. In the city, the western areas are predominantly White, and the east is predominantly African. In between these two areas the communities are predominantly Coloured.

Statement of the Problem

The study was triggered by the recurring observations in schools. In the classroom of South African schools, there appears to be a lack of effective ways of teaching and learning plant conservation that is user-friendly and relevant to pupils. The consequences of this are observed in the challenges faced in conservation efforts. Even though teaching and learning of plant conservation is part of the curriculum, there remains a lack of effective plant conservation in the country. Section 2 of the National Curriculum and Assessment Policy Statement (CAPS, 2011) of the Department of Basic Education of South Africa gives educators the freedom to expand concepts and to design and organise learning experiences according to their local circumstances and availability of resources. The CAPS (2011), however, does not clearly say how it should be done. This is a challenge for some teachers who may lack the capacity to do develop such strategies. This study attempts to critically explore how this could be done. School grounds, herbaria, botanical gardens and city streets were considered as resources for promoting conservation awareness and biological teaching and learning.

Conceptual Framework for the Study

Urban area in developing countries have experienced a rapid influx of people (Pasay and Haidy, 1994). This influx can be associated with opportunities for economic growth, access to service and infra-structural development (Wilson and Mafeje, 1963), but has marked impacts on the quality of local and regional environments. Such impacts include land-use change, pollution, loss of habitat and biodiversity, population change and increasing resource demands (Wilby and Perry, 2006). The use and protection of botanical gardens, metropolitan open spaces, museums and herbaria become crucial for the fulfilling of environmental quality goals and attaining economic and socially sustainable conditions (Schopfer *et al*., 2000).

Like any botanical garden, the Makana Botanical Garden (Figure 1 and 2) is a unique public green space (SANBI, 2006). According to the information filed in the Albany Museum archives, it was founded in 1853 and was the second botanical garden to be established in the Cape Colony - the first was Kirstenbosch in Cape Town that was founded in 1849.

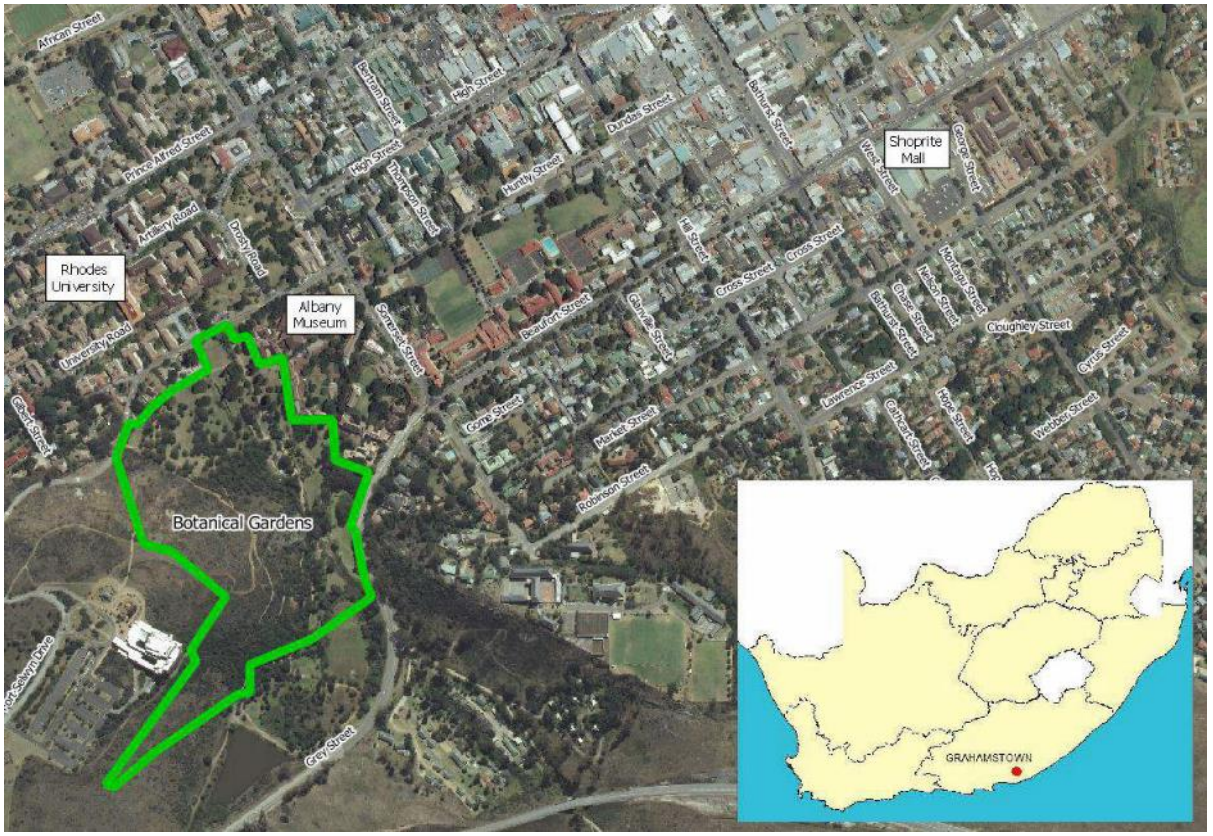

Figure 1. Map of Makhanda with the Albany Museum (that houses the Selmar Schönland Herbarium), the Botanical Gardens, and Beaufort Street where street vendors trade.

Purpose of the Study

The aim of this study was to investigate the benefits of using herbaria and botanical garden resources in biology teaching with a focus on plant conservation to generate awareness of the need to protect natural resources. Specifically, the study endeavoured to answer the following questions:

Main research question

What role can school grounds, herbaria, botanical gardens and city streets play as resources for promoting conservation awareness and biological teaching and learning?

Sub-questions

- *To what extent are school learners able to demonstrate an understanding of the*

interrelationship between these resources and their biology lessons and plant conservation practices?

- *How can awareness be extended to community members so that they will adopt effective plant conservation approaches?*

Towards achieving these aims, this thesis considers a detailed literature review covering the historical cultural valuing and conservation of plants, plant conservation laws, alien plant legislation, the role of museums, herbarium collections and botanical gardens in education and awareness of plant diversity conservation and awareness in the South African school curriculum (Chapter 2).

Chapter 3 provides an outline of the research methodology used in this study and deals with the rationale for the choices of this methodology and the design of the research. This includes the manner in which the learning activities have been planned, designed and developed. The study was undertaken in Makhanda (formerly Grahamstown) in the Eastern Cape, South Africa.

Chapter 4 describes the town and the nature of the social, biological and educational backdrop to this study. This includes information about the education institutions that were used in this research. It also focuses on the findings obtained from learners' interactions, while Chapter 5 addresses the Makana botanical garden as a tool for use in generating plant conservation awareness for visitors. Considering the unique niche of Makana botanical garden education, strategic planning for a Makana botanical garden education programme is designed.

Chapter 6 considers the use of the Selmar Schönland Herbarium for plant conservation education and awareness.

Chapter 7 reports on the perceptions of community members relative to the importance of plant conservation.

Chapter 8 considers the plant diversity, density, abundance and distribution in the Makhanda streets because these plants may also be an important resource for plant conservation as well as environmental education in the Makhanda area.

Chapter 9 Provides a concluding summary and gives recommendations for the establishment of nurseries, community gardens, home gardens and school gardens as can approach to local biodiversity conservation and education.

2. Literature Review

Introduction

In this chapter, literature is reviewed with the aim of describing, summarizing, evaluating, and integrating the content of the available knowledge on the topics addressed in this study. The topics were plant conservation, demarcation laws, alien plants, the law, and the role of botanical gardens, museums and herbarium collections in education. Particular attention is given to the relevance of the education to the community's needs. Further, an investigation into the manner in which schools can effectively make use of these resources as tools of learning and teaching is considered. Consideration is given to the historical background on the use of plants and community plant conservation through cultural ways of knowing, plant conservation demarcation laws, alien plants and the law, the role of museum and herbarium collections, the role of botanical gardens, the role of people in plant diversity conservation and awareness, the role of education in plant diversity conservation and plant conservation in the school curriculum.

2.1 Biodiversity conservation

The conservation of biodiversity uses stewardship agreements that were conceived at national level by the South African National Biodiversity Institute (SANBI) but are implemented sub-nationally by provincial conservation agencies and non-governmental organisations (NGOs). Biodiversity stewardship is most prominent in the Western Cape where it was piloted as the Conservation Stewardship Programme in late 2002 by Cape Nature and the Botanical Society as part of the Cape Action Plan for People and the Environment (CAPE) strategy (Von Hase *et al.*, 2010; Ashwell *et al.*, 2006). The approach was later adopted in other provinces such as KwaZulu-Natal (Burns, 2007). The underlying objective of these Biodiversity Stewardship Programmes (BSPs) is to improve protection of critical biodiversity and threatened ecosystems occurring on private and communal land as determined by national conservation plans and spatial assessments (Rouget, 2003). This protection is to be achieved by encouraging formal conservation agreements between conservation agencies and landowners through financial (e.g. tax relief) and in-kind (extension services - habitat and land management advisory) incentives (Paterson, 2005; Van Wyk, 2010). The programme recognises various levels of participation, namely biodiversity agreements, protected environments and contract nature reserves as defined in the National Environmental Management: Protected Areas Act 57 of 2003. These different levels of participation differ in degree of legal protection status, land-use restriction (on title deeds) and minimum duration

of management tenure: 10 years for biodiversity agreements, 30 years for protected environments and 99 years for contract nature reserves (Ashwell *et al*., 2006). In other provinces (e.g. Gauteng and Eastern Cape), BSPs are more recent (post-2009) and outcomes are not readily available. As the programme has developed, more local authorities and NGOs have expressed interest in adopting the BSP model (Barendse *et al.*, 2016).

2.2 Historical background on the use of plants and community plant conservation cultural ways of knowing

People have always used plants for food, shelter and medicines (Veilleux and King, 2002). Local plant species of the Eastern Cape are used to supplement food resources, for firewood, and for construction (Shackleton *et al*., 2001). However, people also use plants for cultural activities and these uses are not included in text books used in schools (Balick and Cox 1996) even though they are import for people's livelihoods (Cocks and Wiersum, 2003). However, reliance on natural resources can lead to degradation of resources as has already been observed in other parts of the Eastern Cape (Kakembo, 2001).

It is therefore important to expand on concepts and to design and organise learning experiences for pupils according to their local circumstances and availability of resources (PGDP, 2004). This includes implementing programmes that enable community members and young people in particular, to recapture their cultural knowledge and revive their indigenous self-image so that they can take leadership in plant conservation. Learners in the Eastern Cape need to be responsible, engaged and participate in programmes that seek to sustain the environment, because Eastern Cape contributes only 7% to South Africa's GDP despite making up approximately 13.5% of its population (PGDP, 2004).

2.3 Plant conservation and demarcation laws

Grahamstown (now Makhanda) was demarcated at the expense of the local people who were living on the land just like most of the areas in South Africa (Wynberg and Kepe, 1999). This means that demarcation boards did not consult local people. As a result, there has been the inevitable conflict between resource utilisation and conservation (Grundy and Wynberg, 2001). According to DEAT (2000), high densities of poor people were forced to rely heavily on natural resources for survival after the demarcation process. Development in the Makhanda area has challenges associated with provision of social services as observed by Steyn (2003) in most large cities in South Africa. Due to development, including farming,

about 51% of the Albany Thicket has been transformed to other land uses (Low and Rebelo, 1996). Grundy and Wynberg (2001) blame the legacy of apartheid for the lack of effective conservation, because it left most government departments poorly managed, resource deprived (both human and financial) and with a lack of adequate staff training. In addition, natural areas on state land that fall under communal management have tended to become degraded due to the breakdown of the traditional management systems with no effective alternatives in place (Grundy and Wynberg, 2001).

2.4 Alien plants and control laws

The Southern African Plant Invaders Atlas (SAPIA) has provided the raw data for analyses that has been used to prioritize invasive alien species for management (Robertson *et al*., 2003; Nel *et al*. 2004), to map the potential spread of invasive plants (Rouget *et al*., 2004), to describe broad-scale distribution patterns of invasive species (Richardson *et al*., 2004), to correlate patterns of alien plant species richness with the environment and indigenous species richness (Richardson *et al*., 2005), to correlate patterns of invasion with interactions between environments, species traits and human uses (Thuiller *et al*., 2006) and to look at potential ranges and residence time of alien plants (Wilson *et al*., 2007). SAPIA has also played a crucial role in providing information on invasive plants for the revision of the Conservation of Agricultural Resources Act (CARA; Act 43 of 1983), and the drafting of the National Environmental Management: Biodiversity Act (Act 10 of 2004) with its regulations aimed at controlling the spread of alien plants.

After identifying alien plants, they can be classified according to their threat level (Robertson *et al.,* 2003). Category 1 alien species (Act 43 of 1983) are weeds of economic importance and they should be controlled as a matter of urgency. According to Palmer (2004), the Makana Municipality contains over 90% of the serious problem plants listed by Robertson *et al.,* (2003). One of these species is the prickly pear, *Opuntia ficus-indica*. Its invasive status is Category 1 and according to currently active legislation on weeds and invasive plants in South Africa (Conservation of Agricultural Resources Act, 1983 No 43 of 1983) this is one of the prohibited plants that will no longer be tolerated anywhere, neither in rural nor urban areas, except with the written permission of an executive officer or in an approved biocontrol reserve. These plants may no longer be planted or propagated, and all trade in their seeds, cuttings or other propagative material is prohibited. They may not be transported or be allowed to disperse. This high level of control is required because the species competes with

and replaces indigenous species (Zimmermann *et al.,* 2004; Barbera *et al.*, 1995; Novoa *et al*., 2016). Dense infestations reduce the grazing potential of the land and restrict access by domestic and wild animals. The spiny cladodes can cause injuries to animals and during the fruiting season the minute spines (glochids) on the fruits can be highly irritating and can result in animals being unable to feed. Dense infestations can cause drastic devaluation of agricultural and conservation land.

On the other hand, Nattrass (2012), argues that prickly pear fruit plays an important role in the lives of many South African women in shacks, towns and farms around the country. It is known as *turksvy* to the Afrikaners who used it as fruit, food, made jam, syrup and *witblits* spirit from it. It is known as *itolofiya* to the Xhosa people who also used it as fruit, food and brew beer from it. This makes prickly pear an iconic symbol of the Eastern Cape. Although declared a weed, people continue to sell it as fruit or to brew into beer. An appreciative portrait of the role of prickly pear in African life, pointing out how rural 'betterment' programmes separated people from the prickly pear fences they had planted and harvested and how contemporary concerns about stock theft and security are further constricting their access to wild prickly pear on commercial farms has also been provided by Beinart and Wotshela (2011).

Some of the alien plants such as *Bidens pilosa, Chenopodium album, Amaranthus hybridus, Sonchus oleraceus, Solanum nigrum* and *Urtica urens* are used as food (Cimi, 2009). These are well known by learners and community members who find it difficult to believe that they are alien. Shava (2000) call them naturalised exotic plants occurring in the 'natural' environment.

2.5 The role of museums and herbarium collections in education and awareness

Gabriel Casal (pers. comm.) defines a museum as the primary repository and custodian of cultural treasures and biological collections, a research institution and a showcase for the entertainment and education of the public (Patemo, 1995). A herbarium is a collection of preserved plants stored, catalogued and arranged systematically for study by both taxonomists, botanists and amateurs (Bridson and Foreman 1998). Publicly funded museums and herbaria were established in South Africa over 100 years ago to house regional or national biological collections and those who maintain or study them (Briggs, 1991; Allmon, 2004).

Taxonomy and systematics provide the basis for much biological research (Simpson, 1961; Mayr, 1968). Taxonomy and systematics enable other biological research to be compared and integrated (Winker, 2004). The addition of an evolutionary framework has added an understanding of the origins of the biological patterns as observed as well as how these patterns change through time (Ehrlich and Raven, 1964; Mayr, 1968; Danks, 1988). About 25 years ago the estimated number of world species was put at between 3 and 5 million (Raven, 1983). In 1988, this estimated number was revised upwards to 30 to 50 million (May, 1988), but more recent estimates have been somewhat lower at about 10 to 15 million plants (Hammond, 1992; Stork, 1999). As the total number of described species has increased less dramatically over the same period the estimated number of undescribed species has generally increased (May, 1988; Stork, 1999).

The use of biological collections has been and continues to be greatly facilitated by the introduction and development of computer technology and the establishment and linking of computerized databases (Morin and Gomon, 1993; Soberon, 1999; Winker, 1999; Edwards *et al.*, 2000; Graves, 2000; Graham *et al.*, 2004). This is now happening on a global scale through programmes such as the Global Biological Information Facility (GBIF; Edwards, 2004).

The information available in the Selmar Schönland Herbarium collection is similar to that described by Graham and Ehrlich (2010). The extent to which the Selmar Schönland Herbarium collection can provide information of a geographic nature depends upon the distribution and intensity of collecting effort across landscapes, which unfortunately is often limited (Illoldi-Rangel *et al.*, 2004; Van Gemerden *et al.*, 2005). For the most part, collections are made in a haphazard and opportunistic manner, largely dependent on the particular interests of the collector (Rautenbach, 1979; Soule, 1990; Ponder *et al.*, 2001; Schmidt *et al.*, 2005).

According to Graham and Ehrlich (2010) the simplest method to determine the identities and numbers of species in each area is been to calculate which recorded locations (combining all accurate specimen and non-specimen records) lie within each sixteenth degree square and to tally the species (Prendergast *et al.*, 1993a; Fisher and Shaffer, 1996; Kress *et al.*, 1998; O'Hara and Poore, 2000; Soberon *et al.*, 2000). When this has been done, however, the resulting map generally resembles a map of human habitation and connecting roads, reflecting once again the tendency for collecting and observations to occur near centres of human activity (Soberon *et al.*, 2000). South African herbarium collections have mostly been

focused near centres of human activity and along the roads that join them, with many areas that are under-sampled, substantial regions that have not have been sampled at all, and with the numbers of recorded locations being low (Kress *et al*., 1998; MacDougall *et al*., 1998; Soberon *et al.*, 2000; Steege *et al.*, 2000; Parnell *et al*., 2003; Kadmon *et al.*, 2004). Soberon (1999) and Krishtalka and Humphrey (2000) suggested the use of information that is available in collections from different institutions in order to reduce this problem. The use of collections is often restricted by the absence of sufficient information associated with each specimen because most of the specimen labels do not include records of the habitats of the plant at the time it was collected (Hromada *et al.*, 2003). This makes it difficult to compile detailed information about collections. For example, it is not known which other specimens were collected in the same location at the same time. Such gaps limit the extent to which collections can yield information about species abundance, absence or patterns of species co- occurrence.

Graham and Ehrlich (2010) argue that in some cases, a person collecting a specimen may have recorded additional associated information or taken associated photographs, but these activities have generally been carried out as part of the person's research interests, and the information collected tends to remain in field records or personal photographic collections and not become generally available. It may be that access to a portable global positioning system (GPS) was not available during the time of collection and it was not possible to georeference or geocode (Theodorakis *et al*., 1997; Peterson *et al*., 2000; Soberon *et al*., 2000; Illoldi-Rangel *et al*., 2004; Chapman and Wieczorek, 2006).

Plant specimens with no detailed descriptions like those mentioned above are very difficult to use to estimate relative or absolute abundance of populations of species (Bickel, 1999; Baldwin *et al*., 2004). It is also not possible to relate the numbers collected to the nature or extent of habitat due to lack of information about the collection locations (Hansen and Richardson, 1999).

According to Graham and Ehrlich (2010), museum collections have also been used, often in combination with other non-specimen records, to understand and interpolate distributions of species. The assumption is that the ecological 'niche' of a species, and hence whether or not a species can occur at a particular location, is a function of both biotic and non-biotic parameters for this location, and mathematical or statistical methods can be used to determine these functional relationships (Godown and Peterson, 2000; Peterson and Vieglais, 2001; Anderson and Martinez-Meyer, 2004; Illoldi-Rangel *et al*., 2004; Rovito *et al*., 2004;

Vargas *et al*., 2004).

Herbarium collections provide information about species presence/absence rather than population sizes, and therefore they are more likely to be relevant in the context of past species distributions than informative about population sizes (Allen *et al*., 2001). If collection locations are known or can be determined with reasonable accuracy, changes in species distribution can be determined by revisiting and surveying sites or areas where a species was previously collected (Fellers and Drost, 1993; Drost and Fellers, 1996; Fisher and Shaffer, 1996).

The custodians of rare and endangered wildflowers (CREW) programme operates in the Eastern Cape, and in particular in the Albany region (Raimondo and Zikishe, 2014). This is widely known as *Groen Sebenza* coordinated by the South African National Biodiversity Institute (SANBI). This team of well-trained para-ecologists collect plants and take them to herbaria for identification. These newly collected plant specimens contribute to keeping information about changes in plant species distribution up to date. CREW is a programme that involves volunteers from the public in the monitoring and conservation of South Africa's threatened plants (Raimondo and Zikishe, 2014).

The Albany Thicket biome contains high levels of endemism and is recognised as a Centre of Plant Diversity (WWF and IUCN, 1994). The relationship between the number of species and the area sampled is, for example, one of the oldest and best-documented patterns in community ecology (Chiappy-Jhones *et al.*, 2001). The value of an area for conservation may be higher if it is a 'hotspot' for biodiversity, containing a relatively large number of species, or if it contains threatened species (Myers, 1988, 1990; Prendergast *et al*., 1993a,b; Reid, 1998; Krupnick and Kress, 2003).

Goehring *et al*. (2007) are of the view that preferential collecting of rarely encountered plants may make it difficult to distinguish whether a species is growing far away from its usual range or whether it is rare. Failure to collect common species may result in artefactual gaps in their known distribution. Systematic biological surveys are usually carried out to determine or predict which species occur in a given area, describe the nature and extent of habitat variation within this area – including patterns of habitat use (Haila and Margules, 1996; Fuller *et al*., 1998; Kingsford, 1999; Willis *et al.*, 2003).

Using collection records and new collections and surveys it is possible to record the disappearance of some species from some areas or contractions in the range for these species

(Drost and Fellers, 1996; Fisher and Shaffer, 1996; Turner *et al*., 1996; Catling and Larson 1997; Chaudhary and Rao 1998; Joye *et al.*, 2002; Lienert *et al.*, 2002). It has similarly been possible to record increases in the distribution of some indigenous species (Laughlin, 2003) and the spread of alien species following introduction (Johnston and Selander, 1964; Selander and Johnston, 1967; Fraile *et al*., 1997).

Some plant species are in demand by the community for ritual, cultural, medicinal and food activities. The suitability of locations for such species can be predicted and their overall distribution (Peterson *et al*., 2000; Anderson *et al*., 2002; Anderson, 2003; Anderson and Martinez-Meyer, 2004). Such predictions of likely or potential distributions for wild or alien species before they are introduced may help with evaluation of the environmental risk they pose (Sanchez-Cordero and Martinez-Meyer, 2000; Peterson and Vieglais, 2001; Arriaga *et al*., 2004; Iguchi *et al*., 2004). The likelihood that a species will occur in a particular location may depend on past history regarding its distribution or its likely ability to disperse from other locations where it occurs (Jiménez-Valverde *et al.*, 2008). Graham and Ehrlich (2010) argue that the studies of this sort have generally focused on abiotic variables such as latitude, elevation, aspect, soil and climate, that provide relatively crude measures of habitat, and omitted biotic variables such as the known or potential presence of other species of animal (e.g. herbivores, predators, competitors) or plant (e.g. parasites, food plants for herbivorous animal species) (Morin and Gomon, 1993; Ford *et al.*, 2002). Hence, they probably overestimate the suitability of each location for species occurrence and hence the distribution of suitable locations. Because of this, many authors consider that the models produce descriptions of the 'potential' or 'fundamental' niche and distribution of a species, rather than its 'realized' niche and distribution (Anderson *et al*., 2002; Anderson, 2003; Illoldi-Rangel *et al*., 2004; Soberon and Peterson, 2005; Jiménez-Valverde *et al*., 2008).

Biological collections permit detailed examination of individual species (Ricklefs, 1980). Large numbers of specimens available from a wide range of geographic locations allows for exploration of possible relationships among the attributes of individuals and between these attributes and other factors (Ricklefs, 1980). It may also be easier to access reasonably large numbers of specimens already located in biological collections than to examine fresh material (Ricklefs, 1980). Biological collections may, furthermore, be the only source of historical information about individual attributes (Ponder, 1999).

Biological collections have provided information in relation to a number of other reproductive traits such as fruit size, seed size, and number of seeds per fruit (Carpenter *et al*.,

2003) as well as growth (Carlson, 1998), the study of the relationship of body size to shape, anatomy, physiology and finally behaviour (Christian and Garland, 1996; Emerson, 1997; Fitch, 2000; Christiansen, 2002), patterns of variation in external morphology within and between individuals (Ehrlich, 1961; Soule, 1967; Lens *et al*., 1999; Lens *et al*., 2002), and patterns of geographic variation in various attributes (Norman *et al*., 2002).

According to Graham and Ehrlich (2010) historic and geographic variation in average morphological traits and in the prevalence of morphological abnormalities within populations has been detected through examination of collections of specimens. For example, the average size of collected individuals of American Ginseng (*Panax quinquefolius* L.) a plant that is harvested from the wild, has declined since about 200 years ago when harvesting began (McGraw, 2001). Biological collections provide a large resource in terms of information about spatial and temporal patterns of morphology and may enable evolutionary changes to be detected (Tornberg *et al*., 1999; Green and Scharlemann, 2003; May and Ristaino, 2004). For example, based on examination of collected specimens, geographical patterns have been described (Barnett, 1977).

Evolutionary changes have been detected by comparing individuals collected recently (Tornberg *et al*., 1999) with those collected over 100 years ago (Smith *et al*., 1995) as well as comparing recently collected and fossil specimens (Hellberg *et al*., 2001). Seasonal changes in morphology have also been described in a few cases (Yaskin and Emel'chenko, 2003). Information in relation to the incidence and nature of diseased individuals, and how this has varied spatially and temporally, has also been obtained from collections. For example, the proportion of individuals carrying a particular fungal disease amongst a collection of two plant species, *Silene virginica* and *S. columbiana*, was found to have increased significantly over the past century and shown to be higher in marginal populations (Antonovics *et al*., 2003). Such incidence of disease could be an indication of environmental stress at the time.

Collections have also provided information about the identity and abundance of symbiotic organisms, and how this has varied over space and time, sometimes providing further indication of pollution or other environmental stress. In apparent response to air pollution, for example, species of lichens and their abundances on tree specimens from Slovenia varied spatially and temporally (Batic and Mayrhofer, 1996). Similarly, the diatom communities on herbarium macrophytes have been found to reflect water quality (Van Dam and Mertens, 1993). It has also been suggested that a decline in the occurrence of cyanolichens on conifer branches in Europe has resulted from a relatively large increase in acid precipitation there

(Goward and Arsenault, 2000).

Collections of plants have also enabled detection of human-induced changes in the composition of the earth's atmosphere through chemical analysis of plant specimens (Beerling *et al.*, 1993; Baddeley *et al*., 1994; Pedicino *et al*., 2002). It has been possible, for example, to follow spatial and/or temporal changes in atmospheric concentration of carbon dioxide and nitrogen as linked with variation in stomatal density in the leaves of plant specimens (Beerling and Chaloner, 1993).

Graham and Ehrlich (2010) blamed the manner in which collections have generally been assembled, as the reason for less successful attempts to extract useful information concerning species distributions from biological collections. Bagarinao (1995) reported a problem that Natural History museums are not numerous and mostly run by universities for teaching and research. However, the Aquaculture Department (AQD) Museum and Biodiversity Garden aim to be an interesting and educational exhibit for the public, particularly school children, and a laboratory for undergraduate and graduate students in natural history (Motoh, 1980; Bagarinao and Taki, 1986). According to Bagarinao (1998) botanical gardens are museums without walls whose mission is the cultivation and study of the diversity of plants. The accessibility of plants under cultivation presents research opportunities not possible with remote and dispersed wild populations as well as opportunities for increasing public awareness. Conservation is also a major activity of botanical gardens, arboretums, seed banks, forestry institutes, and agricultural research centres (UNEP, 1991). Botanical gardens are a resource for non-formal environmental education and integration of environmental issues (Padgham, 1995). More research is to be done on flora and fauna to produce scientific reports and popular materials for scientists, teachers, tourists, and children (Heire, 1935). The severity of environmental problems will not decrease unless action is taken to develop and encourage more environmentally responsible behaviour (Price *et al*., 2009).

Institutions such as museums and botanical gardens devoted to public science education can offer an encounter with nature that is both vivid and authentic as well as deliver a cultural impact (Novacek, 2001). It is their responsibility to provide lifelong exposure to science. Natural history and science museums have high credibility ratings and their importance as venues for communicating science is in the feeling of trust they invoke in the public (Lake and Associates, 2001). However, there is also evidence that such institutions have not fully capitalized on their reputation (Novacek, 2008). Museums and botanical gardens do not always address plant conservation education in a way appropriate for local children and the

community. Aggravating this problem is the uneven commitment to scholarly activity in many such institutions (Novacek, 1991). However, there are parts of South Africa such as Harold Porter, Kirstenbosch, Karoo Desert, Kwazulu-Natal, Lowveld and Pretoria with Biodiversity Education Programme which are focused on learners, the youth and community groups (Biodiversity Education Overview, 2018).

Botanical gardens have important collections of plant diversity (Heywood, 1990; Maunder, 1994; Marris, 2006). The species richness per unit area of botanical gardens is much higher than that of their surroundings (Heyd, 2006). They may well play a key role in facilitating the migration of plant species made necessary by future global change (Pearson, 2006). But in the 21st century, given that botanical gardens are essential tools for the conservation of plant biodiversity, there is also a need for propagation of plants of the hotspots of biodiversity (Holdgate, 1993; Crawley, 1997; Miller *et al.*, 2004; Pinheiro *et al.*, 2006).

Botanical gardens are of more worth than just the species they house – given their conservation, research and educational activities (Hyams and MacQuitty, 1969; Ashton, 1988; Soderstrom, 2001; Maunder *et al*., 2004; Dosmann, 2006; Havens *et al*., 2006). Many botanical gardens are also major public and tourist attractions. They provide inspiration and relaxation to visitors from their surrounding regions and, for the largest and most famous gardens, from all over the world (Garrod *et al.*, 1993; Kohleppel *et al*., 2002; Lindemann-Matthies and Bose, 2007). The value of botanical gardens with the scientists and conservationists who work there or use their facilities, is greater than the sum of the individual parts as they benefit from a more coordinated management of their collections data (Dosmann, 2006; Pereira and Cooper, 2006; Tankersley, 2006).

2.6 The role of botanic institutions and their researchers in plant biodiversity conservation

While species extinctions are a natural evolutionary phenomenon, in recent times, 99% of the extinctions are attributable to human activities (Primack and Rodrigues, 2001). When people become aware of the causes of extinctions, a higher level of involvement with environmental themes becomes possible. Extinction is considered the biggest threat for biodiversity and conservation and is correlated with the increase in human populations (Primack and Rodrigues, 2001). The public must realise how extinction is the result of the destructive action of the human species.

There is deep concern that the loss of biodiversity and deteriorating ecosystem services

contribute to worsening human health, higher food insecurity, increasing vulnerability of ecosystems to natural disasters, lower material wealth, worsening social relations by damage to ecosystems highly valued for their aesthetic, recreational, or spiritual values, and less freedom for individuals to control what happens and to achieve what they value (MEA, 2005). The willingness of people to confront the loss of biodiversity depends on the monetary value (e.g. source of medicines, ecotourism) and non-market values (e.g. ethical, aesthetic) they attach to biodiversity (Hooper *et al*., 2005). Biodiversity is regarded as a normative conservation concept that is linked to the idea of biological variation and its ecological, economic, ethical, spiritual and cultural values (Callicott *et al*., 1999).

Herbarium collections are important for biodiversity studies (Winker, 1996; Kress *et al*., 2001). Historical collections have great importance for understanding present and former diversity at the population and species level and for clarifying nomenclature problems (Voss and Angermann, 1997). There is a need to make the role of herbarium collections more useful to the general public (Melber and Abraham, 2002). Especially now that there is rapid decline of plant diversity due to human activities such as harvesting, habitat destruction and modification, pollution, overexploitation and the introduction of exotic species (Trombulak *et al*., 2004; Hooper *et al*., 2005).

Economic instability of the country is also a contributing factor to the loss of biodiversity (Malhi 2008). Africa, with a significantly smaller amount of forest cover, lost an amount of forest comparable to that lost from South America over the same time period (Mygatt, 2006). Scientists continually amend the database for both species diversity and loss, thereby providing a clear picture of the scientific realities of the biodiversity crisis. Given the urgent and serious nature of biodiversity degradation, scientists must be involved in public interest, commitment, and engagement. South Africa needs to adopt an approach where scientific information is communicated to the public through the media (National Science Board, 2004). Use of web sites provides effective status reports on species and habitats at risk and steps taken toward remediation (Wilson, 2003).

2.7 The role of education in plant diversity conservation

The world is facing a biodiversity crisis (Wilson, 2003). Education is the primary function for its conservation (Rabb, 1994). Even two decades after the first use of the term biodiversity (Wilson and Peter, 1988), now used to define biological variation at the genetic,

species, and ecosystem levels (Hooper *et al*., 2005), and more than a decade after the Convention on Biodiversity came into force, public knowledge regarding biodiversity remains limited. From an educational point of view, however, biodiversity is a rather ill-defined abstract and complex construct (Van Weelie and Wals, 2002) that should be transformed into small components to enhance learning and understanding, especially in the context of high schools. The most common concept used by conservation groups are species (Van Weelie and Wals, 2002).

Environmental education is aimed at developing a world population that is aware of, and concerned about the environment and its associated problems, and which has the knowledge, skills, attitudes, motivation and commitment to work individually and collectively towards solving current problems or prevention of new ones (UNESCO, 1975). Related to environmental education is the concept of worldview. 'The expression environmental worldview is typically used to describe beliefs, values, and concepts that collectively make up the individual's perception of the environment and humankind's relation to it' (Disinger and Tomsen, 1995).

There is a wide gap in people's knowledge of biodiversity. The taxonomic records of world fauna and flora represent a small share of the species that may exist - estimated at 10 million (WRI-IUCN-UNEP, 1992). Programmes for biodiversity education, as part of the broader operating system of environmental education, should be based on a number of points that should form common ground for all involved in the processes of planning and implementing the programmes (Wals, 1999).

Prior to the 1980s, industry seemed to regard environmental issues as a peripheral nuisance, but during recent decades the process of 'greening the corporate boardrooms' is spreading (Tolba *et al.*, 1992). Institutions like herbaria, botanical gardens, and museums could provide a valuable means of delivery of in-school basic environmental knowledge (ecology, natural resources, population dynamics, and problems of habitat degradation). Botanical gardens could also provide an opportunity for out-of-school activities, involvement in community activity, and problem-solving projects (Lucas, 1980). The use of biodiversity and measures to conserve it can be discussed in many (some controversial) ways, which makes it a challenge for both conservation and education (Gayford, 2000; Trombulak *et al*., 2004).

It could be argued that biodiversity education 'is about nature' and therefore already well covered because, for many years, educators have been creating opportunities for people to

understand and experience a variety of plants and animals and their habitats (McLeish, 1997). Experiences in nature and an understanding of ecological relationships were seen as a direct pathway to achieve environmental awareness and, in turn, result in actions to solve the world problems (Breiting *et al*., 1996; Lundegård and Wickman, 2007). However, there is little evidence for such a linear process, and biodiversity education is now rather approached through concepts related to sustainable development, which implies a process-oriented, participatory and action-oriented learning approach (Tilbury and Calvo, 2005; Stevenson, 2006). As a normative conservation concept, biodiversity is highly suitable for education on sustainable development as it reflects the interaction of ecological, economic and social issues particularly well (Dreyfus *et al*., 1999; Menzel and Bögeholz, 2008) and requires the learner to consider different perspectives to arrive at balanced opinions (Gayford, 2000).

Biodiversity education requires a novel teaching and learning approach because within the framework of education for sustainable development it requires the construction and critical use of knowledge, the critical analysis of the role of natural science, an awareness of scientific and non-scientific aspects (i.e. the benefits and values attached to biodiversity and its conservation), and appropriate pedagogical settings for in-depth discussion and reflection (Gayford 2000; Kyburz-Graber *et al*., 2006). According to the aims formulated by the Council for Environmental Education of England (McLeish, 1997), biodiversity education should enable people to:

- *Understand what biodiversity means.*
- *Appreciate the dynamic aspects of biodiversity and understand that species, habitats and ecosystems change naturally over time.*
- *Become more aware of biodiversity as part of their cultural and spiritual wellbeing, as well as economic heritage.*
- *Be more aware of, informed about, and understand the significance of biodiversity in their own environment and be able to define their own level of interaction with it.*
- *Recognise the relationship between biodiversity and the maintenance and quality of life.*
- *Know what factors influence biodiversity and understand that human activity can both damage and enhance biodiversity.*
- *Be aware of the impact of their own and other people's actions (including lifestyle and consumer choices) on biodiversity.*
- *Improve their skills in relation to biodiversity, including those skills that enhance*

understanding and promote appropriate action.

- *Be aware of what actions they can take to preserve and enhance biodiversity, and act on that awareness.*
- *Recognize that our ideas and understanding of biodiversity might also change over time.*

CAPS (2011) promotes biodiversity education in school as it offers possibilities to learn about the different meanings, interpretations and uses of biodiversity, to observe and monitor biodiversity, to critically investigate its conceptual use in environmental and political discourse, and to discuss the normal or correct way of biodiversity as advocated by Van Weelie and Wals (2002). Mayer (1992) and Barker and Slingsby (1998) suggested that in primary school, biodiversity education should include a wide range of exploratory learning activities and methods for outdoor nature education. Such an approach was observed to be appreciated by both pupils and their teachers (Lindemann-Matthies, 2006; Berkowitz and Hogan, 2004).

Pre-service teacher education has been regarded as particularly important for the spreading and implementation of innovations such as environmental education (Käpylä and Wahlström, 2000; Powers, 2004; Van Petegem *et al.*, 2005). Every teacher will educate a large number of students, who will become part of the educational community and eventually educate a large number of children and share ideas with teacher colleagues. It is thus essential to ensure the quality of the teacher preparation system, because it will ultimately contribute to the formation of future citizens (Barker and Elliot, 2000). Moreover, students in teacher education were found to be more flexible than their more experienced colleagues, with extensive effort being required to shift experienced teachers to innovative practices (Davis, 2003). Research studies have shown that pre-service teacher education programmes do not place sufficient emphasis on environmental education (Kyburz-Graber and Robottom, 1999; Plevyak *et al.*, 2001; Powers, 2004; Van Petegem *et al*., 2005).

The implementation of biodiversity and plant conservation education (including teacher education institutions) depends on a number of factors external and internal to school operation (Kadji-Beltran, 2002). According to Lindemann-Matthies *et al.* (2009) external factors, which can either facilitate or impede the implementation, are policy and curriculum settings as well as school inspections. Internal factors are characteristics of the staff, both in teacher education institutions and in schools, characteristics of the parents, in the community and in the school environment. Even if biodiversity is included more extensively in school

curricula due to policy agreements (UNESCO 2005; UNEP/CBD/COP/8/14 2006), its implementation in teacher education is still a challenging task. Teacher education institutions are required by state legislature and state boards of education to include numerous courses in general and professional education, which might leave little room for focusing on biodiversity (Powers, 2004). Novel teaching/learning approaches such as biodiversity education cannot be outlined as purely rational, cognitive operations. They need engagement from credible leaders within the institutions to support the innovation from within and to set up realistic goals (Van Petegem *et al.*, 2005). Head teachers, for instance, but also department heads were found to have a major controlling effect on how a curriculum is implemented, and as a result can play a leading role in educational reform (Fullan, 2002; Powers, 2004). Their attitudes can determine how much emphasis is placed on biodiversity education within their school's or institution's curriculum. The integration of biodiversity into pre-service teacher education also depends on the teacher educator's own understanding of the concept of biodiversity, their attitudes towards biodiversity and its preservation, and their ability to connect biodiversity education with the mainstream curriculum (Gayford, 2002). In recent decades, academic biology and, in consequence, school biology has become increasingly dominated by physiology, molecular biology and genetics (Hershey, 1996; Greene, 2004). Therefore, many student teachers today have a strong background in these topics but relatively little experience of fieldwork, ecology, whole organism biology and biodiversity (Barker *et al*., 2002a). Unfortunately, the lack of adequate background information or training is a major reason for the lack of sufficient provision of innovations such as environmental education in schools (Fullan, 1991; Lane *et al*., 1995; Lieber *et al*., 2000).

According to Lindemann-Matthies *et al.* (2009), those who enter the teaching profession might not have a strong learning towards the sciences especially in the lower school grades. Kola (2013) also noticed that there are many challenges faced in the teaching and learning of science subjects in South African schools. By contrast, experienced teachers, who act as mentors and thus shape the professional development of students, are also likely not to be science specialists (Powers, 2004). In consequence, student teachers might not be receptive to topics of plant conservation, and school teachers might not want to teach it at all as long as plant conservation is perceived as something related to science education (Gayford, 2000; Brewer, 2002). A teacher's lack of confidence towards science was found to be a major factor in the avoidance of teaching science at school especially in the lower grades (Howitt, 2007).

It is not only the direct physical contact with the natural world but also social connections with the local environment that should be part of plant conservation education (Dawe *et al.*, 2005; Gayford, 2000). For the promotion of emotional connections with nature, value formation, and the development of an environmental ethic, plant conservation education should also encourage students to become familiar with plant species or ecosystems (Novacek, 2008; Saunders, 2003). This might not be necessary in all parts of the world, as people's experiences with the natural world and their environmental literacy may vary strongly within and among cultures (Cole, 2007). In more urbanized areas children's outdoor experiences with nature are decreasing (Louv, 2006; Malone and Tranter, 2003; Prezza *et al.*, 2005; Thomas and Thompson, 2004). Important factors that limit children's outdoor experiences are parental perceptions of social and traffic danger (Prezza *et al.*, 2005; Robertson, 2006; Valentine and McKendrick, 1997), and the actual loss of 'wild' habitats that children would enjoy for outdoor play and nature investigation activities (Louv, 2006). Aitken (2001) and McKendrick *et al.* (2000) blame use of video games and television for keeping children inside. This contributes to a reduction in children's independent outdoor experiences.

The introduction of activities that promote the living world and develop sensitivity to care for organisms and their habitats can be developed (Barker and Slingsby, 1998; Barker *et al.*, 2002b; Kassas, 2002). Students in primary schools are an important target group, as frequent outdoor experiences and contact with nature during childhood may be essential for a later connection with, and care for the environment (Bögeholz, 2006; Chawla, 1998; Meinhold and Malkus, 2005; Palmberg and Kuru, 2000; Ward Thompson *et al.*, 2004). According to Louv (2006) as long as teachers do not realise the necessity for, or do not feel confident to implement outdoor nature activities in school, children will continue to have few opportunities for such experiences. Bandura (1986, 1997) and Schunk (1985) explain people's behaviour as something that can often be better predicted by their beliefs about their capabilities than by what they are actually capable of accomplishing. Bandura (1986) refers to this as perceived self-efficacy, which is defined as 'people's judgements of their capabilities to organise and execute courses of actions required to attain designed types of performance'.

According to Gist (1987) self-efficacy arises from the gradual acquisition of complex cognitive, social, linguistic, and/or physical skills through experience, and is task-specific. Self-efficacy beliefs are strong predictors of related performance that means that the

confidence people bring to a specific task plays a strong role in their success at completing or failure to complete a task (Pajares and Johnson, 1994). Bandura (1997) differentiates self-efficacy from the colloquial term 'confidence' – he defines confidence as a non-descript term that refers to strength of belief but does not necessarily specify what the belief is. However, in the context of this study, the term confidence could refer to the confidence of teachers to perform specific tasks and is thus can be used more in the sense of self-efficacy than in it colloquial (Bandura, 1997) meaning.

According to Bandura (1994) a strong sense of efficacy enhances human accomplishment and personal wellbeing in many ways. As a result, people with high assurance in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided. They set themselves challenging goals and maintain strong commitment to them. They heighten and sustain their efforts in the face of failure. They quickly recover their sense of efficacy after failures or setbacks, and attribute failure to insufficient effort or deficient knowledge and skills that may be acquirable. As efficacious people believe in their own capabilities, persist on tasks, take risks, and use innovations (Moseley *et al.*, 2002), they achieve the profile of teachers who will more likely engage their students in biodiversity education under the framework of education for sustainable development. The confidence people bring to a specific task strongly contributes to an individual's perceived competence, which is 'the perception a person has concerning his or her abilities' (Losier and Vallerand, 1994). This, in turn, is an important determinant of a person's intrinsic motivation and actual competence to carry out a task (Bandura and Schunk, 1981; Losier and Vallerand, 1994; Pajares, 1996). People who are confident that they have the ability to perform a certain task will be more likely to engage in it (Pintrich and Schunk, 2002).

A short distance between school and an outdoor study site saves not only money for transportation but also valuable teaching time and these are two factors that might otherwise restrict the teachers' willingness to engage in outdoor education (Keown, 1986; Lock, 1998). A short outdoor learning experience can also have a positive influence on the future environmental attitudes of children (Bogner 1998). School teachers could use schoolyards for explorations as a resource to teach about ecological principles including those of plant conservation (Simmons 1998). According to Lindemann-Matthies (2006) and Metz (2004), school children are capable of engaging in simple scientific practices and should be trained accordingly. Appleton (2003), Howitt (2007) and Powers (2004) raised concerns about teachers who might tend to avoid science-related activities in school because they do not

have a strong orientation towards science. The formation of educational partnerships with local schools in the areas where plant conservation research is done can help improve scientific literacy (Brewer, 2002). Conservation biologists need to be engaged with education and outreach (Rivas and Owen, 1999; Brewer, 2001; Brewer, 2006; Bride, 2006).

2.8 Plant conservation in school curriculum

Although issues of plant conservation are included in the South African school curriculum, the majority of schools are not equipped with either the teachers or facilities to effectively achieve the goals of the curriculum. Furthermore, analysis of the examinations done at the end of high school (National Senior Certificate) show that students fare particularly poorly in environmental studies (National Senior Certificate 2013: Diagnostic report, Department of Basic Education). Plant conservation needs to be incorporated into the school curriculum at provincial level to ensure that the curriculum is relevant to local language(s)/culture(s) and biome(s) because a blanket curriculum intervention for South Africa will miss an opportunity to engage at a local level (Cocks *et al.*, 2012). Plant conservation is part of conservation biology and the biggest impediment to bringing conservation biology to secondary schools is the issue of where to incorporate it into the curriculum. A national emphasis on testing leaves little room to add new topics to already over packed curricular mandates (Charlesworth *et al*., 1994; Barksdale-Ladd and Thomas, 2000). As a result, bringing an introductory conservation biology course to middle and high school students may not be possible. Nevertheless, applying a conservation biology perspective to ecological topics covered in science classrooms is possible, useful, and within the mandates of secondary school education.

The major themes of conservation biology centre on the importance, complexity, threats, and efforts to protect the world's biodiversity and ecological integrity (Trombulak *et al.* 2004). These themes occur in simplified forms in the Assessment Policy Statement (CAPS, 2011), specifically biodiversity, basic ecological principles (e.g. populations and ecosystems, interdependence of organisms), and environmental issues (e.g. populations resources and environments, environmental quality, and human induced hazards). Nevertheless, the interconnectedness and inherent complexity of these topics is not being taught in life science courses at the secondary level, largely because of the way environmental issues and ecological principles are studied in the context of formal classroom settings.

The South African school curriculum should include a section on control measures of invasive alien plants. Biological control of invasive plants using introduced insects and pathogens is the only sustainable, effective and inexpensive solution to the most intractable of the invasive alien plant problems (Marais *et al*., 2004). When they are successful, the damage inflicted by biological control agents causes a decline in population densities, distribution and, or, rates of spread of invasive plants, and reduces the costs of other management practices (Zimmermann *et al*., 2004).

The use of local environmental issues can engage a diverse range of students about the increasing human impact on nearly all of Earth's environmental systems (Pfirman and AC-ERE, 2003; NSF AC-ERE, 2005), nurture the development of civically engaged citizens (Hungerford *et al.,* 2003; NAAEE. 2007; SENCER, 2008), and add a new and vibrant dimension to environmental science curricula (Johnson, 2004). Taking the additional step of linking daily life to ecological processes can help students discover the hidden interconnectedness of basic ecological principles (Elder *et al.*, 1998; Thomashow, 2002; Johnson, 2004; NAAEE, 2007). For example, on a sunny day a student standing outside in an open space will feel more heat than standing under a tree. By placing this example in its ecological context, students can deepen their understanding of the consequences of not conserving plants and related ecological principles (Elder *et al*., 1998; Thomashow, 2002). This ecology disrupted approach will help students learn that no matter where they live, they are part of a system in which ecological processes and disruptions to these processes affect their daily lives.

Olson and Jackson (2009) observed that educational resources that explain environmental issues are hindered by contextual barriers in the classroom since most environmental curricular resources describe environmental issues on their own terms. Young (1998) suggests that in order to overcome these contextual barriers, existing knowledge should be reviewed, revised and applied in new contexts. Even in schools where environmental education is prioritized, the extent of access to outdoor classroom activities or experiential learning opportunities can limit the degree to which children can observe, explore, and directly experience the natural world (Hudson, 2001, Louv, 2006, Ernst, 2009). Interestingly, the same information technologies that might serve to limit contact with nature also have the potential to enhance and encourage interest and concern for the natural world (Blewitt, 2011, Pearson *et al.*, 2011).

Ahmed Djoghlaf revealed that the 2010 target set in 2002 by the 110 Heads of State during

the Johannesburg World Summit on Sustainable Development had not been met (AMNH podcast, 2010). National reports submitted by the affiliated parties to the Convention on Biological Diversity confirmed that biodiversity loss continues at an unprecedented rate (Djoghlaf, 2010). Results from the recent global survey conducted by Survey Sampling International and sponsored by Airbus on behalf of the Secretariat of the Convention on Biological Diversity, reveal the need for increasing the efforts to inform and empower future generations (Airbus, 2010). According to the Convention on Biological Diversity, effective action to address biodiversity loss relies on communication, education and awareness strategies to ensure that everyone understands the value of biodiversity and what steps they can take to protect it, including through changes in personal consumption and behaviour (SCBD, 2010).

Education has been acknowledged as an important tool to achieve sustainability as well as biodiversity protection through the transformation of human attitudes towards nature (Ehrlich and Pringle, 2008). In this sense, there are great opportunities for education to contribute by helping citizens become well-informed, critical and competent, and in consequence, able to act in favour of biodiversity (Dreyfus *et al.*, 1999). From a pedagogical point of view, it is undesirable that the goals of environmental education are one-sidedly determined by outside experts or authorities who are not an integral part of the community of learners who take centre stage in the educational process (Margadant-Van Arcken and Wals, 1998).

Environmental education in the world, has been developed with traditional attitude-behaviour models in mind where people are treated as if they need lots of information about the state of the environment (Fishbein and Ajzen, 1980). There is, however, a growing body of research that shows that these models represent an oversimplification of reality and incorrectly assume a linear correlation between knowledge, awareness and behaviour (Pelikaan, 1996; Spaargaren, 1994). Providing information simply is not enough to change people's behaviour, education should enable participants to construct, transform, critique, and emancipate their world in an existential way (Stapp *et al.*, 1996; Wals and Van der Leij, 1997). Programmes such as plant conservation have much potential if they allow more people to participate, their impacts are more thoroughly analysed, and participants are better familiarised with the environmental issues that relate to their contribution (Brossard *et al.*, 2005).

Conclusions

The purpose of this literature review was to synthesise research done on plant conservation in

school education. It is clear from this review that there is still a lot to be done in Makhanda, South Africa. This review can be used to contextualise different aspects of education on plant conservation. This is significant because many learners, teachers and community members have a challenge when approaching biodiversity because educational resources that explain environmental issues are hindered by contextual barriers in the classroom (Olson and Jackson, 2009). More research and testing are required to gain a better understanding of and improvement in plant conservation strategies.

3. Research methodology and design

In this chapter I explain the theory informing the research - the subjects and choice of sampling used. Information about three education institutions and the manner in which the learning activities were designed and developed is presented. This involved use of school grounds, the botanical garden and herbarium resources in plant conservation education lessons. The role that can be played by plant species diversity, density, abundance and distribution in the Makhanda streets to promote greening using indigenous plants instead of alien plants is considered. Public awareness about biodiversity and the environment, and their importance for sustainable development in South Africa.

During this research study community members were also interviewed. In these, I included four of six street vendors in the Beaufort Street. The four street vendors I chose were community members and the other two were not from Makhanda. These four street vendors were interviewed to find information about collection site and obtain relevance of medicinal and cultural plants they sell to the community members. This interview, however, endeavoured to capture information about which plants were displayed, what parts of the plants were used, the plant origin, its medicinal function(s) and the cost of the plant material per unit.

It was also important to know how certain plants were harvested from the wild, in order to determine whether the collection methods promote sustainable harvesting. Environmental legislation such as the Environmental Management Act, National Environmental Management: Biodiversity Act, National Environmental Management: Protected Area Act and National Forests Act were consulted with regard to harvesting medicinal plants for commercial gain. The questions asked to four street vendors were supplemented by field visits to collection sites in the Makana Botanical Garden. Table 1 gives more detailed information about participants in this study.

In this research study I have adopted a mixed methods approach with the use of a combination of qualitative and quantitative approaches (Creswell and Plano Clark, 2010). Creswell (2007) argued that mixed method research involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in many phases during the research process.

The research methodology and design were informed by the research area. According to Statistics South Africa (2003) the population of the Makana Municipality (City of Makhanda)

in 2003 was 124 758 of which 77.4% were African, 11.8% Coloured, 10% White, and 0.7% Asian. The racial divide is still significant in Makhanda even though now people are free to stay in any area. They are also free to attend a school in any area. In the city, the western areas are predominantly White, and the east is predominantly African. In between these two areas the communities are predominantly Coloured.

3.1 Research site and participants

There are 12 high schools in Makhanda and three of these were selected for this study. A school was randomly chosen from the east (Makhanda East School), central (Makhanda Middle School) and western areas (Makhanda West School) each. The different schools were established at different times and the pupil composition differs in several respects. The advantage of choosing schools from different areas of Makhanda was that I was able to obtain information from different perspectives. The main data generation techniques used in this study were questionnaires, interviews, document analysis and observation. Community members and four street vendors were also questioned using interview questionnaire (Appendix E).

3.2 Learner activities

Learner activities were chosen that are learner centred and could help to utilise learner centred resources such as school grounds, botanical garden and herbarium resources. This data collection method also aims at developing the mind and the intellect in the context of rigorous intellectual activity and community-oriented research (Emeagwali, 2003). I have used stratified sampling to choose each of the three selected schools (Lance and Hattori, 2016). Stratified sampling is a method of sampling from a population by dividing members of the population into homogeneous subgroups before sampling.

3.3 Ethical considerations

All three school principals were given consent forms with indemnity forms in advance requesting permission to conduct the research. The details of the research were explained on the forms and permission was granted and they had no problem for the use of their real names in the research publications (Appendix A).

All participants (Table 1) were informed about the objectives of the research. Confidentiality and anonymity as well as the right to withdraw were guaranteed during the study. The right to withdraw protects the autonomy of participants (Gertz 2008). Information generated during the study was taken back to participants, in particular, the school principals before any form of report writing was undertaken. They were assured that the resulting research and

publications would not be used in a way that may harm the participants.

My ethical considerations were guided by the NMMU code of ethics which are in line with what Bryman and Bell (2007) regard as ten points which represent the most important principles related to ethical considerations in a thesis:

1. Research participants should not be subjected to harm in any ways whatsoever.
2. Respect for the dignity of research participants should be prioritised.
3. Full consent should be obtained from the participants prior to the study.
4. The protection of the privacy of research participants has to be ensured.
5. Adequate level of confidentiality of the research data should be ensured.
6. Anonymity of individuals and organisations participating in the research has to be ensured.
7. Any deception or exaggeration about the aims and objectives of the research must be avoided.
8. Affiliations in any forms, sources of funding, as well as any possible conflicts of interests have to be declared.
9. Any type of communication in relation to the research should be done with honesty and transparency.
10. Any type of misleading information, as well as representation of primary data findings in a biased way must be avoided.

In order to address the ethical considerations of my research in an effective manner, I made sure that participants have the right to withdraw from the study at any stage if they wish to do so. This option for an individual to withdraw, is done to ensure that participation is voluntary (Wertheimer, 1996). The principle of informed consent required providing sufficient information and assurances about taking part to allow individuals to understand the implications of such participation and to reach a fully informed, considered and freely given decision about whether or not to do so – without any pressure or coercion (Saunders *et al*., 2012). No offensive, discriminatory, or other unacceptable language was used in the formulation of Questionnaire/Interview/Focus group questions. The three schools are referred to by using pseudonyms.

Table 1. Participants in this study.

Facilitators	Participants	Activity	Duration
Researcher and Assistant researcher	3x30 Grade 10 Learners from three high schools	Administered questionnaires and interviews to mobilise learners' prior knowledge about plant conservation	1 day per school
Researcher and Assistant researcher	3x30 Grade 10 Learners from three high schools	Learners were taken to School grounds where they collected plants specimens that were then taken to the herbarium for identification	1 day per school
Researcher and Assistant researcher	3x30 Grade 10 Learners from three high schools	Learners were taken to the botanical garden for more exposure on to plant species.	1 day per school
Researcher and Assistant researcher	3x30 Grade 10 Learners from three high schools	Introduce learners to herbarium for conservation and herbarium lessons for plant identification	1 day per school
Researcher and Assistant researcher	Street vendors from Beaufort street	Interview 4 street vendors	1 days

3.4 Mixed method approach (qualitative and quantitative)

The mixed method focuses on collecting, analysing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone (Creswell, 2007).

Quantitative data includes closed-ended information such as that collected on attitude, behaviour, or performance of students (Creswell 2006). Evaluation of the findings involved analysing scores collected to answer research questions or to test hypotheses. In contrast, qualitative data consists of open-ended information that the researcher gathers through interviews with participants. The general, open-ended questions asked during these interviews allow the participants to supply answers in their own words.

By mixing datasets, the researcher provides a better understanding of the problem than if either dataset had been used alone. It is also not enough to simply collect and analyse quantitative and qualitative data; they need to be 'mixed' in some way so that together they form a more complete picture of the problem than they do when standing alone (Creswell,

2007).

I have chosen this mixed methods research approach so as to use strengths that offset the weaknesses of both quantitative and qualitative research as observed by Jick (1979). Creswell (2007) argued that quantitative research is weak in understanding the context or setting in which people talk and the voices of participants are not directly heard. According to Moghaddam *et al.* (2003) quantitative approach detaches information from its original ecological context. Qualitative research makes up for these weaknesses (Gelo *et al.*, 2008). On the other hand, purely qualitative studies have often been regarded as methodologically weak when applied to the conduct of scientific research because it favours a smaller sample size compared to quantitative research (Gelo *et al.*, 2008; Yoshikawa *et al.*, 2008).

Greene *et al*. (1989) identified five purposes for mixing quantitative and qualitative data: triangulation (i.e., quantitative findings are compared to the qualitative results); complementarity (i.e., results from one analysis type [e.g., qualitative] are interpreted to enhance, expand, illustrate, or clarify findings derived from the other strand [quantitative]); development (i.e., data are collected sequentially and the findings from one analysis type are used to inform data collected and analysed using the other analysis type); initiation (i.e., contradictions or paradoxes that might reframe the research question are identified), and expansion (i.e., quantitative and qualitative analyses are used to expand the study's scope and focus).

3.5 Action Research Theory

Action research is a process of systematic inquiry that seeks to improve social issues affecting the lives of everyday people (Stringer, 2008). While there are different forms of action research, this study assumed a collaborative action research mode. Action research is a tool that is used to help educators to uncover strategies to improve teaching practices (Sagor, 2004). Action research helps educators to 'pick up threads suggested in academic circles, and weave them in their own classroom' (Ferrance, 2000). The action research progression is interactive; it is not a passive process, as learners, community members and researcher are active constructors of knowledge (Miller and Pine, 1990; Williamson, 1992). According to Sax and Fisher (2001), action research allows teachers the opportunities to identify changes they need to make in their teaching practices by providing teachers with the framework to build their own classroom projects. This study followed the four-stage method in action research as proposed by Mertler and Charles (2005): planning, acting, developing, and reflecting. According to Hopkins (1985) and Kemmis and McTaggart (1988), action research

is participatory in nature and involves a spiral of self-reflective cycles of:

• Planning a change.

• Acting and observing the process and consequences of the change.

• Reflecting on these processes and consequences and then replanning.

• Acting and observing.

• Reflecting.

Kemmis and McTaggart (1988) suggest that action research is a form of collective reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of these practices and the situations in which these practices are carried out. According to Waterman et al. (2001), action research is a period of inquiry, which describes, interprets and explains social situations while executing a change of intervention aimed at improvement and involvement. It is problem-focused, context specific and future-orientated. Action research is a group activity with an explicit value basis and is founded on a partnership between action researchers and participants, all of whom are involved in the change process. The participatory process is educative and empowering, involving a dynamic approach in which problem-identification, planning, action and evaluation are interlinked. Knowledge may be advanced through reflection and research, and qualitative and quantitative research methods may be employed to collect data.

Winter and Munn-Giddings' (2001) definition of action research, as a 'study of a social situation carried out by those involved in that situation in order to improve both their practice and the quality of their understanding', captures the essence of the philosophy underlying the action research approach. Action researchers 'engage in careful diligent enquiry not for the purpose of discovering new facts or revising accepted laws or theories, but to acquire information having practical application to the solution of specific problems related to their work' (Stringer and Genat, 2004). An action research approach was selected as it aims to generate knowledge about social systems as well as attempting to change these (Hart and Bond, 1995).

Meyer (2000) maintains that the strength of action research lies in its focus on generating solutions to practical problems and its ability to empower practitioners, by getting them to engage with research and the subsequent development or implementation activities. Meyer

(2000), states that practitioners can choose to research their own practice, or an outside researcher can be engaged to help to identify any problems, seek and implement practical solutions, and systematically monitor and reflect on the process and outcomes of change. As Reason and Bradbury (2008) explain, the primary purpose of action research is to produce practical knowledge that is useful to people in the everyday conduct of their lives. Meyer (2000) describes action research as a process that involves people and social situations that have the ultimate aim of changing an existing situation for the better.

Customarily, the role of research has been 'that of a consumer of someone else's research results' or as 'the object' of what is being researched, instead of an active participant in the research design and data collection (Johnson and Button, 2000). Action research has provided the opportunity to devise a systematic plan in order to closely examine the research study. Conducting action research puts everyone in control of the results. When one has ownership of the research process, specifically action research, learning can occur in numerous ways including trying new strategies, evaluating existing programs, expanding instructional repertoires, engaging in professional development, and most importantly helping teachers develop new pedagogical knowledge (Henson, 1996). Section 2 of the National Curriculum and Assessment Policy Statement (CAPS, 2011) of the Department of Basic Education of South Africa gives educators the freedom to expand concepts and to design and organise learning experiences according to their local circumstances and availability of resources. Educators are empowered when they are able to collect and use data in making informed decisions about their own schools and classrooms (Book, 1996; Fueyo and Koorland, 1997; Henson, 1996). Action research enables me to demonstrate how educators can put CAPS into action. By doing so, learner achievement is enhanced (Marks and Louis, 1997; Sweetland and Hoy, 2002), and schools become more effective learning communities (Detert *et al.*, 2001).

3.6 Data generation techniques

In this study questionnaires, interview, observations and ecological techniques have been used.

3.6.1 Questionnaires

Closed-ended questions were used to prompt a yes or no response or any other kind of A or B response to corroborate information and secure specific details (Rudacille, 1994). For example, have you ever been to the forest? (Appendix D, Q1). A funnel sequence and inverted funnel sequence was used in questionnaire design so as to motivate respondents to

co-operate and fully complete a questionnaire (Fisher and Geiselman, 1992; Loftus *et al.*, 1975). Questionnaires were administered by continuously responding to learners who need clarity. They were used to mobilise learners' prior everyday knowledge about plant conservation. Learners answered a series of questions in writing as Irwin (2002) suggested. However, Worker (1993) warns that questionnaires may suffer some problems of mass production and lack of interpretive opportunities. Thus, questionnaires could be misunderstood and that could result in undesirable responses. I administered the questionnaires and so was able to monitor the process of answering in order to ensure that the learners were able to ask for clarification. This also helped in making sure that all questionnaires were returned. Questionnaires were written in English although learners were allowed to respond or ask questions in their home language.

In Chapter 4 questionnaires were used to determine the level of knowledge about conservation for each learner prior to the designed experience. In these Source Based Questions, the learner could use the herbarium and the botanical garden as a source of information to correctly answer the questions in a way as proposed by Venkateswaren et al. (2004). In working with sources, especially primary sources, learners are offered an exciting opportunity to study and work. During the administering and monitoring of the process of answering the questionnaires by the learners, care was taken to ensure that learners were able to ask for clarification.

In Chapter 5 learners were given worksheets with questions that were used to determine what learner perceptions about botanical garden were before visiting it. This made it possible to determine what learned and they enjoyed about the botanical garden trip?

3.6.2 Interviews

Merriam (2002) regards interviews as the best technique to use when conducting intensive case studies of a few selected individuals, especially if semi structured. Interviews are flexible, which allows the researcher to change the sequence of questions, even the wording, to probe the unexpected. Open-ended questions were used in the interviews to assess the subject's knowledge, attitudes, opinions, beliefs and feelings. For example, what kinds of activities, programs and strategies have you experienced or received related to plant protection and conservation issue? What community institutions or structures have been involved in plant protection and conservation efforts in your community and why? Please explain. Who has historically been seen as 'responsible for' plant protection and

conservation relations in your community? What is that person's occupation and title? Please describe him/her (Appendix D; Q1, Q5, Q6). I chose semi-structured interviewing as I was not going to get more than one chance to interview each participant (Bernard, 1988). According to Merriam (2002), this is where the interview, as a primary instrument of data generation, has its advantages. This type of interview ensures that a specific question does not lose its purpose (Sanders, 1999).

I also used interview questionnaires to find out how community members see, interpret and relate to nature. I asked local communities what their real needs are because there is a tendency to think that our power, knowledge and resources can give us the right to predict what communities need without actually asking them. When our imposed initiatives fail, we often accuse these communities of a lack of interest in our issue. During interviews, it is important to guard against the common pitfalls of presuming that what scientists have to offer is what the community wants and needs.

Interview questionnaires were also used to obtain information from street vendors on medicinal and cultural plants (Appendix E). Since these were semi-structured not all questions were designed and phrased ahead of time, allowing both the interviewer and the person being interviewed the flexibility to probe for details or discuss issues. Street vendors answered a series of questions put to them and their answers were written on the questionnaire (Appendix E). This also ensured that answers were relevant to the questions asked. Questionnaires were written in English although community members could ask in isiXhosa for clarification and also reply in their language of choice. It was first established that street vendors understood the questions before their replies were recorded.

Interviews seek to cover both a factual and a meaning level, though it is usually more difficult to interview on a meaning level (Kvale, 1996). According to Merriam (2002), interviews allows the interviewer to change the sequence of questions, even the wording, to probe the unexpected so as to ensure that the questions do not lose their purpose. Interviews are particularly useful for getting the story behind a participant's experiences. The main task in interviewing is to understand the meaning of what the interviewees say (Kvale, 1996). The interviewer can pursue in-depth information around the topic. Interviews may be useful as follow-up to certain respondents to questionnaires, e.g., to further investigate their responses (McNamara, 1999).

3.6.3 Observations

I have used the non-participant observation technique to capture behavioural reactions to the questions in order to supplement the data generated through questionnaires and interviews. I decided to use observation because it is a purposeful, systematic and a selective way of watching and listening to an interaction phenomenon as it takes place (Kumar, 1996). I documented whatever I observed during administration of the questionnaires and was able to provide reflections on this process. I also chose non-participant observation as it involves observing participants without actively participating (Liu and Maitlis 2010).

3.6.4 Analysis of documents

The documents on plants and their uses kept in the Albany Museum herbarium were analysed. These were compared with the information given by community members in the questionnaires. Street vendors indicated that plant species such as *Rubia petiolaris*, *Strychnos henningsii*, *Cassipourea flanaganii*, *Bulbine latifolia*, *Silene undulata* and *Rhoicissus tomentosa* are in demand by the community for medicinal and cultural purposes. The use of documents and filed plant specimens in Albany Museum herbarium allow prediction of possible locations plant species (Peterson *et al.*, 2000; Anderson *et al.*, 2002; Anderson, 2003; Anderson and Martinez-Meyer, 2004). Such predictions may be used alien species before they are introduced and as a result this may help to evaluate the environmental risk they pose (Sanchez-Cordero and Martinez-Meyer, 2000; Peterson and Vieglais, 2001; Arriaga *et al.*, 2004; Iguchi *et al.*, 2004). The likelihood that a species will occur in a particular suitable location may depend on past history in terms of its distribution or its likely ability to disperse from other locations where it also occurs (Jimenez-Valverde *et al.*, 2008).

3.6.5 Data validation

Xhosa plant names from street vendors and community members were matched to scientific names by following the preliminary list of Xhosa plant names from the Eastern Cape, South Africa (Dold and Cocks, 1999). The botanical nomenclature of this list follows Germishuizen and Meyer, (2003). In addition to literature reports Selmar Schönland Herbarium specimens were used to validate the ethnobotanical information given by the community members and street vendors. Herbaria are repositories of information in the form of vouchers, originally serving economic botany, and increasingly seen primarily as resources for plant taxonomy (Bebber *et al.*, 2010; Van Andel *el al.*, 2012). Today, the wider value of herbaria is appreciated (Lavoie *et al.*, 2013). Herbaria worldwide house more than 300 million

specimens collected over 400 years and as such are a rich repository of specimen collection dates and localities (Thiers, 2014).

3.6.6 Ecological techniques

Fieldwork was conducted by collecting plant samples from two schools, 17 streets, community gardens and the Makana botanical garden. A 1 m x 1 m quadrat was used and the cover abundance of the species in each quadrat were estimated. The woody species were measured by the means of counting the number of trees in the area. The number of quadrats measured in each green space were done in proportion to its area: four quadrats for an area more than 500 m^2, two quadrats for an area less than 500 m^2 but more than 100 m^2 and 1 quadrat for an area less than 100 m^2. All the samples collected were pressed for later identification in the Selmar Schönland Herbarium.

Searches were undertaken specifically for Red List species and any other species of conservation concern. All exotic species were recorded and categorised as alien or weeds. The National Environmental Management: Biodiversity Act 2004 (Act No 10 of 2004) (NEMBA, 2004) provides for the management and conservation of South Africa's biodiversity and the establishment of a National Biodiversity Institute for the implementation of the Act. A person may not carry out restricted activities involving a specimen of alien species on such list without a permit issued in terms of Chapter 7 of the Act, which shall only be issued after the prescribed assessment of risks and potential impact on biodiversity is carried out. Restricted activities include amongst others importing, having in possession, conveying, moving or translocation, and acquiring or disposing of a listed invasive species. Historical occurrences of threatened plant species were drawn from NewPOSA (http://newposa.sanbi.org/) for the quarter degree square of the area. According to SANBI this website provides access to South African plant names (taxa), specimens (herbarium sheets) and observations of plants made in the field (botanical records). Data is obtained from the Botanical Database of Southern Africa (BODATSA; Golding, 2001). In one of the continent's largest collaborative conservation projects to date, South Africa has become the first megadiverse country to fully assess the status of its entire flora. The Red List of South African Plants (http://redlist.sanbi.org/) provides up to date information on the national conservation status of South Africa's indigenous plants. Vegetation sensitivity was based on the concept of irreplaceability (SANBI, 2017). Areas containing high diversity, threatened species, high habitat complexity or systems vital to sustaining ecological functions were considered sensitive. South Africa uses the internationally endorsed IUCN

Red List Categories and Criteria in the Red List of South African plants. This scientific system is designed to measure risk of extinction. The purpose of this system is to highlight those species that are most urgently in need of conservation action. Due to its strong focus on determining risk of extinction, the IUCN system does not highlight species that are at low risk of extinction but may nonetheless be of high conservation importance. Because the Red List of South African plants is used widely in South African conservation practices such as systematic conservation planning or protected area expansion, we use an amended system of categories designed to highlight those species that are at low risk of extinction but of conservation concern. The Regulations to the Act as well as the list of invasive species were both published on 1 August 2014 and the Regulations came into force on 1 October 2014.

I also investigated plant diversity, abundance and distribution of street trees in the Makhanda area because they can be an important resource for plant conservation as well as environmental education in the Makhanda area. Town streets in Makhanda were randomly sampled, and as a result not all streets were counted. All the trees growing in the streets listed in Table 1 of Chapter 8 were sampled. Sampling took place in the spring and early summer (October, November and December).

3.7 Designing and developing the learning activities

I have designed the lessons so that learner can be able to:

- *Demonstrate an understanding of the interrelationship between the botanical garden and herbarium resources and their biology lessons learned about plant conservation, biodiversity and vegetation ecology;*
- *Extend awareness to community members so that they will adopt effective plant conservation approaches. This was done by introducing learners to some basic principles related to plant conservation, biodiversity and vegetation ecology; and*
- *Familiarise learners with the range of skills that they will need to develop an understanding of plant conservation, biodiversity and vegetation ecology.*
- *Lessons presented in the herbarium were based on a three-step learning cycle method (Rakow, 1986; Colburn and Clough, 1997). In this lesson format, the instructional period was divided into three sequential phases: exploration, concept development, and concept application. During exploration, learners were allowed to work with the lesson material as individuals or in small groups without the direct help from the herbarium educator.*

3.8 Data analysis

Data analysis is a process of inspecting, transforming, and modelling data with the goal of discovering useful information, informing conclusions, and supporting decision-making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, while being used in different science and social science domains. Data analysis plays a role in making decisions more scientific (Xia and Gong, 2015).

In this research study I have used mixed data analysis. The data questionnaires are quantitative findings, but qualitative analysis was incorporated to increase understanding of the findings. The rationale for mixing quantitative and qualitative analysis was for complementarity and expansion (Greene et al., 1989). The questions were structured in order to determine the extent to which school learners were able to demonstrate an understanding of plant resources and the interrelationship between these resources and their biology lessons and plant conservation practices. After analysing the responses from question 1 to 13 it enabled me to plan the lesson that involved trips to the botanical garden and the herbarium. Responses from learners provided information on the role the community had in promoting awareness so that learners and community could adopt effective plant conservation approaches. In Chapter 4 the questions are categorised into themes. This process of identifying patterns or themes it is not tied to a particular epistemological or theoretical perspective (Braun and Clarke, 2006).

In Chapter 5 the data gather was qualitative and was mostly summarised in tables. All the responses were analysed according to the goals and questions of the research study. That is, during data analysis the achievement of goals and success of the methodology was used as a measure of success.

4. Education institutions and Learning activities

4.1 Education institutions used in research

The three schools chosen were established at different times and for different reasons. Together they cover of a diverse group of learners from townships, the town (urban) and some from farms around Makhanda. The advantage of this diversity was that I was able to obtain information from different perspectives.

4.1.1 Makhanda East School

The Makhanda East School was built in 1976 (Mrs Madeleine Schoeman, pers. comm.) and is located to the north-east of the central business district of Makhanda. The school has a homogeneous group of pupils, all being Xhosa. This school teaches according to the CAPS (2011) from the South African Department of Basic Education. Most of the pupils come from the eastern areas of Makhanda and neighbouring farms.

4.1.2 Makhanda Middle School

The Makhanda Middle School is between Makhanda West and East. It was founded in 1940 to cater for Coloured children (Mr Samuel Wessels, pers. comm.). The medium of instruction at this school is both English and Afrikaans and they use the CAPS (2011) from the Department of Basic Education.

4.1.3 Makhanda West School

Makhanda West School for boys was founded in 1855 (Anon., 2012). It has become an innovative independent boarding school that caters for pupils from the area and includes international pupils. The school curriculum follows the Independent Examinations Board (IEB) syllabus (Anon., 2012).

4.2 Questionnaire Responses

The questionnaires were given to the learners on the first day when I met them in their schools.

4.2.1 Makhanda East School

Just over half of the learners in the Makhanda East School had been to a natural forest (Table 2, Question 1 and 2). Most learners chose to go to a wilderness for a vacation (Table 2, Question 3) and most chose camping for accommodation (Table 2, Question 4). The most commonly reported environmental problem reported was fire, with a third of the respondents listing overgrazing, plant harvesting, and industrialisation received as problems (Table 2, Question 5). Half of the respondents reuse paper (Table 2, Question 6) and most learners (83%) believe that people need plants to exist (Table 2, Question 7). Most learners believe in natural forests (Table 2, Question 8). Only half of the learners believe plants are for humans to use as they see fit (Table 2, Question 9). Most learners have grown a garden (Table 2, Question 10) with just over half having grown vegetables (Table 2, Question 11).

More than half (57%) of the learners from Makhanda East School were unable to correctly list any indigenous plants (Table 2, Question 12) and most learners (87%) could not name any invasive alien plants (Table 2, Question 13). Just under a fifth of the learners could correctly name indigenous plant (Table 2, Question 12). Two learners could list 5 indigenous plants correctly. More than half of the learners could not name a single correct indigenous plant (Table 2, Question 12). Fewer learners could name an invasive alien plant (87% could not name any; Table 2, Question 13).

A fifth of the learners had signed a petition for protection of indigenous plants (Table 2, Question 14), but only 7% had signed a petition related to alien plants (Table 2, Question 15). A fifth of the learners had gone to a demonstration related to invasive plants (Table 1, Question 16). A quarter of the learners had attended a lecture or public forum organized by a group that protects indigenous plants (Table 2, Question 17) while a fifth had attended such a lecture or public forum organized by a group that is concerned with invasive plants (Table 2, Question 18). A quarter of the learners have been or are a member of a group or club at school or outside of school that protect plants (Table 2, Question 19).

Table 2. Responses of learners from the Makhanda East School to the written questionnaire.

Questions	**a**	**b**	**c**	**d**	**e**	**f**	**Response Choices**
1. Have you ever been to the forest?	17	11	2				a. Yes = 57% b. No = 37% c. Left blank = 6%
2. If yes, was it a natural forest (a) or a plantation (b)?	17	0	13				a. Forest = 57% b. Plantation = 0% c. Left blank = 43%
3. If you choose where to take a vacation, would you go to a wilderness place (a) over a populated place (b) or both (c)? Why?	20	2	8				a. Wilderness = 67% b. Populated = 7% c. Left blank = 26%
4. Do you prefer to camp (a) than stay in a hotel (b)?	22	4	4				a. Camp = 73% b. Hotel = 13% c. Left blank = 13%
5. What are environmental problems you are aware of associated with the following: Fire(a), Overgrazing(b), Plant harvesting(c), Industrialisation (d).	18	9	9	7			a. Fire = 60% b. Overgrazing = 30% c. Harvesting = 30% d. Industrialisation = 23%
6. Do you try to reuse paper?	16	9	5				a. Yes= 53% b. No = 30% c. Left blank = 17%
7. Do you believe that people need plants to exist?	25	1	4				a. Yes= 83% b. No = 3% c. Left blank = 14%
8. Do you believe in natural forests?	25	1	4				a. Yes = 83% b. No = 3% c. Left blank = 14%
9. Do you believe plants are for humans to use as they see fit?	14	11	5				a. Yes = 47% b. No = 37% c. Left blank = 16%
10. Do you or have you ever grown a garden or nursery?	21	6	3				a. Yes = 70% b. No = 20% c. Left blank = 10%
11. If yes is it a vegetable (a) garden, a flower garden (b) or a plant nursery with indigenous plants (c)?	16	3	1	10			a. Vegetable garden = 53% b. Flower garden = 10% c. Indigenous plants = 3% d. Left blank = 33%

12. List at least 5 indigenous plants you know of?	5	4	2	0	2	17	Correct answers: a. 1 name given = 17% b. 2 names given = 13% c. 3 names given = 7% d. 4 names given = 0% e. 5 names given = 7% f. No names given = 57%
13. List at least 5 invasive alien plants you know of?	1	2	1	0	0	26	Correct answers: a. 1 name given = 3% b. 2 names given = 7% c. 3 names given = 3% d. 4 names given = 0% e. 5 names given = 0% f. No names given = 87%
14. Have you ever signed a petition for protection of indigenous plants?	6	20	4				a. Yes = 20% b. No = 67% c. Left blank = 13%
15. Have you ever signed a petition for elevation of invasive alien plants?	2	25	3				a. Yes = 7% b. No = 83% c. Left blank = 10%
16. Have you ever gone to a demonstration for elevation of invasive plants?	5	20	5				a. Yes = 16.7% b. No = 66.6% c. Left blank = 16.7%
17. Have you ever gone to a lecture or public forum organized by a group that protects indigenous plants?	8	15	7				a. Yes = 27% b. No = 50% c. Left blank = 23%
18. Have you ever gone to a lecture or public forum organized by a group that elevates invasive plants?	6	19	5				a. Yes = 20% b. No = 63% c. Left blank = 17%
19. Were you ever a member of a group or club at school or outside of school that protect these plants? If yes, what activities did you do with the group?	8	18	4				a. Yes = 27% b. No = 60% c. Left blank = 13%

4.2.2 Makhanda Middle School questionnaire responses

Most of the learners (93%) had been in a natural forest (Table 3, Question 1 and 2) and two-third of them chose to take a holiday in the wilderness because they live most of their lives in a very populated area and were hoping that the wilderness will be relaxing. Choice of wilderness was an indication that a trip to the botanical garden could be expected to benefit them. (Table 3, Question 3). Some learners thought that they would get a chance to know more about plants and animals, showing that these learners are hungry for knowledge. Those that chose populated places over the wilderness mentioned that they are afraid of wild animals, but others would not give a reason. 60% of learners prefer to camp (Table 3, Question 4). These learners had a high awareness of all the environmental problems (Table 3, Question 5). Most of learner's responses (60%) indicated that they reuse paper (Table 3, Question 6). 93% of learners believe that people need plants to exist (Table 3, Question 7) and 80% believe in natural forest (Table 3, Question 8). 53% of learners believe plants are for humans to use as they see fit (Table 3, Question 9). 63% of learners have grown a garden (Table 3, Question 10) with most growing vegetables (Table 3, Question 11).

A third of the learners could provide four names of indigenous plants with a further 27% giving two names (Table 3, Question 12). One learner could list six indigenous plants and only one could not name a single correct indigenous plant. Only a fifth of the learners could name one invasive alien plant and two-thirds of them could not name any (Table 3, Question 13).

Most learners have never signed a petition in support of protection for indigenous plants (Table 3, Question 14) nor signed a petition for control of invasive alien plants (Table 3, Question 15). A quarter of the learners attended a demonstration for awareness of invasive plants (Table 3, Question 16). Less than a quarter had attended a lecture or public forum on issues relating to invasive plants and about a fifth had attended such an event on indigenous plants (Table 3, Question 17 and 18). A fifth of learners have been or are a member of a group or club at school or outside of school that protects indigenous plants (Table 3, Question 19).

Table 3. Responses of learners from the Makhanda Middle School to the written questionnaire.

Questions	**a**	**b**	**c**	**d**	**e**	**f**	**Response Choices**
1. Have you ever been to the forest?	28	2	0				a. Yes = 93% b. No = 7% c. Left blank = 0%
2. If yes, was it a natural forest (a) or a plantation (b)?	18	9	3				a. Forest = 60% b. Plantation = 30% c. Left blank = 10%
3. If you choose where to take a vacation, would you go to a wilderness place (a) over a populated place (b)? Why?	21	8	1				a. Wilderness = 70% b. Populated = 27% c. Left blank = 3%
4. Do you prefer to camp (a) than stay in a hotel (b)?	18	12	10				a. Camp = 60% b. Hotel = 40% c. Left blank = 0%
5. What are environmental problems you are aware of associated with the following: Fire (a), Overgrazing (b), Plant Harvesting (c), Industrialisation (d).	27	26	18	17			a. Fire = 90% b. Overgrazing = 87% c. Harvesting = 60% d. Industrialisation = 57%
6. Do you try to reuse paper?	18	10	2				a. Yes = 60% b. No = 33% c. Left blank = 7%
7. Do you believe that people need plants to exist?	28	2	0				a. Yes = 93% b. No = 7% c. Left blank = 0%
8. Do you believe in natural forests?	24	6	0				a. Yes = 80% b. No = 20% c. Left blank = 0%
9. Do you believe plants are for humans to use as they see fit?	16	11	3				a. Yes = 53% b. No = 37% c. Left blank = 10%
10. Do you or have you ever grown a garden or nursery?	19	11	0				a. Yes = 63% b. No = 37% c. Left blank = 0%
11. If yes is it a vegetable (a) garden, a flower garden (b) or a plant nursery with indigenous plants(c)?	17	7	0	6	0		a. Vegetable garden = 57% b. Flower garden = 23% c. Indigenous garden = 0% d. Left blank = 20% e. Vegetable and flower garden = 0%

12. List at least 5 indigenous plants you know of?	2	8	5	10	4	1	Correct answers: a. 1 name given = 7% b. 2 names given = 27% c. 3 names given = 17% d. 4 names given = 33% e. 5 names given = 13% f. No names given = 3%
13. List at least 5 invasive alien plants you know of?	6	3	1	0	0	20	Correct answers: a. 1 name given = 20% b. 2 names given = 10% c. 3 names given = 3% d. 4 names given = 0% e. 5 names given = 0% f. No names given = 67%
14. Have you ever signed a petition for protection of indigenous plants?	5	25	0				a. Yes = 17% b. No = 83% c. Left blank = 0%
15. Have you ever signed a petition for elevation of invasive alien plants?	3	27	0				a. Yes = 10% b. No = 90% c. Left blank = 0%
16. Have you ever gone to a demonstration for elevation of invasive plants?	7	23	0				a. Yes = 23% b. No = 77% c. Left blank = 0%
17. Have you ever gone to a lecture or public forum organized by a group that protects indigenous plants?	9	21	0				a. Yes = 23% b. No = 77% c. Left blank = 0%
18. Have you ever gone to a lecture or public forum organized by a group that eradicates invasive plants?	5	25	0				a. Yes = 17% b. No = 83% c. Left blank = 0%
19. Were you ever a member of a group or club at school or outside of school that protect these plants? If yes, what activities did you do with the group?	6	24	0				a. Yes = 20% b. No = 80% c. Left blank = 0%

4.2.3 Makhanda West School questionnaire responses

Very few of the learners in this school (10%) had never been to a forest (Table 4, Question 1) and most (90%) had visited a natural forest (Table 4, Question 2). 60% of learners chose wilderness for a vacation of choice (Table 4, Question 3). Those who chose wilderness place said it was because they enjoy being in nature as it is clean, beautiful, peaceful, quiet, natural, enjoy seeing animals, for relaxing and just getting away from people, enjoy open land around, experiencing new things in nature, like being outdoors, it is calm, closer to nature, to get out of cramped and stressful environment, enjoy being away from civilization and do not like to compete with people (Table 4, Question 3). Those who chose populated place said they like people; they like to socialize, they like to stay connected, it has readily available transport, there are shopping malls, there is vibe, there is more fun (Table 4, Question 3). 30% of learners prefer to camp and 70% of learners chose to stay in a hotel (Table 4, Question 4). All environmental problems were identified by most learners (95% to 65% of learner's responses; Table 4, Question 5). Most learners reuse paper (Table 4, Question 6). All but one learner believed that people need plants to exist (Table 4, Question 7) and all believe in natural forest (Table 4, Question 8). Only a quarter of the learners believe plants are for humans to use as they see fit (Table 4, Question 9). Three-quarters of learners have grown a garden with 22% growing vegetables, 13% growing flowers and 28% growing both (Table 3, Question 10 and 11).

Three of the learners could list 7 indigenous plants correctly while a quarter could not name any (Table 4, Question 12). There were some learners who listed fruit trees in the indigenous list. This confusion needs to be addressed. Fruit trees contribute positively to food chain and add value to economy but that does not make them indigenous plants. For example, guavas and prickle pear are invasive alien trees. Two-thirds of the learners could not correctly name an invasive alien plant, while one learner could name 5 correctly (Table 3, Question 13).

Most learners had never signed a petition for protection of indigenous plants (Table 4, Question 14) or one for control of invasive alien plants (Table 4, Question 15). Most of these learners had never been to a demonstration for control of invasive plants (Table 4, Question 16) while a quarter had attended a lecture or public forum on protection of indigenous plants (Table 4, Question 17) or on invasive plants (Table 4, Question 18). Most learners have never been a member of a group or club that protects indigenous plants. (Table 4, Question 19).

One learner mentioned that she was a member of a group that protects plants at primary school.

Table 4. Responses of learners from the Makhanda West School to the written questionnaire.

Questions	**a**	**b**	**c**	**d**	**e**	**f**	**Response Choices**
1. Have you ever been to the forest?	36	4	0				a. Yes = 90% b. No = 10% c. Left blank = 0%
2. If yes, was it a natural forest (a) or a plantation (b)?	36	0	4				a. Forest = 90% b. Plantation = 0% c. Left blank = 10%
3. If you choose where to take a vacation, would you go to a wilderness place (a) or a populated place (b) Why?	24	16	0				a. Wilderness = 60% b. Populated = 40% c. Left blank = 0%
4. Do you prefer to camp (a) than stay in a hotel (b)?	12	28	0				a. Camp = 30% b. Hotel = 70% c. Left blank = 0%
5. What are environmental problems you are aware of associated with the following: Fire (a), Overgrazing (b), Plant harvesting(c), Industrialisation (d).	38	35	26	32			a. Fire = 95% b. Overgrazing = 88% c. Plant Harvesting = 65% d. Industrialisation = 80%
6. Do you try to reuse paper?	31	9	0				a. Yes = 78% b. No = 22% c. Left blank = 0%
7. Do you believe that people need plants to exist?	38	2	0				a. Yes = 95% b. No = 5% c. Left blank = 0%
8. Do you believe in natural forests?	40	0	0				a. Yes = 100% b. No = 0% c. Left blank = 0%
9. Do you believe plants are for humans to use as they see fit?	11	25	4				a. Yes = 28% b. No = 62% c. Left blank = 10%
10. Do you or have you ever grown a garden or nursery?	28	12	0				a. Yes = 70% b. No = 30% c. Left blank = 0%

11. If yes is it a vegetable (a) garden, a flower garden (b) or a plant nursery with indigenous plants (c)?	9	5	2	13	11		a. Vegetables = 22% b. Flowers = 13% c. Indigenous = 5% d. Left blank = 32% e. Both = 28%
12. List at least 5 indigenous plants you know of?	3	10	7	2	7	11	Correct answers: a. 1 name given = 8% b. 2 name given = 25% c. 3 name given = 17% d. 4 name given = 5% e. 5 name given = 17% f. No name given = 28%
13. List at least 5 invasive alien plants you know of?	6	0	3	3	1	27	Correct answers: a. 1 name given = 15% b. 2 name given = 0% c. 3 name given = 8% d. 4 name given = 8% e. 5 name given = 2% f. No name given = 67%
14. Have you ever signed a petition for protection of indigenous plants?	4	36	0				a. Yes = 10% b. No = 90% c. Left blank = 0%
15. Have you ever signed a petition for elevation of invasive alien plants?	1	39	0				a. Yes = 2.5% b. No = 97.5% c. Left blank = 0%
16. Have you ever gone to a demonstration for elevation of invasive plants?	2	37	1				a. Yes = 5% b. No = 92.5% c. Left blank = 2.5%
17. Have you ever gone to a lecture or public forum organized by a group that protects indigenous plants?	11	29	0				a. Yes = 28% b. No = 72% c. Left blank = 0%
18. Have you ever gone to a lecture or public forum organized by a group that elevates invasive plants?	4	36	0				a. Yes = 10% b. No = 90% c. Left blank = 0%
19. Were you ever a member of a group or club at school or Outside of school that protect these plants? If yes, what activities did you do with the group?	5	35	0				a. Yes = 12% b. No = 88% c. Left blank = 0%

4.3 Comparison of the three schools

Most learners from Makhanda Middle School and Makhanda West School had been in a forest while only half of the learners from Makhanda East School had (Tables 2, 3 and 4, Question 1). Learners from Makhanda East School demonstrated low levels of awareness of environmental problems associated with overgrazing, plant harvesting, and industrialization in contrast to the other two schools (Tables 2, 3 and 4, Question 5).

Some 90% of the learners agreed that people need plants to exist (Table s2, 3 and 4, Question 7). There was a significant amount of percentage of learners from all schools who believe plants are for humans to use as they see fit (Tables 2, 3 and 4, Question 9). This needed to be addressed through programmes that promote plant conservation awareness and education to avoid species extinctions that are attributable to human activities (Primack and Rodrigues, 2001). Although the majority of them have grown their own gardens, the third of learners who have no experience of growing their own gardens do not know how to take ownership and care for a plant (Tables 2, 3 and 4, Question 10).

Learners from the three schools were able to list up to five indigenous plants. However, the 57% who could not name one from Makhanda East School learners were a clear indication that more attention was needed in promoting effective awareness and education programmes for plant conservation. Learners from Makhanda East School and Makhanda Middle Schools were unable to list more than three invasive alien plants beyond three. The outcomes resulted in the decision to have learners from Makhanda East School and Makhanda Middle Schools to collect plant specimens. These were taken to Selmar Schönland Herbarium for an identification lesson that included differentiation between the indigenous plants and invasive alien plants and disadvantages of having invasive alien plants.

Learners from the three schools had significantly different knowledge pertaining to indigenous plants. On average, the Makhanda East School learners could only list 1 (+ 2 S.D.) indigenous plants while the Makhanda Middle School learners could list an average of 3 (+ 1 S.D.; significantly different: $W = 130$, $p < 0.001$, d.f. = 58) while the Makhanda West School learners could list an average of 2 (+ 2 S.D.; significantly different: $W = 340$, $p = 0.001$, d.f. = 68). There was no significant difference between the number of indigenous plants listed by the Makhanda Middle School and the Makhanda West School learners ($W = 759$, $p = 0.056$, d.f. = 68). The high percentage of ‘no answer” (NA) responses to questions from 14 to 19 were the indication that majority of learners need awareness and education.

4.4 Activities

The activities learners completed (Table 1) commenced with the pre-activity questionnaire and at the time they were also interviewed in order to record their knowledge about plant conservation before the herbarium and botanical garden experience. After this, the learners were taken to their own school grounds where they collected plant specimens (see Appendix C) and pressed them (Plate 1). They then took their specimens to the herbarium for identification (Chapter 7).

Plate 1. Learners collecting and pressing plant specimens from their own school grounds.

4.5 Conclusion

Responses are assessed according to the goals and objectives of the study. Analysing data in a mixed research study is the most complex step because the researcher must analyse both the quantitative and qualitative data that has been collected, but in particular, must integrate the results from both 'in a coherent and meaningful way that yields strong meta-inferences (i.e. inferences from qualitative and quantitative findings being integrated into either a coherent whole or two distinct sets of coherent wholes. Tashakkori and Teddlie, 1998)' (Onwuegbuzie and Combs, 2010).

Theme 1: Learner understanding and experience of variety of plants

The results from learner responses that indicated understanding and experience of variety of plants (Tables 2, 3 and 4, Questions 1, 2, 3 and 4) indicated that there is a need for educators to create opportunities for learners to understand and experience a variety of plants and their habitats (McLeish, 1997). The responses on environmental problems provided information on the learner knowledge about the environment and the role they are playing

to protect it (Table 2, 3 and 4, Question 5, 6, 7, 8, 9, 10, 14, 15, 16, 17, 18 and 19). This means that learners need experiences in nature and an understanding of ecological relationships that are a direct pathway to achieve attitudes of environmental awareness and, in turn, result in actions to solve the world problems (Breiting *et al*., 1996; Lundegård and Wickman, 2007).

Theme 2: The confusion between indigenous and alien plants

It was also possible to see gaps and confusion in learner knowledge of differentiating between indigenous and alien plants (Tables 2, 3 and 4, Questions 12 and 13). In questions where learners were asked to list indigenous plants and invasive alien plants, prickly pear (*Opuntia ficus-indica*) was often listed as indigenous plant (Tables 2, 3 and 4, Questions 12 and 13). This is an invasive alien plant yet for impoverished rural and township communities of the Makhanda area it provides a significant income for poor families as they sell it as an edible fruit (Zimmermann and Moran, 1991). Aloe was listed as alien (aloes can either be indigenous or alien plants). This confusion needs to be addressed. Aloe (*Aloe ferox*) is an indigenous plant with medicinal, cosmetic and commercial value (Van Wyk *et al.*, 1997).

Some learners listed alien crop plants such as maize, prickly pear, msobosobo (*Solanum nigrum*), imbikicane (*Chenopodium murale*), utyuthu (*Amaranthus hybridus*), ihlaba (*Sonchus oleraceus*) and irhawu (*Urtica urens*) as indigenous plants. Fox and Norwood Young (1982) reported that the Xhosa tribe were already gatherers of wild plants for food, including wild vegetables, by the time they settled in the south eastern part of the country in the 1650s. Most learners listed fruits (orange, banana and apple) and vegetables (cabbage, spinach and carrot) as indigenous plants, indicating that learners consider plants that provide good and healthy nutrition to be indigenous.

Theme 3: Knowledge testing tasks

There were tasks that require knowledge of specific facts (e.g. list of indigenous and alien plants) (Tables 2, 3 and 4, Questions 12 and 13) and tasks that require application of facts, concepts, and principles to novel problem-solving situations (e.g. environmental problems) (Tables 2, 3 and 4, Questions 5) all from the perspective of Bloom's taxonomy according to Gettinger and Lyon (1985). Questions asked during classroom assessment were to facilitate learning, because most efficient and effective student learning result when classroom instruction and materials align with objectives or standards (Bumen, 2007). Eber and Parker (2007) regard this approach as a tool that can help educators broaden the depth of

learning. One of the greatest challenges for teachers today is to provide a curriculum that effectively caters to their diverse student population (Noble, 2004).

Theme 4: Learner involvement in extending awareness to community members

In Question 19 (Table 3) learners were asked if they have been members of a group or club at school or outside of school that protect these plants and if yes, what activities did they do with the group? The response they gave after the 'yes' response was that they taught their neighbours how to make a garden; participated in activates of plant planting and protection; explaining to people how to grow plants, cleaning the garden and watering the plants. These positive attitudes should be encouraged. This answers the sub question research on how awareness can be extended to community members so that they will adopt effective plant conservation approaches.

The above analytical statements enabled me to identify the gaps in learner's understanding and experience of variety of plants, confusion in learner's knowledge of differentiating between indigenous and alien plants and in involvement in extending awareness to community members. I had to consider these gaps when planning the next lessons which involved plant collection, the trip to botanical garden and plant identification during herbarium visit.

5. The role of the Makana Botanical Garden in plant conservation education and awareness

The Makana Botanical Garden was chosen for a plant conservation education and awareness lesson because it has a diversity of plant collections with information in the form of labels. Some of the plants found in the Makana Botanical Garden are indigenous while others are alien. Some of the collection is cultivated and others grow naturally. This made the Makana Botanical Garden relevant in addressing the understanding and experience of variety of plants and the confusion between indigenous and alien plants.

In this Chapter the role of the Makana Botanical Garden in advancing plant conservation knowledge and awareness is explored. The benefits of using the Makana Botanical Garden are considered with the aim to describe, summarize, evaluate, clarify and integrate the available primary knowledge. This was done by considering the Garden as a resource in plant conservation education and awareness promotion, the community plant conservation cultural ways of knowing and plant conservation laws. The chapter addresses conservation education and awareness, the role of Garden as a tool, the unique niche of the Garden, and ends with a strategic plan for the Makana Botanical Garden education in the light of its future use.

Botanical gardens are one of the more popular social institutions and they are perfect places to demonstrate how important plants and people are to each other as they can act as a metaphor for the complex relationships that humanity has with the environment (Saunders 2007). However, according to the records of Makana Botanical Garden users Bookings by Facility section of Rhodes University it appears that the General Education and Training (GET) and Further Education and Training (FET) schools are under-utilising its potential for the conservation of endangered species as agued by Azevedo *et al*. (2012), for the conservation of biodiversity (Hoban and Vernesi, 2012) and for educational programs aimed at public awareness of environmental issues (Wheater, 1995; Marandino and Diaz Rocha, 2011; Meadows, 2011).

Bagarinao (1998) advocates for nonformal environment education through nature recreation as a means toward 'greening' the mind and the spirit of the citizens. In her article, she provided information about the status and potential of resource institutions such as botanical gardens in education about biodiversity. She argued that public consciousness about biodiversity and the environment, as well as their importance for sustainable development

was not widespread in Philippines. The same argument can be made regarding the public of Makhanda.

In general, education, training and public awareness are recognized as essential tools in bringing about effective conservation and sustainable development. Indeed, education and training are mentioned 617 times in *Agenda 21*, the work programme agreed at the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil (IUCN, 1993). With regard to biodiversity, it is clear that the spectrum, value, threats to and conservation of biodiversity are major issues facing humanity (WRI/IUCN/UNEP, 1992). Their importance is reflected in numerous global and national conservation strategies. According to the Global Biodiversity Strategy (WRI/IUCN/UNEP, 1992): 'Since policy makers, activists and scientists cannot slow biodiversity loss without wider public support, a multi-faceted effort is required to expand public awareness about biodiversity's importance and to strengthen the public's will and ability to act'.

5.1 Field trip to Makana Botanical Garden

Learners were taken on a field trip to the Makana Botanical Garden (Plates 2 and 3). Group leaders were assigned to each learner group and they were given clear instructions of their roles which were to monitor and make sure that instructions are followed. Groups walked along a circular route that took them through the gardens. During the walk, their attention was drawn to the categories of plants (low plants, high plants, indigenous and alien species) and took notes. If they recognised something they were encouraged to write down the information. After all the groups finished all the participants regrouped and considered each other's findings. Each group reported on how the field trip went and whether their expectations had been met. They were encouraged to report on the level of participation in the group and whether they discovered interesting things.

Equipment provided by the Selmar Schönland Herbarium included plant presses, secateurs, newspaper/blotting paper, a 100 m rope, pencils, note books, and cameras. Learners collected available information from plants with labels and they wrote a description of the habitat.

The Botanical Garden visit had the following objectives:

- *Promoting the use of Makana Botanical Garden as a tool in plant conservation education awareness.*
- *Promoting an understanding of the holistic nature of the environment and the value*

of biodiversity.

- *Delivering an integrated and active approach to education outside of the classroom.*
- *Creating opportunities for learners to decide to take action to address environmental issues.*

Plate 2. A botanical garden visit for learning about plants and why they must be conserved.

Plate 3. Learners collecting and pressing plants.

After walking around the gardens, learners collected some plants and recorded information about them. Learners also had experience of working in a group and taking responsibility for a learning outcome task. During the fieldwork, I informally assessed the learners on the group behaviour and participation in the activities. I also gave learners a worksheet.

5.2 Learner response worksheet on the botanical garden trip

Thirty learners from each of the three schools took part in the botanical garden trip. A worksheet was given to each school. The questions are given in Table 5 and the responses of all the learners are provided in Appendix F. The schools are referred to as A, B and C (Appendix F). Thereafter I gave a summary of learner response in each of the 10 questions. This enabled me to analyse the responses in my conclusion and I have used literature to back my analysis. I also added few scanned worksheets with learner answers.

Table 5. Worksheet questions and what each was intended to explore.

No.	Worksheet questions	What the worksheet intended to gather
1	What is it that you did not know before visiting the botanic garden?	It intended to find out the gap between learner's prior knowledge and knowledge after visiting botanical garden. Did they learn something?
2	What were your perceptions about botanical garden before visiting it?	It intended to find out leaner's expectation of the trip?
3	What have you learnt on the botanic garden trip?	Reflections on the trip in order to have remedial action. Did learning happen? If so what is it that learners learned? If not, what is it that I need to do differently next time?
4	Why is it important to learn about botanic gardens, plants and conservation?	Do learners see any value or educational benefit to the trip? If they see it what is it? If they do not see it, how can they be made to see it?
5	What do you think are the greatest threats to botanic gardens, plant diversity and conservation efforts?	To determine learner's skill to identify problems.
6	How can you personally impact plant habitat?	To find out how do learners see themselves as having an impact on plant habitats.
7	How can you use the botanical garden for the benefit for the community?	To found out how learners see botanic gardens as having solutions to societal issues such as promotion of plant conservation, awareness campaigns, picnics, wedding events, plants used in medicine, cosmetics and cultural activities?
8	How can a botanical garden be of value to learning about plants?	Find out how learners see botanic gardens as having solutions to plant related issues, such as promotion of plant conservation, awareness campaigns, plant uses activities?
9	In what way can a botanical garden be of value to biodiversity and its role in urban greening?	The intention is to see if learners can use the information they have learnt to benefit to biodiversity and urban greening
10	Using all your senses, how would you describe a botanical garden?	Intended to find out if the learners can describe what they have seen, touched and smelt in a botanical garden.

Learners did not know before visiting the botanic garden that it is a place with a wide variety of plants that are cultivated for scientific, educational and ornamental purposes. They did not know that botanical names are scientific names conforming to the International Code of Nomenclature. Learners did not know that there are also birds and snakes in the botanical garden. They did not know that different types of plants come from different places and indigenous plants from different parts of the country (Appendix F).

Learners were expecting to see both indigenous and alien plants on the visit, but the problem was that they could not distinguish between them. Some were expecting to only see indigenous plants and were surprised to find some alien plants. Others thought that they were going to see a forest or just a garden with flowers, or a place where there are plants only. Some thought that it was a place with more common plants that are known by most people. Some expected just a place for picnic or for relaxing and having fun. Some even thought that it was a boring place full of plants (Appendix F).

Learners said that during botanical garden trip, they learned to distinguish between alien and indigenous plants and about how plants survive during different seasons. They learnt about also how plants can benefit human beings and learned that the botanical garden is a beautiful place where there are many different species of plants. Learners discovered that many medicines are extracted from plants that are conserved in the botanical garden. They learnt that plants are grouped in families. They commented that botanical gardens help the public because it has plants they need. Plants also create habitat for animals.

Learners said they liked the herbs and medicinal plants they saw in the garden. Learners learnt that every tree has to have a name. They liked the place because it has a lot of beautiful plants and have learned that in life they must always respect flowers. They learnt that some plants are tall, and others are low growing. They mentioned that the botanical garden is a safe and clean environment with birds and insects. It is a calm area.

Learners discussed how human activities are affecting plants through climate changes, how alien plants use a lot of water and also how they grow faster than indigenous plants. Learners see the importance of protecting the garden as a beautiful place with wonderful nature and is a tourist attraction (Appendix F).

In response to the question of what learners have learnt about plants: learners were able to list that they learned how to distinguish between alien and indigenous plants, about different species of plants and how they can be of benefit to humans. They learned that alien plants

should be controlled so that they do not to spread and invade the space of indigenous plants. They learned that every plant species has two names just like humans (genus and species names) (Appendix F).

Learner's response on why is it important to learn about botanical garden, plant and conservation were that they got to know about ways of taking care of different plants; how each plant is different from the other; because they have to conserve the garden so that it can save the animals and plants for future use; that the botanical garden is educational and helps a lot of people and scientists to observe different plants; because plants are beautiful and need to be conserved for other generation; it is important because scientists and people often go to it and see the relationship between plants, pollination and horticultural practices; it is important to learn about plants because they are important in our lives, also 90% of medicine is from plants; to know about plant life; it is important that everyone has to learn about nature where medicine come from; learning about plants helped learners to know more about the environment; it is important because conserving the plants assist humans in understanding about plants; so that learners can know the environment and plants that are surrounding them and diversity is very important; it's important to know what population of the plants and what must be done to keep them; it is important because lately there is a lot of carbon dioxide and the only way to reduce it is by planting more plants and trees; because people need plants to survive, they provide us with oxygen (Appendix F).

Learner's response on the greatest threats to botanical garden, plant diversity and conservation effort were that some plant might become extinct; it is humans that damaged plants and the botanical garden by leaving out rubbish; the climate change can affect botanical garden in a bad way; people coming to botanical garden and pollute the environment which can lead to dying of plants; littering and not having people to take care of the garden; alien plants brought from other places without any insects to feed on them invades land; people harvest plants for their own use to make herbs at home; cutting down of trees could be the greatest threat; alien plants because they invade and take up a lot of space and water; some plants get stolen by people who need money; is deforestation and fire; people who throw rubbish and pollute the place (Appendix F).

Learner's response on learners' personal impact to plant habitat was to make sure that no plant is in danger of being extinct by putting volunteers that can pick up the litter so that the garden can be clean; stepping on small plants and cutting down trees without replacing them can harm plants habitats which is in a way a negative impact; keep the place clean and put

fence around the place so plants won't be polluted; the place must have more water for plants so that they can grow well and environment should be safe; put rubbish away; by looking out for it, picking up litter, come up with ways to prevent littering, like having posters which says 'do not pollute the garden'; teach other people about plants and the importance of plants in our everyday of living (Appendix F).

Learner's responses on how they can use botanical garden for the benefit of the community was by providing more information on how to conserve each plant, what will it take to ensure that it survives; use the garden for learning about plants; educate the community on different plants and the importance of plants and trees, how caring for them can make life better. It can be a place for entertainment, where people could socialise and get to know the plants; to help people who are sick; teach the youth about the diversity of plants; by finding information on particular plants and also understanding what are they used for; it can be used for scientific, educational and ornamental purposes; to make community look beautiful, and also teach community about plants. It can be used as a place of pleasure and relaxation because most plants are decorative. Academically, it can help students obtain information about plants (Appendix F).

Learner's responses on how a botanical garden can be improved to enhance lessons that more information should be provided on how changes in climate will affect the relationships between plants and their pollinator; most plants at the botanical garden are labelled with names and common names; it can be a value as we can see the species that we are being taught about and understand better. However botanical gardens are a place to share knowledge. Botanical gardens can be of value because of plants that are labelled with their botanical names and common names included (Appendix F).

Learner's responses on ways that the botanical garden can be of value to biodiversity and its role in urban greening was that it brings more life; can provide home to many species of plants; it can take care of the urban greening; gives choice of plants to grow in community; it provides a unique plant community including a number of important endemic species; it gives a variety of plants which can be used in city green spaces and as an important component of the urban ecosystem providing usable habitat for many organism, including migrating species; it gives oxygen and it reduces climate change; it makes the area beautiful and the environment cleaner (Appendix F).

Future botanical garden education trends might include developing this unique niche:

teaching about the role of botanical gardens in interactive management, as well as the contribution of botanical garden networks to education. The Makana Botanical Garden should to be used as an education resource tool, and its contribution to plant conservation is likely to significantly improve education programmes (Appendix F).

Botanical Garden visits exposed learners to different types of plant species. They had an opportunity to see, smell and touch these plant species. After the Botanical Garden tour, learners were encouraged to share their experiences. Learners complained about the labels that were found on the trees in the garden. Some labels were faded, not easy to read and only contained scientific names (Plate 4). This was reported to the Department of Grounds and Gardens at Rhodes University for assistance. New name tags with the scientific name, the English name, Afrikaans name and Xhosa name were developed and installed (Plate 5). After this change, the learners found the name tags to be more relevant and accommodating in terms of providing information to all the people of Makhanda.

Plate 4. Faded tree name tags seen in the botanical garden visit with only the scientific names.

Plate 5. New botanical garden name tags with scientific, Afrikaans, English, and isiXhosa names.

Learners were asked whether were they happy with what was done and whether was it difficult or easy to collect plants? They all enjoyed the Botanical Garden walk and plant collection but complained of being tired at the end. They suggested having meetings and networking with other schools to discuss environmental issues in a non-formal environment. They said the environment kept their minds fresh even though their legs were tired. They also enjoyed listening to the sounds of birds and smelling flowers. Learners with learning barriers were accommodated by interacting with groups. I made sure that each group has a socially strong person who could encourage each learner to contribute.

5.3 Document analysis of the Makana Botanical Garden as an education resource

The Makana Botanical Garden is a place of educational activities, relaxation and entertainment. According to McDaniel *et al.* (1985), the Makana Botanical Garden has indigenous and alien plant species exchanged with botanical societies in London, Melbourne, Brisbane, New Zealand, Port Natal, Mauritius, Antwerp, Dublin, and Hampshire. These plants from all over the world are cultivated, grown and propagated so that they can provide for the beautification of all the surrounding Eastern Cape towns. By 1866, 150 trees each had been donated to Fort Peddie, Whittle Sea and Somerset East and 600 had been planted around Grey Dam in Makhanda. By 1871, 1 800 trees had been given to institutions in districts further afield and fruit trees were sent to the Diamond Fields in Kimberley. By 1875, over 12 000 forest trees had been sold (at a cheap rate) and another 40 000 were listed as ready for distribution.

The Makana Botanical Garden serves important social, health, aesthetic and ecological functions within Makhanda (Forsyth, 2003; Chiesura, 2004; Tyrvälinen *et al*., 2005). Makhanda is mountainous, and rivers originating in its hills pass through the Garden. As a result, this area provides environmental services such as air, microclimate stabilisation, water flow, erosion control, habitat provision, and water table enhancement as agued by Chiesura (2004). Urban green spaces also provide social and psychological services to urban inhabitants thereby improving the liveability and quality of cities and towns, as green spaces provide relief from crowded, stressful urban lifestyles (Chiesura, 2004). Benefits of green spaces to human well-being include livelihood provision, health improvements, stress reduction, rejuvenation and recreational activities, as well as providing a sense of peace and tranquillity (Chiesura, 2004; Saz-Salazar and Rausell-Koster, 2008).

According to Mr Tony Dold (pers. comm.) the Makana Botanical Garden belongs to the Makana Municipality, but the Gardens and Grounds section of Rhodes University is responsible for its upkeep. In the Herbarium section of Albany museum there are undated documents written by Dr Selmar Schönland with interesting stories about some old tree in the Makana Botanical Garden. The map (Fig. 2) has marked positions of these very old indigenous trees but others are exotic. Sharing this information during garden tours also makes the history of the formation of the gardens interesting to learners.

Marked trees are:

A. *Dracaena draco*. The Dragon's Blood trees produce a blood-red resin used in varnishes and for pigments. The genus has a number of species from Tropical Africa, Arabia, Socotra, and the Canary Islands). *Portulacaria afra* or spekboom is also found at site A. This species is the best fodder plant in the Eastern Cape and with rooigras (*Themeda triandra*), is one of the two mainstays of the region's stock farming industry. Succulent leaves can be eaten as salad as it has a pleasantly acidic taste. *Macadamia ternifolia* represents an exotic relative of South Africa's *Protea*. This native of Queensland, Australia, is cultivated for its nuts that can be eaten raw or roasted.

B. *Hyphaene coriacea* = (*Hyphaene natalensis*). iLala palm. Palm wine is made commercially of the sap of this palm in Zululand. Fruits have a thin dry flesh that is carved like gingerbread and a hard, white kernel that can be carved like ivory. At site B, there is a plant of the genus Phoenix, the date palm genus. This species growing in the Makana Botanical Garden is the Eastern Cape species, *Phoenix reclinata* - not the true date but the

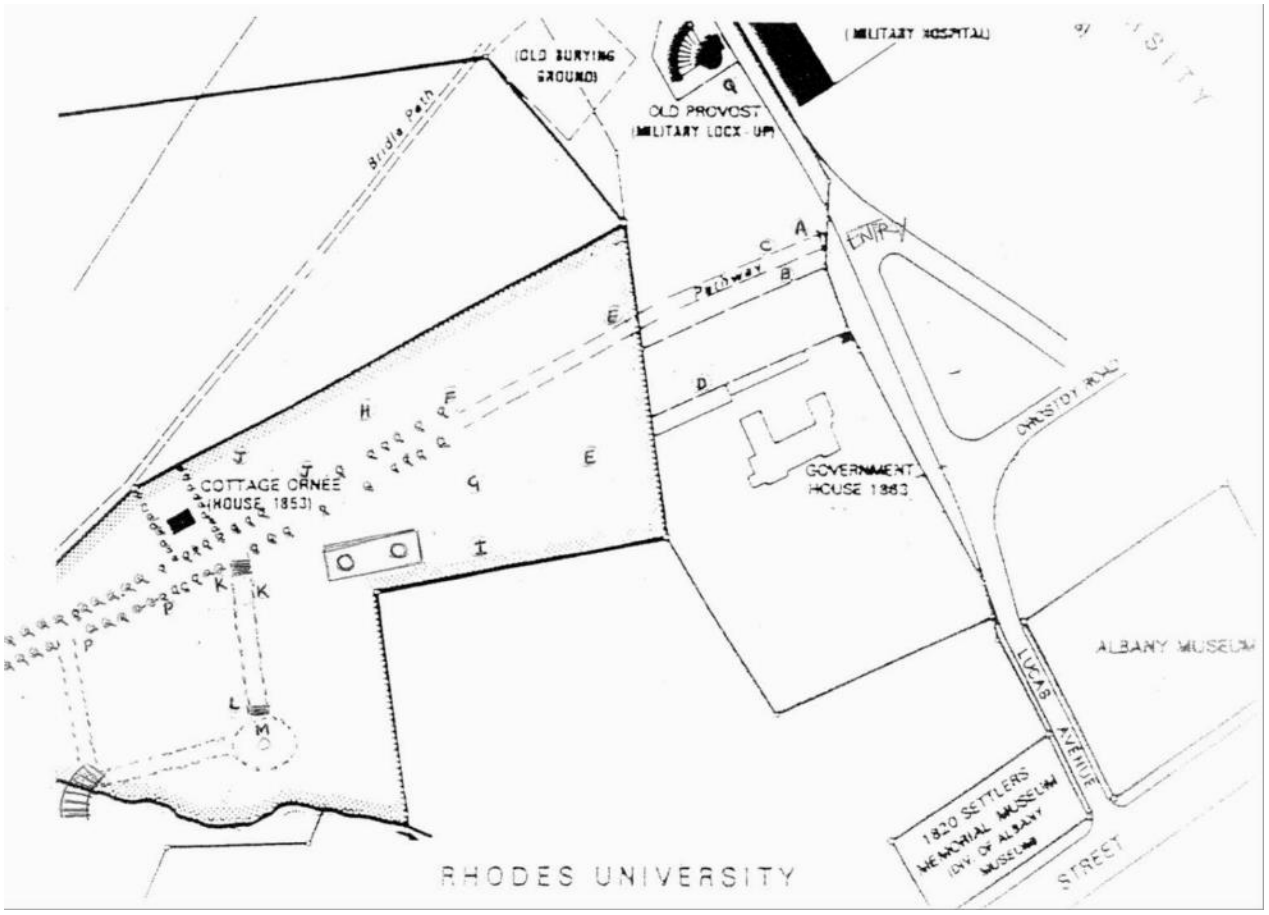

Figure 2. The Makana Botanical Garden map supplied at the gate showing marked positions of interesting trees.

fruits are also edible. The real date, *P. dactylifera* grows in Egypt and Middle East. Because dates were good food, and the trees grew where there was water, they became focal points for people to settle. These palms got their name, from the legendary bird that was supposed to nest in the trees. It is believed that there was supposed to be only one sun set its nest of spices alright and it went up in flames before being resurrected as a new Phoenix to live for the next 500 years. (Africa and Asia). *Sterculia* is an attractive street tree in Makhanda. The nuts are edible, the wood used for building, the bark for fibre rope and some species produce oils, gums and dyes.

C. *Encephalartos altensteinii,* 'cycad'. Not a flowering plant like the palms and Dracaenas but a primitive cone-bearing plant like the Pine trees of the Northern Hemisphere. These kinds of plants have been growing since prehistoric times and fossils 50 000 years old have been found so they are sometimes called 'living fossils'. It is a palm-like cycad in the family Zamiaceae. It is endemic to South Africa. It is commonly known as the breadtree,

broodboom, Eastern Cape giant cycad (Palmer and Pitman, 1972).

D. *Ficus natalensis* 'Strangler fig'. The same genus as the fruit tree. Many species worldwide. Usually very large spreading trees with roots that penetrate rocks. A strong force in breaking down solid rocks into smaller particles, eventually soil. A strangler, with their trunks wrapping around other trees, rocks, walls and crushing them. The tree under which Buddha sat when he became enlightened was *Ficus religiosa*, the Banjan. The Wonderboom near Pretoria in *Ficus pretoriae*. (Worldwide). Homalocladium. 'Tapeworm plant', 'Seaweed Plant'. A plant without any leaves. The stems are flattened and green and work as leaves. Note the flowers at the nodes. Such stems are called cladodes. Cacti also have stems functioning as leaves. (Solomon Islands). *Nerium oleander*. 'Oleander'. The most poisonous plant in the world. Alexander Great lost men and horses. Sticks used for sosaties poised the men. A few leaves in a drinking through can poison animals. One flower is enough to kill a child. In 1992 a marathon runner practising outside to hospital in a coma. (Middle East).

E. *Eucalyptus globulus*. A very big genus of trees in Australia. One of the tallest kinds of trees in the world is *Eucalyptus regnans* which competes with the Californian redwood, *Sequoia sempervirens* for the title of tallest (120m). They grow quickly but impoverish the soil they grow in. Were planted in plantations in South Africa to supply the mines with struts and for telephone poles (Australia). *Eucalyptus*. One row of trees was planted in front of the Military hospital around 1850. Bark peels off completely leaving the trunk shining white. Australian folklore tells a story of a small green snake which curled up the tree to slough off its old skin. The tree made fun of it and called it ugly and tattered, so Mother Nature cursed the tree and said that ever afterwards it would look ragged and tattered because its bark would keep peeling off.

F. *Calodendron capense*. 'Cape Chestnut'. Have big trusses of pink, spotted flowers. Name means beautiful (Callos), tree (Dendron). (E. Cape forests).

G. *Araucaria bidwilii.Araucaria cunninghamia*. 'Monkey puzzle and confuses monkeys. Seeds edible. (Australia).

H. *Casuarina cunninghamiana*. Grown as sand-binders on beaches. Has become a weed tree in South Africa. Has no leaves and the thin twigs that perform the leaf function bear small cone-like fruits, but it is a flowering plant not a coniferous plant.

I. *Bambusa vulgaris*. 'Bamboo'. One of the big grass family. Very useful in the Far East

where they are common, and people make houses, furniture, baskets and hanging bridges of the stems. Very fast-growing.

J. *Strelitzia reginae*. Named after King George III's wife Charlotte whose surname was Mecklenburg-Strelitz, ('reginae means queen). One of South Africa's most famous flowers and has also been used as the emblem of California in the U.S.A. and on one of the S. African coins. (S. Africa). *Phoenix canariensis*. The Canary Island Phoenix.

K. *Schotia brachypetala* 'Boerboon'. The seeds can be roasted and eaten and are also used as a coffee substitute. (South Africa). Unusual growth with swollen base.

L. *Laurus nobilis*. 'Laurel', 'Bay'. A relative of the best South Africa timber tree, 'Stinkwood', *Ocotea bullata*. The fragrant leaves are used in food for flavouring. It is the plant that was used to make wreaths to honour famous people such as the Roman Ceasars. (Europe, Mediterranean).

M. Sundial. An old instrument used for telling the time by the shadow cast by the sun.

N. *Typha capensis*. 'Bullrushes'. Reeds that grow thickly in rivers all over Africa and Middle East. The rushes in which Miriam hid Moses as a baby where the princess of Egypt found him and adopted him.

O. *Gardenia thunbergii*. Tree with fragrant white flowers. Very hard wood favourable by Xhosas as throwing sticks for hunting (South Africa).

P. *Ficus natalensis* commonly known as Strangler fig and *Erythrina humeana* commonly known as dwarf lucky bean tree. (South Africa).

5.4 The Plant Conservation Message needed in the Makana Botanical Garden

The Makana Botanical Garden should be at the forefront of conservation and education. As plant species become extinct and habitats become degraded or lost, the use of the Botanical Garden for plant conservation education will become more important.

The transmission of conservation messages should rely on a variety of communication methods (Fenn, 2003). Various communication methods should include labels (in local languages adding to scientific names), talks, guided tours, lectures, printed materials from pupil- and teacher-centred literature to guide books, brochures and scientific reports;

outreach programmes; use of local media and creating a total ambience of a conservation conscious organization. The Makana Botanical Garden should expand to use a mixture of the above techniques and constantly evaluates its effectiveness. It is important to know whether the messages are being received and whether the media used are appropriate.

5.5 Discussion

The findings from the learner's responses of the worksheet questions reflected an improvement in learner's knowledge following their visit to the botanical garden. According to Stringer (2008) this is in line with action research that is a process of systematic inquiry that seeks to improve social issues affecting the lives of everyday people. Findings showed that learners were able to list that they learned about the plants and distinguish between alien and indigenous plants. This is an indication tool that can determine whether teaching practices were effective (Sagor, 2004).

The learners experienced a documented collection of living plants for the purposes of scientific research, conservation, display and education during their botanical garden visit. This concept could be applied at their school grounds at the discretion of the school. Assistance for planning and implementation of similar lessons could be provided by the Selmar Schönland Herbarium. These education programmes can help the public develop greater environmental awareness by understanding the meaning and importance of ideas like conservation and sustainability (Desmond, 2007).

Botanical garden visits exposed learners to different plant species. Learner's benefited from the Makana Botanical Garden outing lessons as they did not only enable them to differentiate between alien and indigenous plant species but also taught them how to recognise which plants need protection and conservation. They were able to see the decrease in distribution of some indigenous species in a similar way to the findings of Laughlin (2003), and the spread of alien species following introduction, as agued by Johnston and Selander (1964), Selander and Johnston (1967), and Fraile *et al*. (1997). They also learnt about the distribution of plants and the need for a plant collecting effort across landscapes. The issue raised by the learners about labels was an indication that they wanted to be associated with those plant species that they were able to recognise – particularly those that are used in the community for ritual and cultural activities, medicines and food. According to Spencer and Cross (2017) a botanical garden is a garden dedicated to the collection, cultivation and display of a wide range of plants labelled with their botanical names.

6. The role of the Selmar Schönland Herbarium in plant conservation education and awareness

In this chapter I describe how a herbarium can be used as a resource in lessons through the use of plant identification. All instructional materials needed for the lessons are listed in a lesson plan (Appendix B).

A herbarium is a reference library of pressed and dried plant specimens used for, identification so that a user may identify plants to name (Bailey, 1935). Most species of plants were first described from dried specimens and if we were obliged to make diagnoses from living subjects alone, the plants of the world would yet be mostly unknown (Bailey, 1924). Wherever critical judgment is required, files of dried herbarium specimens are the only way to ensure defensible identifications (Svenson, 1935).

Turrill (1964) suggested that herbaria be divided into special and general specimens. Special specimens would include local ones (those devoted to a given area and serving local interests), special research herbaria (e.g. cytological and cytogenetic vouchers), or ecological herbaria (including not only specimens but photographs, field notes, schemes of ecological analysis). Turrill (1964) describes the purposes of a general herbarium as a provider of facilities for determination of material, including new taxa enabling new monographs and floras to be prepared; a preserver of specimens of historic importance, such as type specimens dating discoveries, introductions, and increases or restrictions of ranges; assembling data for working out ranges and ecological distributions; bringing together in a relatively permanent form, specimens for comparative morphological or phylogenetic studies and a provider of material for special researches, as in plant anatomy and palynology.

According to Mr Tony Dold (pers. comm.), the Selmar Schönland Herbarium houses approximately 200 000 plant specimens, making it the 4th largest herbarium in South Africa and the 9th largest on the continent. Its taxonomic coverage is broad, but the majority of the specimens are angiosperms. Geographically, this herbarium focuses on the flora of the Eastern Cape Province of South Africa, although collections from most parts of Southern Africa are also available. It also provides a free information service to students, researchers, and the general public.

6.1 Herbarium presentation

Before learners started identifying plants, I introduced them to the herbarium by giving them a presentation. During this, I explained to the learners how to use the herbarium. This started from the preparation room where specimens are prepared before they are taken into the collection. Learners were shown how to dry their plants and then how to press their collected plants until dry between blotters that absorb moisture. A freezer is used to kill insects that may be on or in the specimens. They were shown that after drying, specimens are mounted onto herbarium sheets with a suitable label, after which the mounted and correctly identified specimens can be filed in the cupboards according to the information on their labels. They were also told that the specimen of the plant that first and originally receives the species name becomes the 'type specimen' against which all others are compared. The purpose of the collection was also explained and included the concept that wherever critical judgment is required, files of dried herbarium specimens are the only reference.

Lessons presented in the herbarium were based on a three-step learning cycle method (Rakow, 1986; Colburn and Clough, 1997). In this lesson format, the instructional period was divided into three sequential phases: exploration, concept development, and concept application. During exploration, learners were allowed to work with the lesson material as individuals or in small groups without direct help from the herbarium educator. Exploration is learner-focused. This phase frequently involves placing learners in cognitive 'disequilibrium' as they attempt to understand a new concept and assimilate it. In concept development, the herbarium educator introduces the main concepts of the lesson utilizing information or insights learners gleaned from the exploration phase; this is the main 'instruction' part of the lesson and the only teacher-centred phase of the cycle. In the third and final phase of concept application, learners apply what they have just learned to a similar (but novel) situation. This learner-focused phase also provides the herbarium educator with opportunities to formally evaluate the learners. The reason for eliciting prior understanding is that current research in cognitive science has shown that eliciting prior understanding is a necessary component of the learning process. Expert learners are much more adept at the transfer of learning than novices. Practice in the transfer of learning is required in good instruction (Bransford et al. 2000).

Exploration phase

During the exploration phase, as herbarium educator, I engaged learners through a demonstration of comparative anatomy. I showed them the leaf of a cycad and a leaf of a palm tree. In addition to this, a male and a female cone of the cycad is placed next to palm fruits (dates). In conversation with the learners, I encouraged them to access their prior learning. During the exercise the learners were asked to place the cones and dates next to the leaf they match. Throughout the exploration phase, learners were allowed the opportunity to ask and attempt to answer questions about these two species. The exploration phase of the learning cycle provided an opportunity for learners to observe, record, plan, interpret, develop hypotheses, and organise their findings.

Learners were allowed to handle the specimens under supervision. Bogue (1894) suggests that all poisonous plant specimens must be treated as dangerous no matter their age because centuries-old specimens can still cause poisoning in susceptible individuals. According to Fisher and Shaffer (1996) all individuals involved in the lesson should wear protective gloves, even if they claim to be immune. Either cotton or vinyl gloves were used, because the poison may pass through latex or rubber gloves.

Concept development

During concept development, as the herbarium educator I framed questions, suggested approaches, provided feedback, and assessed the learner's understanding. I guided learners to coherent and consistent generalizations, helped them with distinct scientific vocabulary, and provided questions that helped them use this vocabulary to explain the results of their explorations. The distinction between exploration and explanation components ensures that concepts precede terminology.

Concept application

The concept application phase ties directly to the psychological construct called 'transfer of learning' (Thorndike 1923). In South Africa, schools provide an education with the expectation that more general uses of knowledge will be found outside of school and beyond the school years (Hilgard and Bower 1975). Transfer of learning can be transfer of one concept to another, but also from one school subject to another; one year to another; and from school to non-school activities (Bransford *et al*. 2000). I asked the learners to use herbarium library books and plant specimens to identify their own specimens and research their history of use. They had to find out if these plants have been always popular, only in the past, or only

recently. Has their use changed over time? Is there any scientific basis for their use and, if so, what is it?

6.2 Plant identification by learners

Learners were able to identify the plants that they collected (Chapter 5) and were able to determine which of them are indigenous. The resources available in herbarium were used to complete this task. Herbarium literature in the library was made available, and they were offered personal assistance to answer their questions, clarify and simplify any complex information. Through this they learnt that alien plants have the potential to spread aggressively and threaten indigenous ecosystem functioning and biodiversity (Vitousek, 1990; Bridges, 1994). Alien plants have been introduced into the country as ornamentals for gardens, or for cultivation in commercial forestry or agriculture e.g. *Acacia mearnsii* (Le Maitre *et al.*, 2002). However, many have also been introduced unintentionally – for example, in animal feed.

Learners also discovered that if plants are removed from their natural environment, they often require special nurturing because their new habitat is not entirely suitable. They also learnt that getting rid of invasive alien plants can be very expensive, especially when using mechanical and chemical controls. They also learnt that controls are seldom effective in the long term.

Learners had gained experience of herbarium plant identification, looking up information about the samples and drawing them. They had gained experience of working in a group and taking responsibility for a task. They also learnt about the classification process which enabled group participation in defining the types of species that should be protected and how at risk those species are.

Learners used the Selmar Schönland Herbarium to identify 73 out of 89 plant species collected from the Makana Botanical Garden (Table 6). Of these, 16 plants had tags with names on them. One group of learners used the herbarium collection in combination with other resources available in the herbarium library to predict distributions of species. This group of learners developed a learning resource that could be of help to the next group of learners who could participate in this type of learning experience. This was done by mounting and labelling the plant specimens collected by the learners and making these available in a file as a source of reference for the teachers and learners at the school. The learners also experienced a documented collection of living plants for the purposes of

scientific research, conservation, display and education during their botanical garden visit. This concept could then be applied at their school grounds at the discretion of the school.

Table 6. Plants collected by learners during the botanical garden visit.

Botanical name		
Aloe ferox	*Harpephyllum caffrum*	*Oedera genistifolia*
Aloe pluridens	*Homalocladium platycladum*	*Ornithogalum longibracteatum*
Aloe speciosa	*Hymenosporum flavum*	*Pelargonium alchemilloides*
Araucaria bidwilii	*Hyphaene coriacea*	*Pelargonium inquinans*
Araucaria cunninghamiana	*Hypoestes aristata*	*Phoenix canariensis*
Asparagus densiflorus	*Hypoestes foesleadii*	*Phoenix dactylifera*
Bambusa bambos	*Hypoxis hemerocallidea*	*Phoenix reclinate*
Barleria obtusa	*Intergrifolia ternifolia*	*Phylica axillaris*
Bauhinia bowkeri	*Jacaranda mimosifolia*	*Plectranthus fruticosus*
Brachychiton populneus	*Kiggelaria africana*	*Plumbago capensis*
Brachylaena discolor	*Lagerstroemia indica*	*Portulacaria afra*
Bulbine frutescens	*Lagunaria patersonii*	*Quercus robur*
Burchelia lubahia	*Lampranthus aureus*	*Quercus turneri*
Calodendron capensis	*Gardenia thunbergii*	*Rothmannia globosa*
Canthium inerme	*Grevilea robusta*	*Phoenix canariensis*
Carissa bispinosa	*Grewia occidentalis*	*Phoenix dactylifera*
Carpobrotus delicimsus	*Harpephyllum caffrum*	*Phoenix reclinata*
Casuarina cunninghamiana	*Homalocladium platycladum*	*Salvia africana-lutea*
Centella asiatia	*Hymenosporum flavum*	*Salvia capensis*
Chamaerops humilis	*Hyphaene coriacea*	*Schotia brachypetala*
Chrysanthemoides monilifera	*Hypoestes aristata*	*Scutia myrtina*
Crassula multicava	*Hypoestes foesleadii*	*Searsia chirindensis*
Cussonia spictata	*Hypoxis hemerocallidea*	*Searsia pallens*
Dietes grandifolia	*Intergrifolia ternifolia*	*Salvia africana-lutea*
Dietes iridioides	*Jacaranda mimosifolia*	*Salvia capensis*
Diospyros dichrophylla	*Kiggelaria africana*	*Schotia brachypetala*
Dracaena cinnabari	*Lagerstroemia indica*	*Scutia myrtina*
Encephalartos attenteinii	*Lagunaria patersonii*	*Senecio linifolius*
Erythrina caffra	*Lampranthus aureus*	*Senecio speciosus*
Erythrina humeana	*Laurus nobilis*	*Sideroxylon inerme*
Eucalyptus regnans	*Macadamia ternifolia*	*Sterculia acerifolia*
Euryops anethoides	*Magnolia grandiflora*	*Strelitzia nicolai*
Felicia amelloides	*Melia azerdarach*	*Strelitzia reginae*
Ficus natalensis	*Macadamia ternifolia*	*Tecomaria capensis*
Ficus sur	*Magnolia grandiflora*	*Themeda triandra*
Gardenia thunbergii	*Melia azerdarach*	*Typha capensis*
Grevilea robusta	*Nerium oleander*	*Vachellia karroo*
Grewia occidentalis	*Ocotea bullata*	*Zantedeschia aethiopica*
		Zanthoxylum capense

6.3 Discussion

An adaptive management approach (which is a systematic approach) was used to prepare herbarium lessons (Appendix B) so as to maximise subsequent lessons. Additionally, use of materials was optimised so that materials from one lesson may be employed in another, minimising preparation time. This lesson plan utilised herbarium specimens and literature in herbarium library to teach basic concepts in plant taxonomy. The lesson embodies three overarching goals: (1) to assist learners in learning plant systematics by presenting them with activity-based practical exercises; (2) to familiarise learners with collection techniques; and (3) to provide learners with practice in working with herbarium specimens.

Learners benefited from the Selmar Schönland Herbarium lesson because they were able to identify their collected plant species. They also used the herbarium library to differentiate between alien and indigenous plant species. They found that some of these plant species are of medicinal use and 80% of people rely on traditional medicine (Weragoda 1980). This allowed them to recognise plants that need protection and conservation. Some herbarium labels were found to contain important data on habitat needs, flowering time, or morphological characteristics that may assist both field botanists or collectors as well as horticulturalists propagating plants for commercial or research purposes. They could see that there have been increases in distribution of some indigenous species (Laughlin, 2003) as well as the spread of alien species following introduction (Johnston and Selander, 1964; Selander and Johnston, 1967; Fraile *et al*., 1997). Through this, they also learnt about information of a geographic nature, which depends upon the distribution and intensity of collecting effort across landscapes.

Conclusion

This study followed the four-stage method in action research as proposed by Mertler and Charles (2005): planning, acting, developing, and reflecting. In my reflections I have noticed that the presentation I gave to learners in a herbarium was of value where the formal education system lack integration of environmental issues (Padgham, 1995). It does appear that the schools are still under-utilising existing institutions that can be used as places of learning about the conservation of endangered species as agued by Azevedo *et al*. (2012), for the conservation of biodiversity (Hoban and Vernesi, 2012), or for educational programmes aimed at public awareness of environmental issues (Wheater, 1995; Marandino and Diaz Rocha, 2011; Meadows, 2011).

This study has developed materials for teachers and pupils. It also integrated appropriate information about biodiversity into the curriculum as early as in the Basic Education and Training phases. This type of activity should be further popularized out of school through effective popular media. South Africa should invest in the environmental education of its people by promoting and adequately funding herbaria and botanical gardens. Awareness of the natural heritage generates pride and scientific curiosity. Visits and first-hand experiences generate awe, pleasure and, hopefully, the will to conserve nature (Bagarinao, 1998).

7. Medicinal and cultural use of plants by community members

From a conservation perspective, the area of Makhanda is of great concern because it falls within the Maputaland-Pondoland-Albany Hotspot, in which there are 39 endemic vascular plant genera (Steenkamp *et al.*, 2004). The use of aromatic and medicinal plants goes back to the dawn of our civilization, with testimonies dated from the year 200 (McHoy and Westland, 1994). Their economic importance also dates from that time (Garland, 1979). In recent years, in most developed countries, a growing interest in the study, research, consumption, and production of medicinal and aromatic plants developed together with a wide and growing field of applications in pharmaceutical, food and cosmetic industries (Muñoz, 1993). Eleven out of fifteen of learners visiting the Albany Museum herbarium from the Makhanda area have also confirmed that they use traditional medicines, food (*imifino*) and cosmetics (*imbola*) derived from wild plants at home.

Plant conservation may be considered to be part of conservation biology, a field that emphasizes the conservation of biodiversity and whole ecosystems, as opposed to the conservation of individual species (Soule, 1985). Within plant conservation many topics can be found that include medicinal plant conservation (Heywood and Iriondo, 2003; Krupnick and Kress, 2005). According to Cocks and Dold (2000) the use and trade of plants for medicine is no longer confined to traditional healers but has entered both the informal and formal entrepreneurial sectors of the South African economy thus resulting in an increase in the number of herbal gatherers and traders. Herbalists are so popular in Africa that a herb trading market in Durban is said to attract between 700 000 and 900 000 traders a year from South Africa, Zimbabwe, and Mozambique. Smaller herb markets exist in virtually every community (Kale, 1995).

Kala (2004, 2005b) argues that the high prices of modern medicine are causing many people to return to herbal medicines that have fewer side effects. The argument that medicinal plants are mainly the alternative income-generating source of underprivileged communities is also supported by Myers (1991), Raven (1998) and Lacuna-Richman (2002). Realising the continuous erosion in the traditional knowledge of many valuable plants for medicine in the past and the renewal of interest at present, the need existed to review the various issues associated with the collection of medicinal plants.

7.1 Medicinal and cultural plants in the street market

Interview questionnaires were used to obtain information from community members on medicinal and cultural plants (Appendix E). The community members interviewed referred to 27 different species used for medicinal or cultural purposes (Table 7). Evidence for harvesting could be found in and around Makhanda. Observations were supplemented by my field visits to illegal collection sites as it was confirmed by the Makana Botanical Garden security. This is where visible holes can be observed as an indication of harvested plants (Plate 6). This means there is a need for security and prevention measures. During interviews I also observed medicinal and cultural plants in the street market (Plate 7). Other street vendors mix their medicinal and cultural plants with fruit and vegetables (Plate 8). They believe that business in a mixed market is more effective than selling only one product.

Table 7. Medicinal and cultural plants listed from community member's responses.

Xhosa plant names	**Scientific plant names**	**Family**	**Use in isiXhosa**	**English translation**	**Source**
Umkhondo	*Agapanthus praecox*	Agapanthaceae	Isifo senkomo	To treat arthritis	Harvest from nearby forests sometimes buy it from street vendors and herbal shops
Umathunga	*Haemanthus albiflos*	Amaryllidaceae	Xa kunyangwa izivubeko	To treat internal injuries	Harvest from nearby forests
Intlolokotshana	*Searsia* spp.	Anacardiaceae	Isifo senkomo	To treat diseases in cattle	Harvest from nearby forests sometimes buy it from street vendors and herbal shops
Ingcelwane	*Bulbine latifolia*	Asphodelaceae	Isisu	To treat stomach ache	Harvest from nearby forests
Impepho	*Helichrysum odoratissimum*	Asteraceae	Uyaqhumsi xa ugxotha izinto ezimdaka	To chase away evil spirits	Harvest from nearby grassland
Isichwe	*Helichrysum pilosellum*	Asteraceae	Xa kunyangwa isilonda	To treat wounds	Harvest from nearby forest or grassland

Unozitholana	*Silene undulata*	Caryophyllaceae	Isilawu	To obtain answers from ancestors	Harvest from nearby forests
Umdlavuza	*Lauridia tetragona*	Celastraceae	Unceda idliso; iintwala zehagu nentlanga	To treat poisoning To treat pig lice Wash for cleansing	Harvest from nearby forests sometimes buy it from street vendors and herbal shops
Ubhoqo	*Convolvulus* spp.	Convolvulaceae	Xa kunyangwa inebekelo	To protect from sorcery	Harvest from nearby forests
Umlahleni	*Curtisia dentata*	Cornaceae			Harvest from nearby forests
Usikoliplati	*Dioscorea sylvatica*	Dioscoreaceae	Unceda isisu; utyila namaphupha	To treat stomach aches To reveal the meaning of dreams	Harvest from nearby forests
Umthombothi	*Spirostachys africana*	Euphorbiaceae	Unceda ibekelo	To treat illnesses caused by witchcraft	Harvest from nearby forests
Ubobobo	*Dalbergia armata*	Fabaceae	Lunceda abakhwetha	To assist male initiates	Harvest from nearby forests
Iphuzi	*Gunnera perpensa*	Gunneraceae	Unceda umlambo	To treat allergies	Harvest from nearby forests sometimes buy it from street vendors and herbal shops
Inqwebeba	*Ornithogalum longibracteatum*	Hyacinthaceae	Uhlambangayo	Wash for cleansing	Harvest from nearby forests
Umagaqana	*Bowiea volubilis*	Hyacinthaceae	Xa kunyangwa izintso	To treat kidney disease	Harvest from nearby forests
Umrateni	*Drimia elata*	Hyacinthaceae	Uyahlamba ngawo	Wash for cleansing	Harvest from nearby forests
Inongwe	*Hypoxis hemerocallide a*	Hypoxidaceae	Xaune HIV, umhlaza, nengxaki zesintyi, iyathanjiswa	To treat HIV To treat cancer For cosmetics	Harvest from nearby forests

Umnonono	*Strychnos henningsii*	Loganiaceae	Iswekile	To treat diabetes	Harvest from nearby forests
Umayisake	*Cissampelos capensis*	Menispermaceae	Unceda xa unentloko	To treat headaches	Harvest from nearby forests sometimes buy it from street vendors and herbal shops
Umaphipha	*Rapanea melanophloeos*	Myrsinaceae	Usetyenziswa Xa unentwala zehagu	To treat pig lice	Harvest from nearby forests
Umnquma	*Olea africana*	Oleaceae	Xa kusenziwa isiko	For rituals	Harvest from nearby forests
Umkhwenkwe	*Pittosporum viridiflorum*	Pittosporaceae	Xaugajiswa	To induce vomiting	Harvest from nearby forests
Ummemezi	*Cassipourea flanaganii*	Rhizophoraceae	Uyaqatywa ebusweni; utsala abathengi	For cosmetics To attract customers	Buy it from street vendors and herbal shops
Impendulo	*Rubia petiolaris*	Rubiaceae	Sisilawu sisetyenziswa xa kufunwa izinyana ziphendule	To obtain answers from ancestors	Harvest from nearby forests
Uchithibhunga	*Rhoicissus tomentosa*	Vitaceae	Utshiza izinto ezimdaka;	For chasing away evil spirits	Harvest from nearby forests
Umnxeba	*Rhoicissus tridentata*	Vitaceae	Xa kusenziwa amakhuko entlahla	To make good luck charms	Harvest from nearby forests

Plate 6. Illegal collection sites showing holes where plants were harvested.

Plate 7. Plants for sale in a Beaufort Street market in Makhanda for medicinal and cultural uses.

Plate 8. Mixed street market with cooking pots, fruit, and medicinal and cultural plants.

7.2 Discussion

Evidence exists of both informal and formal entrepreneurial sectors trading in wild plants from Beaufort Streets in Makhanda. Here, 1 out of 3 street vendors sells traditional medicinal plants (Plate 7). Apart from the informal vendors, there are also three herbal shops. When street vendors were asked to give reasons for selling traditional medicinal plants, they indicated that they do this in order to support their families. These street vendors confirmed that have no formal environmental education background. They rely on their traditional and indigenous knowledge. Each one of them is using her own discretion on the amount of medicinal plants that she is collecting and selling. The efficacy of traditional medicines has not always been tested. More importantly, their collecting is not regulated and there are no formal guidelines that they follow in their activities. However, they argue that they have been using their own methods of collection for years.

Conclusion

Data generated from the interview questionnaires have contributed to an understanding of the background of community members, traditional healers and street vendors and their experience and knowledge about medicinal and cultural plant conservation. Some of the respondents are street vendors selling medicinal and cultural plants in Makhanda were also community members. They were selling the plant material because they need money to buy food, clothes and even pay school fees for their children. Their customers were traditional healers and ordinary people who perform cultural activities. They also said that they were encouraged by the high demand for these plants which keeps their business alive. They collect plants without permission and avoid the authorities who can charge them as they do not have legal permission to sell these plants. Most of their plants are collected from protected areas. They feel justified in collection from the protected areas, because most of the protected areas in the country were demarcated at the expense of the local people who are living on the land at the time (Wynberg and Kepe, 1999). They even blame the previous apartheid government for economic inequalities for taking away their resources. Most of them do not understand and are not interested in conservation policies. It is possible that they do this because they have been alienated from conservation concepts and implementation for many decades (DEAT, 1997). They claim to have been using plants since ancient times and intend to continue to do so. In general, Makhanda people use plants for many different reasons, including agricultural and industrial reasons. These uses are part of the school curriculum. However, others use them for cultural and medicinal activities and these are not catered for in the South African school curriculum.

Although South Africa has acts such as the National Environmental Management: Biodiversity Act 10 of 2004 and according to this act, people and organizations should act with due care to conserve and protect biodiversity, and to use biological resources sustainably, equitably and efficiently, people in South Africa use plants for cultural or medicinal uses without the appropriate approval. Such use, most importantly, is often done without a sense of conservation or an understanding of sustainable utilization levels of the species that are harvested from the wild. These acts are not effective as plants are still being sold widely in towns and cities (Plate 8). Biodiversity strategies advocated a ‘protectionist approach,’ viewed by the majority of South Africans as protecting nature from human activities (Wynberg 2002), and which further intensified the economic divide by making the gathering of livelihood sustaining natural products illegal (Davis and Trzya, 2005).

In Beaufort Street, Makhanda (shown in Plate 7) there were more than five street vendors selling medicinal plants and most parts of plants, including bulbs, roots and bark. This action is likely to reduce plant diversity and may lead to a reduction in the provision of ecosystem services, decreasing productivity and promoting a loss of nutrients from ecosystems (Tilman *et al*. 1996). Ecosystem stability is thought to be affected by such collections, with ecosystem services becoming more tenuous with a decrease in diversity (McGrady-Steed *et al*. 1997; Naeem and Li 1997).

8. Investigation of the plant diversity, density, abundance and distribution in the Makhanda streets

Street trees provide critical ecosystem services that contribute to human health and environmental quality (Kuruneri-Chitepo and Shackleton, 2011). There has been an argument that securing the biodiversity, ecological, social and economic benefits offered by street trees is particularly challenging in developing countries because of rapid development and urbanization (Jim and Chen, 2009). Street trees offer an immediately available resource for learners without the expense of travelling.

Randomly selected streets in Makhanda were surveyed for trees that could be used in environmental educational activities. Figure 3 gives a map showing the locality of the streets listed in Table 8.

Table 8. The streets (alphabetically arranged) surveyed for sidewalk trees in Makhanda, South Africa.

African Street

Allen Street

Artillery Road

Bathurst Street

Beaufort Street

Chase Street

Donkin Street

Drostdy Road

High Street

Hill Street

Lawrence Street

Market Street

Milner Street

New Street

Prince Alfred Street

Somerset Street

West Street

Specimens were taken from each tree and a list of plant species was compiled using field guides (Palgrave, 2002; van Wyk and van Wyk, 2011). The specimens were identified in the Selmar Schönland Herbarium. The role of street trees was assessed by annotating the species list to indicate whether the trees are aliens or indigenous and whether they are useful species. For each species, the impacts of chopping of branches and selling the wood, as well as harvesting and selling of medicinal plants is assessed.

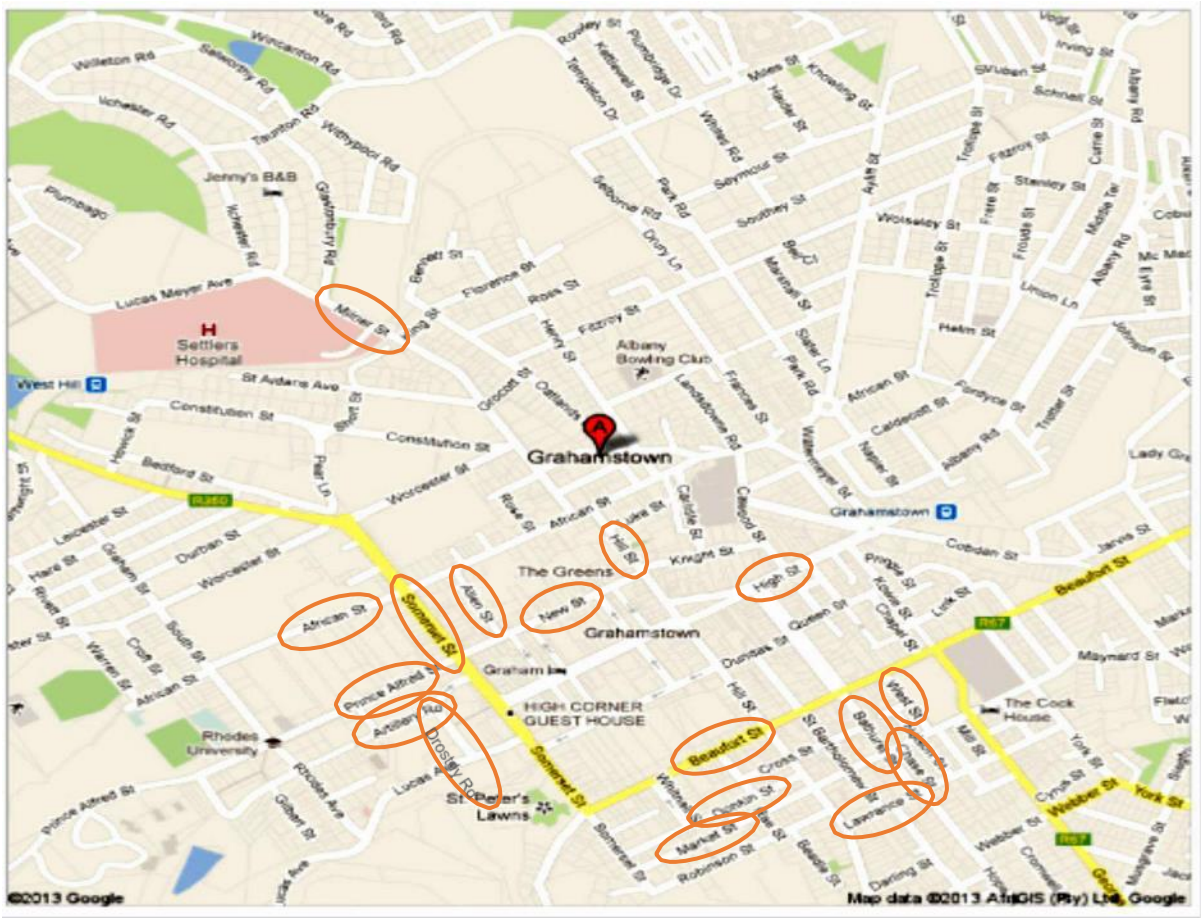

Figure 3. Google Map of Makhanda showing the location of the streets surveyed (orange circles) for sidewalk trees.

The total number of trees of each species was recorded from all 17 sampled streets. The probability of a street having the species (# plants of the species / 17 * 100) as well as finding the species in any street (# of streets with that species/17*100) is given. At the time of surveying of the sidewalks, an additional list was recorded of tree species found in gardens or hedges of the properties adjacent to the street. The number of trees were not counted because accurate counting would have necessitated permission to access private property. A

significant limitation of this study was that the area was surveyed over three months and therefore seasonal changes were not observed. These limitations may result in an under-representation of flowering specimens due to the time of year when the survey was undertaken.

8.1 Results and Discussion

A total of 1 467 trees, comprising 35 species were recorded from the 17 selected streets in Makhanda (Table 9). Of the 35 species, only 15 (43%) were indigenous with 20 (57%) being alien. Some streets such as African Street, High Street, Hill Street, Lawrence Street, Market Street, Prince Alfred Street and Somerset Street had diverse species (Figure 4). This mixture of plants provides forage for a variety of insect and vertebrate species and this promotes biodiversity. In a mixture there are some plants that will tolerate drought, are insect resistant, or able to withstand disease outbreaks so that the long-term survival of trees is assured. The lack of diversity of species in other streets (such as Allen Street, Figure 4) is a warning sign because if a pest or disease occurs, all the trees in that street will be affected.

A further 41 plant species were found alongside the 17 streets in the properties adjacent to the sidewalks (Table 10). Of these there were only 15 alien species (37%) with 26 species being indigenous (63%). Most of these additional species were recorded in Makhanda West (Plate 9). In this area the public enjoy wildlife gardening (Baines, 1985; Lavelle and Lavelle, 2007). Community members of Makhanda West promote the planting of indigenous tree species in residential gardens, stressing their value to nature conservation biodiversity. This has a major impact on the composition of the ‘urban forest’ (Gaston, 2007) as trees in private gardens account for the vast majority of trees in residential areas (Britt and Johnston, 2008) as has been reported in the literature (Gaston, 2007).

Makhanda West (Plate 9) is a residential area that is predominantly occupied by Whites, with only a few African households. This is due to the high socio-economic standards. In the same area, schools with their playgrounds have many trees (Plate 10).

In these areas there are a large number of plants and no livestock. The learners attend schools where their playgrounds are surrounded by trees that provide shade and create an awareness of plants and the environment. These images are a stark contrast to photographs taken in Makhanda East (Plate 11), an area mostly occupied by Africans.

In Makhanda East, streets (Plate 11) as well as schools and playgrounds (Plate 12) hardly have any trees, but instead you see children play in areas where livestock graze.

Table 9. Plant species collected from the sidewalks of Makhanda Streets (Fig. 8.1). The total number of trees of each species are also given, as well as the number of streets with that species and the probability (%) of occurrence of each species for a street. Exotic species are indicated with an *.

Names of Plants	**Bathurst**	**Hill street**	**Lawrence**	**Prince Alfred**	**West street**	**Chase street**	**High street**	**Milner street**	**Somerset**	**New street**	**African**	**Allen street**	**Market street**	**Donkin street**	**Beaufort**	**Drosdy street**	**Artillery**	**Total**	**Probability**
*Brachychiton populneum**	0	0	0	0	5	0	11	0	3	0	0	0	0	0	0	0	0	**19**	1.3%
*Callistemon rigidus**	0	0	0	0	0	0	0	0	5	0	2	0	0	0	0	0	0	**7**	0.5%
Calodendron capensis	2	0	0	0	0	0	11	0	1	0	0	0	1	0	3	0	1	**19**	1.3%
Celtis africana	0	0	2	9	0	0	43	0	3	6	2	0	13	3	16	32	13	**142**	9.7%
*Cordyline australis**	0	32	12	0	0	0	0	0	0	0	10	0	0	0	0	0	8	**62**	4.2%
Dais cotinifolia	0	0	3	3	0	0	0	1	2	0	0	0	0	0	0	4	0	**13**	0.9%
Ekebergia capensis	0	0	0	0	0	0	5	2	2	2	0	0	2	0	12	1	4	**30**	2.0%
Encephalartos altensteinii	4	0	1	8	0	0	15	6	4	0	4	0	2	0	0	0	0	**44**	3.0%
Erythrina caffra	0	11	1	27	0	0	7	2	2	0	1	0	6	1	3	5	0	**66**	4.5%
Eucalyptus spp.*	6	13	0	0	0	0	10	24	0	1	0	0	0	0	58	0	1	**113**	7.7%
*Ficus macrophylla**	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	**6**	0.4%
Gardenia thunbergii	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**	0.2%
*Grevillea robusta**	29	47	0	0	1	0	0	0	2	0	1	0	27	45	12	0	0	**164**	11.2%

Harpephyllum cafrum	0	16	4	11	0	2	0	1	22	0	0	0	3	1	0	9	0	**69**	4.7%
*Jacaranda mimosifolia**	17	21	3	4	1	4	1	17	31	5	4	17	20	16	14	1	35	**211**	14.4%
*Melia azerdarach**	0	11	1	0	0	0	0	2	1	0	2	0	5	0	0	0	0	22	1.5%
Olea europaea	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	3	0.2%
Phoenix reclinata	0	4	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2	9	0.6%
Pinus spp.*	0	8	0	9	0	0	7	4	12	0	3	0	15	0	6	0	0	64	4.4%
*Platanus occidentalis**	2	12	1	0	2	0	2	0	0	0	0	0	0	0	0	0	0	19	1.3%
Podocarpus spp.	0	2	2	13	0	0	0	0	0	0	0	0	2	0	0	10	4	33	2.2%
Ptaeroxylon obliquum	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	2	4	9	0.6%
*Pyracantha coccinea**	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0.1%
*Quercus coccinea**	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3	0.2%
*Quercus nigra**	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	9	0.6%
*Quercus robur**	6	13	4	17	0	1	11	12	40	5	4	0	19	2	4	0	0	138	9.4%
Rauvolfia caffra	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0.3%
*Schinus molle**	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0.3%
*Schinus terebinthifolius**	0	2	1	1	0	0	0	0	0	0	18	0	18	0	0	0	0	40	2.7%
*Senna didymobotrya**	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	4	0.3%
*Sterculia acerifolia**	9	25	0	10	4	0	21	3	22	4	0	0	1	0	0	0	0	99	6.8%
*Tecoma stans**	2	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	6	0.4%

*Tipuana tipu**	0	0	0	7	0	0	0	0	0	0	0	0	2	0	0	0	0	9	0.6%
Trichilia emetica	0	0	0	14	0	0	0	0	0	0	0	0	2	0	0	0	0	16	1.1%
Vepris undulata	0	0	1	0	0	0	0	0	0	0	0	0	0	5	0	0	0	6	0.4%
Total no. of trees per street	**77**	**219**	**40**	**139**	**13**	**8**	**152**	**74**	**156**	**34**	**60**	**17**	**141**	**73**	**128**	**64**	**72**	**1 467**	**100%**

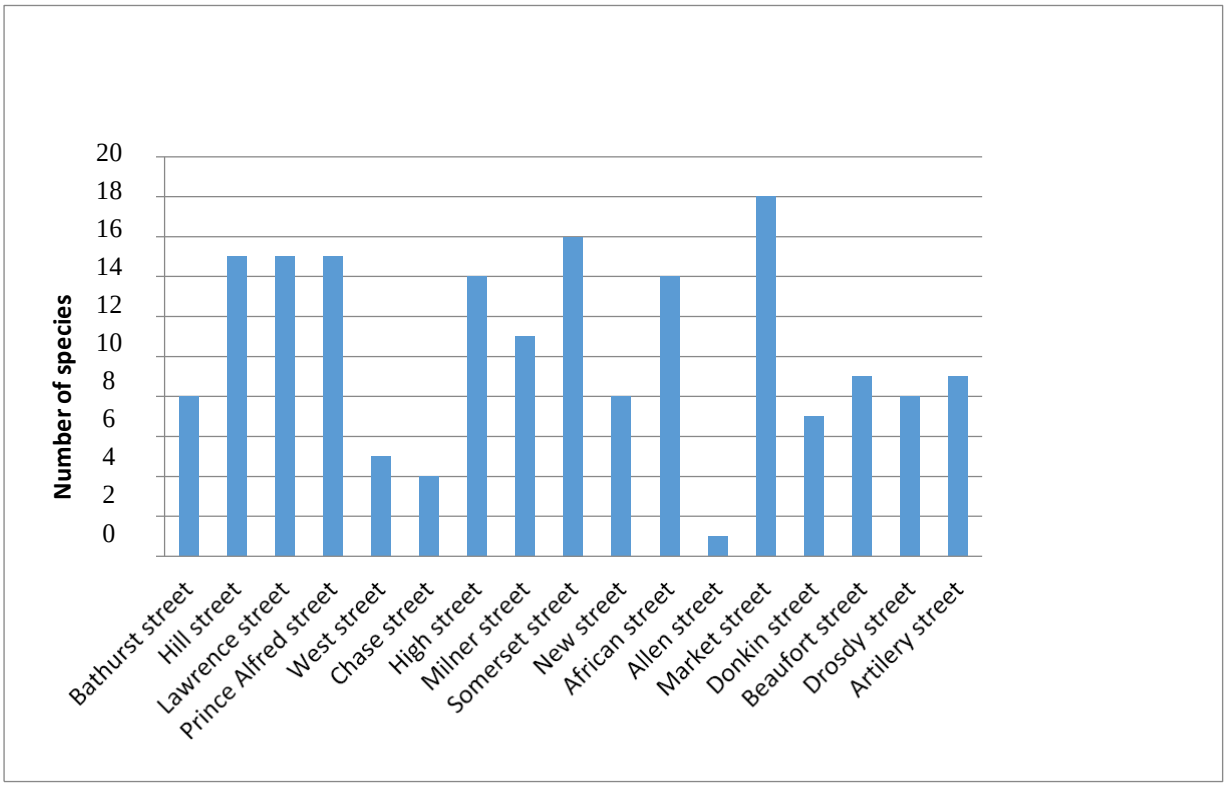

Figure 4. The total number of species recorded in each street.

Table 10. Additional plant species recorded from the private properties adjacent to the Makhanda streets surveyed in Table 9. Exotic species are indicated with an *.

Scientific names	**Common names (E=English, A=Afrikaans and X=Xhosa)**	**Streets**
Acacia mearnsii *	Black wattle; Black wattle (E); Swartwattel (A); idywabasi (X)	Hill
Agapanthus africanus	Blue lily (E); Bloulelie (A); isicakathi (X)	Hill, Lawrence
Aloe ferox	Bitter aloe (E); Bitteraalwyn (A); Ikhala (X)	African, Allen, Bathurst, Market, Hill, Lawrance, Nelson, Prince Alfred, West
Arundo donax *	Gaint reed (E); Spaansriet (A); iqalo (X)	Market
Asimina triloba *	Paw paw (E); papaja (A); ipopo (X)	Market
Bulbine frutescens	Cat's tail (E); Kopieva (A); Utswelana (X)	Allen, Lawrence
Carpobrotus deliciosus	Cape fig (E); Kaapsevy (A) Igcukuma (X)	Allen, Hill, West
Cassinopsis ilicifolia	Lemon Thorn (E); Lemoentjiedoring (A); Igcegceleya (X)	Hill
Catharanthus riseus *	Madagascar Periwinkle (E); Maandrosies (A); umkhaza (X)	Allen, Lawrence

Chamaerops humilis *	European Fan Palm (E); Europese Waaierpalm (A); isundu lasentshona (X)	Hill, Lawrence, Market
Citrus limonium *	Lemon (E); lemeon (A); ilamun (X)	African, Hill, Lawrence, Market, Nelson
Cotyledon orbiculata	Cotyledon(E); Kouterie(A); iphewula(X)	African, Hill, Market, Somerset, West
Crassula multicava	Fairy crassula(E); Skaduplakkie(A); intelezi, phewula(X)	African, Market, Lawrence, Somerset, West
Cussonia spicata	Cabbage tree(E); Waaiboom(A); umSenge(X)	African, Market, Hill, Prince Alfred
Dietes bicolor	Yellow Wild Iris(E); Uintjie(A); UmbonakaXam(X)	Allen, Lawrence, Somerset
Diospyros dichrophylla	Poison star-apple(E); Gewone Sterappel(A); Umbongisa(X)	Hill, Prince Alfred
Euphorbia milii	Christ plant(E); Christusdoring(A); intsema(X)	African, Lawrence
Euphorbia triangularis	River euphorbia; Chandelier Tree(E) Riviernaboom; Noorsdoring(A); umhlontlo(X)	Bathurst, Hill, Nelson
Euryops anethoides	Golden Daisy Bush(E); Wolharpuisbos(A); Ulwapesi(X)	Allen, Hill
Ficus carica *	Edible Fig(E); Makvy(A); ikhiwane(X)	African, Market, Lawrence, Hill, Nelson
Gazania linearis	Treasureflower(E); Botterblom(A); uBendle(X)	Hill
Lantana camara *	Tick- berry(E); gomdagga(A); utywala bentaka(X)	Hill
Ligustrum lucidum *	Privet(E); Liguster(A)	Nelson
Metrosideros excels *	New Zealand Christmas tree(E); Nieu-Seelandse perdestert(A)	Prince Alfred
Nerium oleander *	Ceylon rose(E); selonsroos(A)	Nelson
Opuntia spp. *	Prickly Pear(E); itolofiya(X)	Bathurst
Passiflora caerulea *	Blue passion flower(E); Siergrenadella(A); ikomakoma(X)	Hill
Pelargonium capitatum	Rose-scented pelargonium(E); kusmalva (A); umuncwane wethafa(X)	Allen
Pelargonium inquinans	Scarlet pelargonium(E); Wilde malva(A); ibhosisi(X)	Hill
Phytolacca dioica *	Belhambra(E); bobbejaandruifboom(A); isidungamzi(X)	Market

Plectranthus fruticosus	Spurflower(E); Poorsalie(A); Imbicani(X)	Hill
Plumbago capensis	Plumbago(E); Blousyselbos(A); Umatshininini(X)	African, Hill, Lawrence, Prince Alfred
Polystichum incongruum	Forest shield fern (E); woud skildvaring(A)	Hill, Lawrence, Nelson
Portulacaria afra	Elephants Food(E); Spekboom(A); Igwanishe(X)	Hill, Lawrence
Searsia pallens	Kuni-bush(E); Koeniebos(A); Intlolokotshane(X)	Hill
Sansevieria hyacinthoides	Mother-in-law's tongue(E); Skoonma-se-tong(A); isikholokotho(X)	Lawrence, Somerset
*Solanum mauritianum**	Bugtree(E); Bitterappel; Grootbitterappel(A); uMthuma(X)	Hill
Strelitzia nicolai	Natal mock banana(E); Natalse valspiesang(A); Ikhamanga(X)	Hill, Lawrence, Market
Strelitzia reginae	Crane flower(E); Kraanvoëlblom(A); Ikhamanga(X)	African, Bathurst, Hill, Lawrence, Market
Tecomaria capensis	Cape honeysuckle(E); Kaapse Kanferoelie(A); Umsilingi, Isicakathi(X)	African, Hill
Vachellia karroo	Sweet thorn(E); Soetdoring(A); umnga(X)	African, Hill, Nelson, Prince Alfred

Makhanda East, like most of South Africa's townships, is the direct product of apartheid. One of the most important challenges facing the post-apartheid South African government in 1994 was how to provide greater access to land and its resources for all the country's inhabitants (Bernstein, 1996). Even the Reconstruction and Development Programme where the Department of Land Affairs purchased farmland from private owners (DLA, 1997) which was then transferred in ownership to municipalities to be included as commonage and build houses that provide shelter to previously disadvantages people could not address the gap between Whites and Black Africans. These areas have been under-resourced and typically suffer from high population densities, with individuals who use the land having few rights to own or sell land (Meadows and Hoffman, 2002). These socio-economic imbalances create an environment that is challenging, and, in some sectors, it is close to impossible to effectively educate the community about plant conservation without redress of the socio economic imbalance. Unsurprising, people in these areas chop down and sell trees. They also harvest and sell plants for medicinal purposes wherever they find them.

Plate 9. Streets, gardens and trees in the Makhanda West residential area. Sampling is shown in the top right photograph.

Plate 10. School grounds and play areas in Makhanda West.

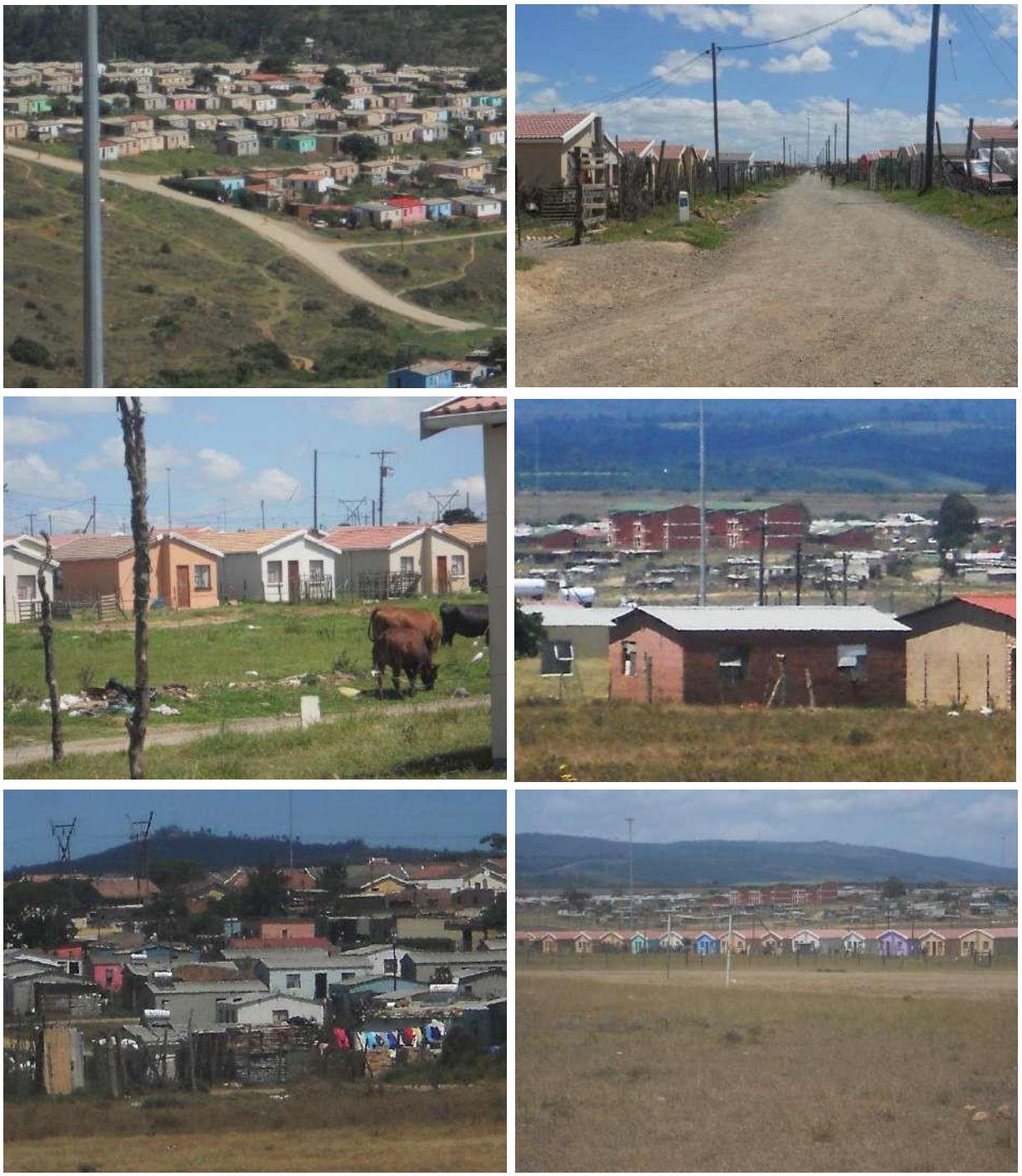

Plate 11. Streets largely without gardens and trees in the Makhanda East residential area

Plate 12. Schools grounds and play areas in Makhanda East.

In South Africa, the first week of September is celebrated as Arbour week each year. During this week, individuals and institutions, including schools, are encouraged to plant trees. In most parts of Makhanda East, with predominantly Black African families, this has clearly not been effective at all. The legacy of the colonial and apartheid era under which land ownership was racially segregated (Lubbe *et al.*, 2010; McConnachie and Shackleton, 2010) is the cause of these stark differences. The fact that in Makhanda there is a suburb (Makhanda East) that remains predominantly Black African clearly indicates that the legacy of the apartheid era remains, when Africans were restricted to living in separate suburbs locally called 'townships' (Wilkinson, 1988), which were poorly serviced and deprived of most upliftment.

Street trees are largely ignored in research (Stoffberg *et al*., 2008, 2010) and there is only a limited literature on urban greening in the context of street trees. Trees in urban environments play a vital role in the enhancement of human well-being given the social benefits and recreational opportunities they offer for inhabitants (Tyrväinen *et al.,* 2005). Street trees also promote economic benefits as it is well established (and confirmed here, Plates 9-12) that urban trees increase the value of houses that are in proximity to them (Georgi and Dimitriou, 2010). They also promote tourism and economic development by contributing to the quality and aesthetics of residential and working environments (Tyrväinen *et al.,* 2005; Chaudhry and Tewari, 2010). From an aesthetic perspective, tree-lined streets are generally regarded as important in providing visual relief in city settings (Nagendra and Gopal, 2010). Street trees are also beneficial to street vendors through the provision of shade, providing some protection from the sun and rain as they try to make a living for their families (Nagendra and Gopal, 2010).

Conclusion

Street trees, similar to trees outside the urban setting, provide numerous ecosystem goods and services that benefit humankind (Colding *et al.,* 2006), a key one of which is biodiversity that it underpins so many other ecosystem goods and services (Jim and Chen, 2009). Biodiversity facilitates the interaction of people with nature, thereby enhancing an appreciation and understanding of the important ecological, social and psychological functions green areas perform (Kuruneri-Chitepo and Shackleton, 2011).

While planting trees in urban environments is important, planting alien species, however is a mistake that Makana Municipality must make every effort to correct. These alien trees have

become overrepresented in Makhanda environment and their control has become important if the Municipality is to maintain an ecological balance (Table 9). Some of these alien trees are invasive and compete with native plants for resources and also impose serious costs on our economy, which depends on benefits provided by nature (Pimentel *et al*., 2005). In the poorer neighbourhoods, these invasives can out-compete plants that provide food for livestock. This may result in animals depending on non-native plants for food or, if they are specialists, losing their food source entirely. Invasive plants normally lack predators and may more easily outcompete natives that have to cope with their natural predators through altering rates of resource supply, trophic level relationships, and the disturbance regime (D'Antonio and Vitousek, 1992). It is therefore important for learners and community members to make use of the information on alien plants and control laws (Chapter 2 section 2.4) so as to avoid the spread of these plant species.

9. Conclusions and recommendations

9.1 Conclusions

9.1.1 Effectiveness of the herbarium as resource

I have noticed that learners continue to come to herbarium, even after the research study was concluded, requesting information on plant related topics. This demonstrates an understanding of the interrelationship between these resources, their biology lessons and plant conservation practice. The herbarium experience provided the learners with information of species presence or absence that can be compared to past species distributions, provided collection locations are known or can be determined with reasonable accuracy (Allen *et al.*, 2001). When learners understood about changes in species distribution that can be determined by revisiting and surveying sites where a species was previously collected (Fellers and Drost, 1993; Drost and Fellers, 1996; Fisher and Shaffer, 1996), they wanted to continue collecting. This was an indication of the effectiveness of the herbarium visit.

9.1.2 Effectiveness of the botanical garden as resource

The most important reason for undertaking botanical garden visits is that they offer more than just an opportunity to address topics listed in the science curricula (Jones, 2000). These include issues such as plant adaptation and measuring of the environment (e.g. temperature and humidity). However, during the visits, the learners did not only obtain scientific knowledge but were also encouraged to develop their sense of social justice and moral responsibility and were also taught to understand that their own choices and behaviour which could affect local, national and global issues (QCA, 2000). These school trips to a botanical garden did not only increase knowledge and understanding of plants but also understanding of the process of science and general aspects, such as care for the environment and communication (Tunnicliffe, 2001). Learners that went to the garden were taught to think about the origins of products such as medicine and cosmetics when they got back to school. Learners were taught to link these products with plants and to consider how the botanical garden is linked to both their schools and their community. I found that the experience of going to the botanical garden has a positive impact on learner's environmental understanding but of most significance is the personal experience that led to development of a better understanding of the environment.

The extensive selling of bulbs, roots and bark is not unique to the Makhanda area. It has been observed by Kala (1998) and Nautiyal *et al.* (2002) in some areas of India where several medicinal plant species have slow growth rates, low population densities, and narrow

geographic ranges. In South Africa, and locally, there is a need for identifying various conventional and contemporary conservation measures for medicinal and cultural plants, their subsequent executions, assessing various prospects, constraints in the development of medicinal plants enterprise, identifying and recommending solutions that are based on existing information and for the benefit and development of the medicinal plants sector in Makhanda.

Wiersum *et al.*, (2006) reported that the intensive harvesting of wild medicinal plants due to increasing use has in many places resulted in overexploitation and is a serious threat to biodiversity in the region. Cunningham (1993) suggests cultivation on a large scale as the option for many species so that the wild species are maintained and become financially viable.

9.1.3 Effective plant conservation awareness of community members

In Makhanda there is the Umthathi Project that is working with traditional healers. Its staff have been coming to me as a botanist at Selmar Schönland Herbarium of Albany museum to assist them in identification and in accessing collection permits. The Umthathi Project staff told me that they also share the awareness information they got from me with the traditional hears and community members as they work with them often. There also is support for the establishment of community-based natural resource management (CBNRM) mechanisms where communities would be able to manage their environment using ecological principles and thereby benefit economically from becoming stewards over wildlife and land as suggested by Street and Prinsloo (2013) who also believe that this may contribute to a growing economy and job creation for a developing country such as South Africa by researching plants.

The fact that community members have been collecting and selling plants without permission continuously over the past 10 years is evidence that the Makana Municipality has failed to effectively enforce the law with respect to biodiversity conservation. Government policies in South Africa are viewed by traders as discriminating against indigenous healing which includes medicinal plants (Marshall, 1998). Dauskardt (1991) blames legislation for doing little to curb the medicinal trade, and numerous controls to reduce trade are not implemented effectively due to the informal nature of the medicinal plant trade.

The introduction and subsequent use of alien tree species in the streets of southern African towns and cities has had a negative impact and South Africa is the worst affected by alien tree

species (Nyoka, 2002). Unfortunately, alien tree species are in almost every street in Makhanda (Table 9) and they outnumber the indigenous trees. Apart from the obvious challenge of invasive species, it is important to note that at least part of the 'natives versus aliens' debate is an emotional one (that does not invalidate it) rather than a scientific one (Fenton, 1986). Novel ecosystems, with the so-called 'alien' species, may have unexpected benefits (Hamilton, 2011).

I am of the opinion that Makhanda should consider following in the footsteps of Leicester, a large city in the East Midlands of the United Kingdom, a city that was one of the first to adopt an ecology strategy (Moughtin and Shirley, 2005). While this strategy ostensibly focused on nature conservation, it also described itself as adopting an innovative approach to landscape planning and management for the city's full range of open spaces (Leicester City Council, 1989). Throughout the 1980s and 1990s, many other local authorities followed Leicester's example and developed similar strategies. These tended to emphasise the value of native species of trees and shrubs and advocate the limitation of exotics. However, it should be remembered that native tree species also vary considerably in their potential to support wildlife in an urban context (Alexander *et al.*, 2006).

Since introduced alien plant species can lead to diminishing biodiversity, it has become evident that there is a need for initiatives to reverse this decline and protect and restore threatened species and habitats. While priority should be given to indigenous tree species, it is also important to recognise that under special circumstances non-indigenous tree species will be important. Examples of this may be found in historic landscapes or special collections such as those in the Makana Botanic Gardens (see Chapter 5). There is also a need to develop a basic re-vegetation, rehabilitation and landscaping plan to assist authorities and residents in recommending suitable species and approaches to the renewal of urban landscapes.

9.2 Recommendations

Schools and community projects such as the Umthathi project should have their own small herbaria with samples of identified dried mounted plant specimens. This can be a starting point for identification education lessons. The Selmar Schönland Herbarium is more willing to donate to local schools and community projects the duplicates especially locally collected plant specimens. Collaboration programmes should be established between schools and the Selmar Schönland Herbarium to continue to promote these initiatives.

There is a need for the establishment of more nurseries in addition to the one of the

Umthathi project to revive threatened plant species. Community gardens should be established within a protected area for the cultivation and domestication of endangered medicinal plants. There is also a need for the identification of a natural habitat, or a place that is only a short distance from where the plants naturally grow. An educational centre could also be established to provide an understanding of local environmental issues, i.e. social behaviour, ethics, resource management, conservation and the sustainable use of natural resources, ecotourism, biodiversity and how the ecosystem functions. The use of a community-based natural resources management endeavour is also needed as a tool to promote environmental and ecological sustainability as well as improving community access to ecosystem services. This may also serve as an input for policy makers to take appropriate measures to create a positive stimulus for future research. All these recommendations can be achieved if a meaningful relationship is established with street vendors, community members, policy makers, law enforcers and institutions such as the Botanical Garden, Rhodes University and the Selmar Schönland Herbarium of the Albany Museum.

There is a need to record all Makana Botanical Garden users including those who do not request keys to use its facilities with chairs, tables chalk board and bathrooms. During this study, users of Makana Botanical Garden were found to be Rhodes university students, local school learners and community members who requested keys to use its facilities with chairs (767 bookings in the Ornee Cottage Botanical Garden Room 1 between 1 January 2017 and 30 November 2017). The Makana Botanical Garden is a place that can be used as a tool to promote conservation, education, training and public awareness. According to the bookings there are no records of walks by these groups, but many other users were observed to visit the Makana Botanical Garden for walks, relaxation and picnics rather than for education.

Part of the findings in the Makana Botanical Garden are historic plants older than 60 years according to undated documents written by Dr Selmar Schönland in the herbarium section of Albany museum. These plants should to be conserved as they form part of our heritage (Tanselle, 1998). The use of the Makana Botanical Garden as an education tool can be truly effective with careful, coordinated strategic planning. It should be clear about the message it conveys. Confining this to plant conservation (which is not the only subject possible in Makana Botanical Garden education), will limit its value. The messages should be global, local and relevant to all visitors.

Strategic plans convey messages to specific groups of people and target audiences. These may be within formal or informal education systems. The message should be defined for the

target audience and be implemented using realistic goals. Learning programmes will only be effective if they consider educational norms that are scientific, traditional, cultural and include indigenous knowledge. Target audiences for teaching about plant conservation in the Makana Botanical Garden should include school learners as informed by Curriculum and Assessment Policy Statement (CAPS) published 2011 by Department of Basic Education of South Africa, general visitors including local communities who may not otherwise be exposed to formal education system, as well as tertiary education students and plant conservation professionals.

Plant conservation should be a priority, especially at this time of climate change, to promote survival of genetic diversity, supplies of biotic resources for local needs, and delivery of ecosystem services. Learners indicated that the Makana Botanical Garden shows that plants may offer exceptional opportunities for landscape-scale conservation where many people depend on these resources. The argument is that the major benefits associated with these plants can serve as motivational foundations to improve the management of plants and their habitats.

Learners also noticed that plants had been dug out and suggested that a nursery should be built to supply those community members who need medicinal plants. All groups agreed that this will be a major benefit to society by locally growing plants that are medicinally and culturally important to support local healthcare, provide opportunities for income generation, and affirm of local culture. Medicinal plants can assume particular prominence in places that are poorly provisioned with conventional (western) health services, economically disadvantaged, and with cultures distinct from those that are nationally dominant. The whole socio-ecological system needs to be taken into consideration in efforts to achieve conservation through medicinal plants. Interventions should be appropriate to local livelihoods, workable for village institutions, and entail a socially acceptable distribution of benefits and costs. This is particularly true for medicinal plants growing in those wilder habitats, such as the Makana Botanical Garden, that are typically of most value for conservation of genetic diversity (considering the national or global scale) and provision of ecosystem services (e.g. carbon sequestration, soil stabilisation and delivery of water supplies). These habitats are legally protected, but, in practice they are often considered to be ‘open access’ biological resources. Their management is hard to improve without the engagement of the whole community.

Effective Makana Botanical Garden education should also unlock the key awareness about

plant conservation. It should begin with the perception of the visitor rather than that of a botanist. Only then is there a possibility of introducing new concepts. The immediacy and proximity of real, active, well-adjusted plants should remain the primary source material for Makana Botanical Garden. Additional goals should be to teach about fragmentation of natural ecosystems that constitutes biodiversity today, and the Makana Botanical Garden's role within that spectrum. Makana Botanical Garden education should continue to provide experiential and active learning opportunities. Although most people still visit Makana Botanical Garden for recreation, I believe that with careful planning this is entirely compatible with education as agued in The World Zoo Conservation Strategy (Weater, 1993).

The Makana Botanical Garden should network with other botanical gardens to become bigger as the wild shrinks, so that it can support large numbers of plants. Such conservation management could be very effective education and public awareness tools. In my opinion, the Makana Botanical Garden is one of the best places for education. Within the garden I can enhance class visits, provide up-to-date information, allow for lively teaching methods and present a fresh face of plants to pupils. Use of the Garden for teaching at school level will offer a combination of resources not otherwise available to schools. The educational outcome is likely to be memorable, lasting, tailored to relevant curricula and cost effective. The Makana Botanical Garden education experience can also make provision for the tertiary education sector and all aspects of local communities. The garden should be engaged in training programmes to educate present and future generations of wildlife biologists, educators and conservationists as it is done by botanical gardens in many parts of the world (Waugh and Wemmer, 1994).

More research should be done to develop materials for teachers and pupils. Appropriate information about biodiversity and utilisation of local relevant resources must be integrated into the curriculum as early as the Basic Education and Training phases. This type of activity should be further popularized through effective use of media. South Africa should invest in the environmental education of its people by promoting and adequately funding herbaria and botanical gardens. Awareness of the natural heritage generates pride and scientific curiosity. Visits and first-hand experiences generate awe, pleasure and, hopefully, the will to conserve nature (Bagarinao, 1998).

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Appendix A: Ethics approval letter

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• Port Elizabeth • 6031 • South Africa • www.nmmu.ac.za

Nelson Mandela Metropolitan University

for tomorrow

Chairperson of the Faculty RTI Committee (Faculty of Science)
Nelson Mandela Metropolitan University
Tel: +27(0)41 - 504 2249 Fax: +27(0)41 - 504 2369

Ref: H11-Sci-Bot-011

Contact person: Mrs C Venter

Student No: 211210978

Date: 25 November 2011

Mr Phumlani Cimi
Albany Museum
Somerset Street
Grahamstown
6139

Dear Mr Cimi

TITLE OF PROJECT: INVESTIGATION OF WAYS THAT CAN HELP TO MAKE PLANT CONSERVATION EFFECTIVE.

Your above-entitled application was considered and approved by the Sub-Committee for Ethics approval in the Faculty of Science on 07 November 2011.

The Ethics clearance reference number is **H11-Sci-Bot-011**, and is valid for three years. Please inform the FRTI Committee, via your faculty officer, if any changes (particularly in the methodology) occur during this time.

An annual affirmation to the effect that the protocols in use are still those, for which approval was granted, will be required from you. You will be reminded timeously of this responsibility, and will receive the necessary documentation well in advance of any deadline

We wish you well with the project. Please inform your co-investigators of the outcome, and convey our best wishes.

Yours sincerely

pp

Chairperson: Faculty Research, Technology and Innovation Committee
(Faculty of Science)

cc: Department of Research Capacity Development
Faculty Officer, Faculty of Science

• PO Box 77000 • Nelson Mandela Metropolitan University

Nelson Mandela Metropolitan University
for tomorrow

[Investigation of ways that can help to make plant conservation effective]

Project Information Statement/Letter of Invitation to School Principals

My name is [Phumlani Viwe Cimi], and I am a [PhD in Botany] student at the Nelson Mandela Metropolitan University (NMMU). I am conducting research on [plant conservation] under the supervision of [Prof Eileen Campbell]. The Provincial Department of Education has given approval to approach schools for my research. A copy of their approval is contained with this letter. I invite you to consider taking part in this research. This study will meet the requirements of the Research Ethics Committee (Human) of the NMMU.

Aims of the Research

The research aims to:

- [investigate ways and means that can be of help in making plant conservation effective]
- [redress the approach so that it can talk to the community and address the needs of the community at large].

Significance of the Research Project

The research is significant in three ways:

1. ['It will provide information about the importance of plants']
2. ['It will provide information about the need for plant protection and conservation']
3. ['It will provide schools and teachers with greater understanding about the influence of schools on the environmental issues']

Benefits of the Research to Schools

1. ['Dissemination of results to schools, Eastern Cape Department of Education, and the broader public']
2. ['The results will inform curriculum development in environmental science']

Research Plan and Method

[The data generation techniques will include questionnaires (administered questionnaires to mobilise learners' prior everyday knowledge about plant conservation), observations and interviews (semi-structured)]. Permission will be sought from the learners and their parents prior to their participation in the research. Only those who consent and whose parents consent will participate. [I will administer the surveys/interview/data collection and the approximate amount of time that it will take]. All information collected will be treated in strictest confidence and neither the school nor individual learners will be identifiable in any reports that are written. Participants may withdraw from the study at any time without penalty. The role of the school is voluntary and the School Principal may decide to withdraw the school's participation at any time without penalty. [the nature of the data to be collected is not a

sensitive nature]. If a learner requires support as a result of their participation in the survey steps can be taken to accommodate this.

School Involvement

Once I have received your consent to approach learners to participate in the study, I will

- arrange for informed consent to be obtained from participants' parents
- arrange a time with your school for data collection to take place
- obtain informed consent from participants

Further information

[Any further information which you feel needs to be conveyed]

Attached for your information are copies of the Parent Information and Consent Form and also the Participant Information Statement and Consent Form.

Invitation to Participate

If you would like your school to participate in this research, please complete and return the attached form.

Thank you for taking the time to read this information.

[Phumlani Viwe Cimi]
Researcher
NMMU

[Prof. Eileen Campbell]
Supervisor
NMMU

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• Port Elizabeth • 6031 • South Africa • www.nmmu.ac.za

[Investigation of ways that can help to make plant conservation effective]

School Principal Consent Form

I give consent for you to approach learners ['in grades 10'] to participate in the [**Investigation of ways that can help to make plant conservation effective**].

I have read the Project Information Statement explaining the purpose of the research project and understand that:

- The role of the school is voluntary
- I may decide to withdraw the school's participation at any time without penalty
- ['Learners in grades ten'] will be invited to participate and that permission will be sought from them and also from their parents.
- Only learners who consent and whose parents consent will participate in the project
- All information obtained will be treated in strictest confidence.
- The learners' names will not be used and individual learners will not be identifiable in any written reports about the study.
- The school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time without penalty.
- A report of the findings will be made available to the school.
- I may seek further information on the project from [Phumlani Viwe Cimi] on [0466222312].

_____ _____

Principal Signature

_____

Date

Please return to: [return address]

Faculty of Science
NMMU
P.O. Box 77000
Port Elizabeth
6031
22 March 2012

Parent/guardian

My name is Phumlani Cimi from Selmar Schönland Herbarium housed at Albany Museum and a PhD student at NMMU. I'm doing a research study on plant protection and conservation in Makana community. This research involves a group of residents including students to address plant protection and conservation issues in Makana community.

As Part of this research your child will visit Selmar Schönland Herbarium housed at Albany Museum and Makana Botanical Garden. I would also be videotaping this research in which your child will be part of, and write down my observations, it is important that I request your permission for your child to be involved in this study. I promise you that your child's name will not be revealed without your consent. I also wish to promise you that you have a right to access the information that will be gathered during this research study at any time when you want it.

If you have anything that you need to know please feel free to contact me at this number: 072 260 7190 or your child`s teacher or my supervisor Prof Eileen Campbell at this number: 041 504 2329 NMMU or Mr Tony Dold at this number: 046 6222312 Albany Museum, Herbarium.

Yours sincerely

Phumlani Cimi
(Student number: 211210978)

APPROVAL

I, _____

Parent/Guadian of_____

give permission for my child to be part of the research study which Phumlani Cimi is doing. I confirm that my child's participation in the study is entirely voluntary. I am pleased with the assurance that my child`s name will not be revealed without my permission. Also, that the research report about this will be made available whenever I want it.

Signature _____ Date_____

Appendix B: Lesson plans used in the study presented in Chapter 5, 6 and 7

Lesson plan 1

Subject: Life science

Topic: Plant conservation, plant collection

Grade: 10

No. in class: 30

Lesson duration: 7 hours

Prior knowledge: Administered questionnaires and Interviews to mobilise learners' prior everyday knowledge about plant conservation.

Introduction: After prior knowledge learners will be taken to school grounds where they will collect some plants specimens and bring them to herbarium for identification. Tell them that for the next lesson we will go to herbarium and on a fieldtrip to the Botanical garden.

Aim of the lesson: By the end of the lesson the learners should know how to cllect plants using secateurs, papers, cardboards and plant pressers. Learners should also know what Plant conservation, Biodiversity and classification are**.** The learners should have an idea about indigenous and invasive species.

Forms of assessment during the lesson: Informal assessment on behavior and participation. Draw a mind-map of local ecosystem. Their ability to form groups and divide roles.

Learning and teaching support materials: PowerPoint presentation with information about Plant conservation, Biodiversity and classification. Instructions how to collect, clasify and identify plants. Field form to show them (to be handed out during the field trip). A room with a projector.

Lesson development: Prepare the learners for the field trip; divide them in groups and give instructions: 5 groups of 6 learners with group leaders. Each group must have a mix boys and girls except Makhanda West School which has boys only. The group leader must assign tasks: taking small samples, making sketches, record the kind of plants, and the numbers etc. (I will give them a list of possible tasks and roles) Hand in a paper with the names of the learners in the group.

Consolidation / conclusion: Tell the learners what is expected of them at the end of the lesson and the field trip. Accommodate learners with learning barriers by interacting with groups. Make sure that each group has a socially strong person who will encourage each learners to contribute. The roles should help the learners to use their strengths.

Lesson plan 2

Subject: Life science
Topic: Field trip to Makana Botanical Garden and Herbarium plant identification
Grade: 10
No. in class: 30
Lesson duration: 5 hours

Prior knowledge: Show learners some plants to check if they will recognise any of the plants, do they know a plant that is used in food, or as a medicine? Make sure to record that on the field forms!

Introduction: Learners will take field trip to Makana Botanical Garden. Then do the sampling and recording. After that walk back to the herbarium and will use herbarium specimens and books to look up for information to identify collected plant specimens.

Aim of the lesson: By the end of the lesson the learners will have experience of a fieldtrip combined with fieldwork; collecting samples, looking up information about the samples and drawing them. They will have experience of working in a group and taking responsibility for a task.

Forms of assessment during the lesson: During the fieldwork, learners will be informally assessed on group behavior and participation. Formal assessment is on field-report with descriptions and drawings for neatness, clarity, insightfulness. Behavior in the Herbarium.

Learning and teaching support materials: Plant presser, secateur, Newspaper / blotting paper, 100 m rope to set out an area or length of path to investigate, pencils and field forms / note books for all children, information booklets for species identification, containers and camera. Field forms for description/drawing of species. Visit to Herbarium (Albany Museum) for plant identification.

Lesson development: Each group gets its field equipment. Hand out the field trip packages to each group leader and remind them of their roles (drawn up by themselves). Walk to the Makana Botanical Garden together. Groups will make a circular walk through the Makana Botanical Garden to point out the categories of plants (water plants, plants/trees, dassies, indigenous and alien). On the field-forms, they can draw plant and take notes. If they recognize something, write down the information. After all the groups have finished we will regroup and look at each other's findings. Thereafter we will walk to the herbarium. Groups can look up information about the plants in herbarium books and write it down.

Consolidation / conclusion: Each group can have a briefing on how the fieldtrip went; what were the expectations? Did everybody in the group do his/her share? Was everybody happy with what has been done, was it difficult/easy to find information in the books? Did you discover interesting things? How would you do things different next time? Accommodate learners with learning barriers by interacting with groups. Make sure that each group has a socially strong person who will encourage each learners to contribute. The roles should help the learners to use their strengths.

Appendix C: List of plant species collected and identified (#) from school grounds of Makhanda Middle School (M) and Makhanda East School (N).

Scientific names / Botanical names	Common names: English (E); Afrikaans (A) and Xhosa (X)	Herbaceous (H) and Woody (W)	Use	M	N
Vachellia karroo	Sweet thorn (E); Soetdoring (A); umnga(X)	W	Treatment for dysentery, diarrhoea, colds, haemorrhage, oral thrush, conjunctivitis, sprue (Barnes *et al.*, 1996; Bisby *et al.*, 1994).		#
*Acacia mearnsii**	Blackwattle (E); Swartwattel (A); iDywabasi (X)	W	To treat microbial infections (Olajuyigbe and Afolayan, 2011).	#	
Agapanthus praecox	Bluelily (E); bloulelie (A); isicakathi (X)	H	Considered to have magical and medicinal traits (Van Wyk, Van Oudtshoorn, and Gericke, 1997).		#
Aloe ciliaris	Red Climbing Aloe (E); Rankaalwyn (A); ikhalana (X)	W	Used for landscaping in frost free climates (Reynolds, 1950).	#	
Aloe ferox	Cape Aloe (E); Bitteraalwyn (A); iKhala (X)	W	Has laxative properties and also taken for arthritis (Gurib-Fakim, 2010; Van Wyk, Van Oudtshoorn, and Gericke, 1997).	#	#
*Amaranthus hybridus**	Pigweed (E); Hanekam (A); uTyuthu (X)	H	Leaves are used as vegetable (Cimi, 2009).	#	#
Arctotis arctotoides	Botterblom (A); uBushwa (X)	H	For the treatment of epilepsy, gastritis, indigestion and in wound healing (Afolayan, 2003).	#	
Asclepias physocarpa	Balloonmilkweed (E); Balmelkbossie (A); uSingalwesalukazi or uNyawu lenkukhu (X)	H	For intestinal troubles in children or as a remedy for colds (Hutchings *et al.*, 1996).		#

Asparagus officinalis	Asparagus (E); Spargel (A); Imvane (X)	H	Used to treat diabetes and also used for combating obesity as it reduces weight and also increases bowel evacuations (Grubben and Denton, 2004).	#	
Atriplex semibaccata	Australian Saltbush (E); Australiese Brakbossie (A), iNtlungunyembe (X)	H	The berries are edible (Doyle, 2011).		#
Barleria obtusa	White Bushveld Barleria (E); Bosviooltjie (A); iVamna (X)	H	In its natural habit the leaves are browsed by buck (Maclear, 1998).		#
Berkheya heterophylla	Berkheya (E); disseldoring (A); ikhakakhaka (X)	H	Not found	#	
*Bidens pilosa**	Black jack (E); Umhlabangulo (X)	H	Used in the treatment of immune disorders such as allergy (Horiuchi and Seyama, 2008).	#	#
Buddleja dysophylla	Sagewood (E); Witranksalie (A); igqange (X)	H	Makes aromatic herbal tea, remedy for cough and relief of colic and eye lotion (Van Wyk and Van Wyk, 1997).		
Celtis africana	WhiteStinkwood(E); Witstinkhout(A); uMnonono, Umvumvu(X)	W	To treat cancer (Koduru, Grierson and Afolayan, 2007) and drops in eyes and ears (Arnold and Gulumian, 1984).		#
Centella asiatica	Asiatic Pennywort (E); uNongotyozana (X)	H	To cure syphilis and to treat open and infected wounds (Cheng-jian Zheng, 2007)	#	
*Cestrum laevigatum**	Inkberry (E); Inkbessie (A); um-Inki (X)	W	Poisonous to mammals, and used as a cannabis substitute (Mabberley, 1987).	#	
*Chenopodium murale**	Nettleleaf, Goosefoot (E); iMbikicane (X)	H	Treats coughs, abdominal pains, pulmonary obstruction and nervous affections (Lall and Meyer, 1999) and used as food (Cimi, 2009).	#	#

Chrysocoma ciliata	Bittercowcurd (E); kaalsiektebos (A); Ihbosisi (X)	H	Used in the management of pains, stomach and menstrual disorder in the Eastern Cape Province of South Africa (Ashafa and Afolayan, 2009).	#	
*Cirsium vulgare**	Spearthistle (E); Skaapdissel (A); uNomeva (X)	H	Used both internally and externally to treat bleeding piles and as a herbal steam for treating rheumatic joints (Moerman, 1998).	#	#
*Conyza scabrida**	Bakbos (A); uMfazonengxolo (X)	H	Treats sores and inflammation and relief fever and diarrhoea (Hilliard, 1977).	#	
Cotyledon orbiculare	Pig's ear (E); varkoor (A); iphewula (X)	H	For the treatment of painful conditions such as headache, earache, toothache, and inflammation (Van Wyk, Van Oudtshoorn, and Gericke, 1997).	#	
Dais cotinifolia	Pompomtree (E); Kannabas (A); iNtozane (X)	W	For treating stomach-ache and used as thread or cord (Brink, 2009; van Wyk and Gericke, 2000).	#	#
Elytropappus rhinocerotis	Rhinoceros-bush (E); Renosterbos (A); iBhobhosi (X)	H	Used for the treatment of stomach complaints, indigestion, dyspepsia, stomach cancer and a lack of appetite (Watt and Breyer-Brandwijk, 1962).	#	
Eriospermum abyssinicum	Fan Palm Elephant's ear (E); Blomkool (A); Intelezi (X)	H	Used as a charm (van Wyk and Gericke, 2000).	#	
Eucalyptus spp.*	Gum tree	W	For relieving nasal congestion in cold (Sadlon and Lamson, 2010; Silva el al., 2003).	#	#
Exomis axyrioides	Hondebossie (A); umvenyathi (X)	H	Remedy for epilepsy; winds, cramps and convulsions in infants (Dold and Cocks, 2001).		#

Exomis microphylla	Hondebossie (A); umvenyathi (X)	H	For treating epilepsy; winds, cramps and convulsions in infants (Dold and Cocks, 2001).	#	#
Gazania rigens	SunGold (E); Botterblom (A); iSaphetha (X)	H	To prevent miscarriage, relieve toothache, earache, in cases of stricture of the urethra (Ahmed, 1981 and Watt et al., 1962).		#
Gladiolus ochroleucus	Gladiolus (E)	H	Food for Lepidopteran larvae and used to treat circumcision wounds.	#	
Gnaphalium hypoleucum	Strawflower (E); Kooigoed (A); Impepho (X)	H	A paste of the plant is used in the treatment of coughs and backaches and is also applied externally on affected parts (Manandhar, 2002).	#	
Haplocarpha lyrata	Harp onefruit (E); Bietou (A); Uphantsikomnga (X)	H	Producing swelling from flatulence and toxic to stock (Watt and Breyer-Brandwyk 1962).	#	
Helichrysum anomalum	Helichrysum (E); Impepho (X)	H	A fresh plant is crushed, boiled and the infusion taken orally.	#	
Helichrysum pedunculare	Helichrysum (E); bietou (A); izicwe (X)	H	Used during circumcision to heal wounds (Scott and Hewett, 2008).	#	
Hermannia grandiflora	Doll's roses (E); Poprosie (A); iNceba (X)	H	Use as a lucky charm. It is palatable and its presence indicates good veld (Verdoorn, 1986).		#
Jacaranda mimosifolia *	Jacaranda (E); Jakaranda (A); umjakaranda (X)	W	Used as an ornamental tree (Henderson, 2001).	#	
Kalanchoe rotundifolia	Chandelier-plant (E); Kandelaarplant (A); iPhewula (X)	H	Used by the Zulu as a charm to make one invisible (Mutshinyalo, 2001).		#

*Lavandula spica**	Lavender (E); uMthuma (X)	H	Essential oil, powerful antiseptic that can kill typhoid, diphtheria, streptococcus, and pneumococus bacteria; and antidote for some snake venoms (Garland, 1993).		#
Leonotis leonurus	Wild dagga (E); Wilde dagga (A); umficamficane (X)	H	Used for the treatment of cough, cold, influenza, chest infections, diabetes, hypertension, eczema, epilepsy, delayed menstruation, intestinal worms, constipation, spider bites and scorpion stings and as an antidote for snakebite. (Iwarsson, 1985).		#
Oedera genistifolia	Relhania (E); Perdekaroo (A); ibhosisi (X)	H	Agricultural weed with essential oils and used in traditional and alternative medicines (Watt and Breyer-Brandwyk 1962).	#	
Olea africana	Wild Olive (E); Olienhout (A); uMnquma (X)	W	Cultural rituals and traditional remedies like eye lotions and tonics, lowering blood pressure, improve kidney function and deal with sore throats (van Wyk and Van Wyk, 1997).		#
*Opuntia ficus-indica**	Pricklepear (E); Boereturksvy (A); Itolofiya (X)	H	Used in juices, jellies, candies, teas, and alcoholic drinks (DeFelice, 2004; Saleem et al., 2006).	#	
*Ornithogalum longibracteata**	uMredeni omhlophe (X)	H	As an anthelmintic (Batten and Bokelmann, 1966)		#

*Passiflora incamata**	Blue-crown Passionflower (E); Siergrenadella (A); iGanandela (X)	H	Passiflora is used to lessen anxiety and reduce spasms, pain and depression, and it calms nerves (Dhawan et al., 2001).	#	
Pelargonium capitatum	Rose-scented pelargonium (E); Kusmalva (A)	H	The leaves are a wonderful skin softener. A tea made from leaves was an old remedy used by people from the Cape to treat kidney and bladder ailments, stomach cramps, nausea,		#
Pelargonium hortorum	Geranium (E); iNdlebe yebhokhwe (X)	H	Used as a traditional medicine for treating dysentery, fever, respiratory infections, liver ailments.		#
Pelargonium hybrid	Geranium (E); Iqwangqa (X)	H	Used for essential oils, treating sleeping problems and chronic fatigue (van Wyk and Gericke, 2000).		#
*Physalis peruviana**	Cape gooseberry(E); Appelliefie (A); iGuzu (X)	H	To treat cancer, ulcer, epilepsy and hectic (Franco *et al.*, 2007; Jaca and Kambizi,	#	
Plectranthus fruticosus	Spurflower (E); Poorsalie (A); Imbicani (X)	H	It is a fragrance and spice plant; also used to treat a range range of ailments (Cook, 1995).	#	#
Portulacaria afra	Igwanishi (X)	H	Cooking to medicinal remedies (Coetzee and Miros, 2010).		#
Searsia pallens	Kuni-bush (E); Koeniebos (A); Intlolokotshane (X)	W	Unknown	#	
Romulea spp.	Kaffirlily (E); Umbonakaxam (X)	H	Used to treat cancer (Rajtar, 2008).		#
Sansevieria hyacinthoides	Mother-in-law's tongue (E); Skoonma-se-tong (A); Isikholokotho (X)	H	Used for earache, stomach aches, toothache, ulcers, haemorrhoids, diarrhoea and internal parasites (Hutchings *et al.*, 1996).		#

*Schinus molle**	Brazilian pepper (E); Umngcunube (X)	W	The dried and roasted berries are used as a pepper substitute (Uphof, 1959; Kunkel, 1984).	#	
Scutia myrtina	Cat-Thorn (E); Katdoring (A); iSiphingo (X)	W	Used for fever and to treat malaria, bilharzias, intestinal worms and for gonorrhea (Royal Botanic Gardens, Kew, 1999).	#	
Selago corymbosa	Poverty Bush (E); Bitterblombossie (A); Iyeza lamaqakuva (X)	H	Used for removing pimples (Dold and Cocks, 1999).	#	
Senecio linifolius	Ragwort (E); iNkanga (X)	H	For homeopathy.	#	
Senecio pterophorus	Ragwort (E); iNkanga (X)	H	It causes livestock poisoning (Cheeke, 1988).	#	
*Solanum mauritianum**	Bugtree (E), Bitterappel; Grootbitterappel (A); uMthuma (X)	H	Treatment of menorrhagia (Lewu and Afolayan, 2009)	#	
*Solanum nigrum**	BlackNightShade (E); uMsobosobo (X)	H	Used to ease pain and abate inflammation, burns and ulcers. Leaves and fruits edible (Cimi, 2009).	#	
*Solanum retroflexum**	Sunberry (E); uMsobosobo (X)	H	Ease pain and abate inflammation and applied to burns and ulcers. Edible and used as a cosmetic (Cimi, 2009).		#
*Sonchus oleraceus**	Milk-witch(E); Melkdissel(A); iHlaba(X)	H	Used as food (Cimi, 2009) and medicinally to treat diarrhea, menstrual problems, fever, inflammation, and warts.		#
Taraxacum spp. *	Milk-witch (E); Melkdissel (A); iHlaba (X)	H	Used as food and medicinally (Cimi, 2009)	#	

Typha capensis	Bullrushes(E); Papkuil(A); Ingcongolo(X)	H	Used for venereal diseases or during pregnancy to ensure easy delivery. Also used to in weaving and thatching (Jackson, 1990 and Van Warmelo, 1989).		#
*Urtica urens**	Stingingnettle (E); iRhawu (X)	H	Young leaves are used as a potherb and a very nutritious food (Launert, 1981; Huxley, 1992; Cimi, 2009)	#	#

- *Total number of plant species collected from M was 41*
- *Total number of plant species collected from N was 35*
- *There are 10 woody species from M and 6 from N*
- *There are 31 herbaceous species from M and 29 from N*
- *24 plant species collected from N were indigenous and 11 were alien*
- *24 plant species collected from M were indigenous and 17 were alien*

Appendix D: Samples of questionnaires and interviews

RESEARCH QUESTIONNAIRE

Please will you complete this questionaire? I am trying to understand how different people are environmentally concerned or committed. This questionnaire forms part of my studies for the PhD in Botany.

1. Have you ever been to the forest?
Yes, I have.

2. If yes, was it a natural forest or a plantation?
Yes it was a natural forest

3. If you choose where to take a vacation, would you go to a wilderness place over a populated place? Why? I would like to go to the over populated place, because the wilderness place might have wild an

4. Do you prefer to camp than stay in a hotel/motel?
No I prefe to stay in hotel

5. What are environmental problems you are aware of associated with the following:

Fire, The air will be polluted polluted.

Overgrazing, The cave and grass will have grass and plants

Plant harvesting, we won't have enough air to breathe

Industrialization, If the trees could be chopped down then

6. Do you try to reuse paper? NO

Do you believe that people need plants to exist?...

Do you believe in natural forests? Yes they see it? Yes

you or have you ever grown a garden or nursery? Yes

11. If yes is it a vegetable garden, a flower garden or a plant nursery with indigenous plants?
It is a vegetable garden

12. List at least 5 indigenous plants you know of? Potato, Tropepha, Mgwaya, Isilawu, and Reeds

13. List at least 5 invasive plants you know of? Weed

INTERVIEW QUESTIONS

Assessment of learners, traditional healers, herbalists and community members on plant protection and conservation

I am Phumlani Cimi from Selmar Schönland Herbarium housed at the Albany Museum and a PhD student at Nelson Mandela University. I am doing a research study on plant protection and conservation in the Makana community interviewing a group of residents including students to address plant protection and conservation issues in Makana community. I appreciate you taking the time to allow me to interview you.

One person reads the questions. A second person documents responses as accurately and detailed as possible. If a third person is present, he/she may also document responses or observe quietly.

Q1. In general, what kinds of activities, programs and strateg1es as part of the community have you experienced or received related to plant protection and conservation issue? Do not include activities related to this research study, but do include any other current or recent plant protection and conservation efforts, whether they were directed toward a specific population group, school activities, etc.

Q2. What is your sense of the community's interest in addressing the issue of lack of plant protection and conservation?

1. Doesn't see it as a problem
2. Vaguely aware, sees it as someone else's problem
3. Sees it as a personal or parental or government responsibility issue
4. Recognizes a problem exists but doesn't believe anything can be done about it
5. Recognizes a problem exists but doesn't know what to do about
6. Recognizes that past plant protection and conservation efforts haven't been enough and believe additional resources are needed to do more of the same (more educational programs, more enforcement)
7. Recognizes that past plant protection and conservation efforts haven't been enough and are open to trying something new or different to address this issue.

Q3. Using a scale from 1 to 10, how much of a concem is plant protection and conservation issues to the leadership in your community, with 1 being not at all and 10 being a great concern? Please explain.

Q4. From your perspective, does the general community's lack of willingness to address this issue extend to looking at existing practices and behaviours, also called community norms that might impact this issue? This might result in an examination of things like use of plant for cultural activities, serving or selling medicinal plants to customers. availability of plants at family-oriented community events, to name a few. Please explain your response.

Q5. Rate yourself as extremely good, quite good, slightly good, extremely bad, slightly bad, quite bad, neither

1. In buying wild collected plants
2. In selling wild collected plants
3. In using wild collected plants
4. In buying selling commercially raised plants
5. In selling commercially raised plants
6. In using commercially raised plants

Q6. What community institutions or structures have been involved in plant protection and conservation efforts in your community and why? Please explain.

Q7. Who has historically been seen as 'responsible for' plant protection and conservation relations in your community? What is that person's occupation and title? Please describe him/her.

Q8. Do you think botanic gardens and herbarium among other resources have a role to play in environmental conservation both in the conservation of plants and 1n the education of the public?

Q9. Describe the current make-up of the plant protection and conservation acts in addressmg this issue in terms of community representation

Q10. Descnbe a simliar past research study within your community.

Q11. To your knowledge, has there been any recruit to ensure participation of community in plant protection

and conservation? If yes, please explain.

Q12. To your knowledge, have there been any alliances with informal as well as formal community leadership to progress policy-based solutions?

Q13. Do you know of any strategic plan for the plant protection and conservation that involve community? If yes, continue

Q13a. If you know or you were involved in developing it, please describe the process in general. Q13b. How is the strategic plan used in plant protection and conservation?

ROLE OF PLANT PROTECTION AND CONSERVATION ACT ENFORCEMENT

Q14. What role has enforcement of plant protection and conservation act traditionally played in your community?

Q15. Has this role of enforcement varied among different areas or members of the community? If so, please explain.

Q16. What level of participation if any has enforcement had on local plant protection and conservation?

Q17. Has the level of participation in plant protection and conservation varied among groups of the

community? If so, please explain.

Q18. To your knowledge, are any enforcement resources allocated specifically to plant protection and conservation? For what kinds of activities, programs or strategies related to plant protection and conservation does enforcement provide resources?

Q19 Is this resource allocation typ1cal for all groups which serve your community? If net. please explain.

Q20. Are you aware of any new or different enforcement activities, programs or strategies related to plant protection and conservation implemented in the past 6 months?

Q21.Is enforcement related data for plant protection and conservation visible to the community? If so, please descnbe the data.

Q22. To your knowledge, how is this data used? Possible uses might include but are not limited to

1. Increase community awareness.
2. Identify resource priorities.
3. Identify need for new/ different enforcement strategies or approaches.
4. Justify request for additional resources.
5. Don't know.

Q23. Please indicate to what extent do you use the following legislation or policy frameworks

		1 Indicates never	2	3	4	5	6	7 Indicates be always
1	Agenda 21 (international): a comprehensive plan of action to taken globally, nationally and locally by organizations of the United Nations System. Governments. and Major Groups in every area m which human impacts on the enwonment							
2	Biodiversity Act (No. 10 of 2004) South Africa): supports conservation of plant and animal biodiversity, including the soil and water upon which it depends.							
3	Conservation of Agricultural Resources Act (No. 43 of 1983) (CARA (South Africa): supports conservation of natural agncultural resources (soil, water,							

plant biodiversity) by maintaining the production potential of the land and combating/preventing erosion; for example, by controlling or eradicating declared weeds and invader plants.

4 Constitution of the Republic of Souih Africa (1996): of special relevance in terms of environment is section 24. Alternative source: Constitution of the Republic of South Africa (1996).

5 Environment Conservation Act (No. 73 of 1989) (South Africa): replaced by the National Environmental Management Act 107 of 1998.

6 National Forests Act (No. 84): of sustainable forest management and the restructuring of the forestry sector.

7 National Heritage Resources Act (No. 25 of 1999) (South Africa) supports an integrated and interactive system for the management of national heritage resources, mcluding supports soil, water and animal and plant biodiversity.

Q24. Please indicate which areas you would want to see amended or extended in the legislation and policies

Appendix E: Community members and street vendors questions

1. List the medicinal and cultural plants you use, the number of times you use them i.e. how many times per day, per week, per month, or per year do you use the plant? Where do you get
the plant?

Medicinal and cultural plant names	The use	How many times (per day, per week, per month, or per year do you use the	Do you harvest plants from nearby forest, get them from a traditional healer or buy them from herbal shops or street vendors?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

2. Do you think the demand for these medicinal and cultural plants will be high or low in future?

a. Demand will remain high
b. Demand will remain the same
c. Demand will decrease
d. I cannot tell

3. Give reasons for your answer?

……

……

……

……

4. Which times of the year are these medicinal and cultural plants in the greatest demand?

Winter	
Spring	
Summer	
Autumn	

5. Which seasons and which medicinal and cultural plants would you say is in demanded due to illnesses, rituals and cultural activities?

Medicinal and cultural plant names	Season	Illness, ritual, cultural	Reason

6. Do these medicinal and cultural plants have any substitutes? Please give name of substitute/s if the answer is yes.

Plant Name	Yes	No	Name of substitute/s

7. What is causing substitution to take place?

8. Do you accept the substitutes as being effective?

Plant Name	Readily Acceptable	Acceptable	Not Acceptable

9. Is the use of plants changing over time?

Plant Name	New uses/ treatments	New plant part used	Smaller size used

10. What unit of measure do you use for the medicinal and cultural plants?

Plant Name	Unit (cup, handful, etc)	Weight	Size (thickness of bark or bulb)

11. How long can you keep the medicinal and cultural plants before they lose their healing

properties?

Plant Name	Shelf life (months, etc)

12. When buying do you ask the plants by name or you describe the problem and ask the seller to prescribe the appropriate medicine?

a. Ask for a specific medicine by name
b. Problem is described and prescription given

13. Why do you use medicinal and cultural plants instead of visiting clinics?

……

……

……

……
.

14. How readily do you accept price when buying medicinal and cultural plants?

a. *You bargain with the seller*
b. *You accept the price*
c. *You leave if the price is too high*

15. If the medicinal and cultural plants you are looking for is not available, would you:

a. *Settle for an alternative*
b. *Leave the shop and look elsewhere*
c. *Not sure*

16. Would you say you are concerned about quality?

a. *Not concerned*
b. *Do not know*
c. *Very concerned*

17. What are the selling prices for the medicinal and cultural plants listed below?

Name	**Unit**	**Price**

18. Kindly recall how prices have changed in recent years. How much did you buy the various medicinal and cultural plants for in 2005, 2010, and in 2015? (Remember to quote prices for the same unit sizes.)

Plant Name	Unit	Price in 200…	Price in 201…	Price in 201...

19. Have the prices of the substitute medicinal and cultural plants also changed or not over the years?

a. Prices have changed just like the original medicinal cultural plants
b. Prices for substitutes have not changed at all
c. Other

20. Are there any price variations in the different areas you buy your medicinal and cultural plants from?

a. Prices differ depending on where you buy from
b. The prices tend to be the same in different areas
c. I do not know

21. Indicate whether or not there are differences in the prices of the medicinal and cultural plants during different times of the year.

Plant Name	Large seasonal variations in prices	Small price variations	No price variations

22. What reasons would you give for the price variations?

……

……

……

23. If these plants had to be cultivated, would you accept them or not?

Plant Name	Accept them	Not accept them

24. If you answered 'not acceptable' to any of the plants above, please explain why?

……

……

……

25. How would you recognise a cultivated medicinal and cultural plant compared to a plant that has been harvested from the bush?

26. What would you use if certain wild plants are no longer available?

……

……

27. Would you be interested in buying cultivated plants from the growers?

a. Yes
b. No
c. I do not know

28. Which of the age categories do you belong to?

a.	15-25	b.	26-35
c.	36-45	d.	46-55
e.	56-65	f.	66+

29. Gender

a. Male
b. Female

30. When buying plants, would you prefer?

a. hygienically packaged	[ ]
b. as they are	[ ]

Appendix F: Learner responses to the botanical garden visit

No.	A- HIGH SCHOOL GRADE 10	B- HIGH SCHOOL GRADE 10	C- HIGH SCHOOL GRADE 10
1	**What is it that you did not know before visiting the botanic garden?**	**What is it that you did not know before visiting the botanic garden?**	**What is it that you did not know before visiting the botanic garden?**
	I did not know that there were snakes, I did not expect that	I did not know that plants are labelled with their botanical names	It is a place of a wide variety of plants that are cultivated for scientific, educational and ornamental purposes
	I did not know that trees have scientific names which are like humans and there were also snakes	I did not know that botanical garden have different kinds of low and high plants	Is that some plants we can use in our face
	I did not know what are alien plants	I did not know that there are plants that are used for medicine	I did not know that botanical garden is a place of a wide variety of plants that are cultivated for scientific, educational and ornamental purposes
	I did not know what are alien plants	That it has alien plants and natural herbs/ medicine that we use	I did not know that botanical garden is a place of a wide variety of plants that are cultivated for scientific educational
	It is that there are two in each tree; there are natural trees also did not know there were indigenous and alien plants	Plants have families of their own, they can be identified by their appearances such as structure and colour	I did not know that botanical have such beautiful flower that have seen on TV
	The different between alien and indigenous plants	That there are alien plants in the garden	I did not know that there were many different plants in the botanical garden, and there are sorts of things/ plants types that are very different to each other
	I did not know that plants have both alien and indigenous names and have insects controlling them	I did not know about alien plants habitat in the garden	A place of a wide variety of plants that is cultivated for scientific, educational and ornamental purposes. I didn't know the botanical name is a scientific name conforming to the international code of nomenclature.
	There are indigenous and alien plants	It is the plant used for skin protection from heat and sunshine	I've never been there before. So I did not know nothing about the plants that are there

			in botanical garden
	I did not know that it is necessary to control the dispersal of alien plants seeds	I certainly did not know that the plants were labelled with botanical names and common names	A place of a wide variety of plants that is cultivated for scientific, educational and ornamental purposes. I didn't know the botanical name is a scientific name conforming to the international code of nomenclature
	I did not know that there are alien plants and snakes	About that some of the plants are used for sun cream	I did not know that plants had scientific names, I thought they relied on common names only
	The different types of plants that come from different places	I did not know about the Ganoderma	I did not know that it has different types of flowers
	I didn't know that the botanic garden have different type of plants	I did not know about the definition of botanical garden and what plants must be valued	I did not know that botanical garden have different alien plants that are from outside our country
	I didn’t know there were indigenous and alien plants	I did not know that plants are named and grouped according to their appearance	I did not know that plants in the botanical garden are labelled with the botanical name and common name
	I did not know that plants have scientific names	It’s the ground plants that you use in the face	Not knowing that I will be thought about plants, also get to know where plants are cultivated
	I did not know that animals like snakes existed here	That the botanical garden had different kinds of plants species	I did not know that there are low plants and high plants; alien and indigenous plants
	I did not know that plants have scientific names	I did not now that there were different kinds of plants	I did not know plant has variety of groups before being named a species
	I did not know there were alien plants and indigenous plants	I did not know that botanical names which are scientific	I did not know that there were many flowers with scientific names
	I didn't know there were indigenous and alien plants	I did not know that aloe is used for medicine and Ganoderma for cosmetics	It is a place of a wide variety of plants that are cultivated for scientific, educational and ornamental purposes
	That the garden is used for plant and trees, and it consist of indigenous and alien plants	I did not know that plants can do amazing things	I did not know that plants have names
	I did not know that it has plants from outside	That there are two types of plants	I did not know that they are different plants and that they have scientific names

	I didn't know there were indigenous and alien plants	I did not know that the plants a labelled with scientific names	I did not know that there are different types of flowers with scientific names
	I didn't know there were indigenous and alien plants	What are alien and indigenous plants	I did not know all the scientific names of the plants and the grouping of them
	Some of the names of trees knowing that they are alien, and indigenous plants	I did not know that it has high flowers and low flowers and some of them needed to be watered	I did not know that plants have binomial names and also have Latin names
	That there are trees that are planted	That there is a variety of alien plants in the botanical garden and the different plant that grows there	I did not know that plants have their botanical names
	That would be many plants and snakes	I did not know that the Ganoderma is found at the botanical garden	I didn't know that botanical garden has different flowers and most plants have names
	I didn’t know that the plants can be transported to another country	I didn't know that it has plants	I did not know that botanical garden is an educational showcase for both native and exotic plants
	To see between indigenous and scientific plants	I did not know that the garden is used for educational resources	I did not know that botanical garden is a place of a wide variety of plants that are cultivated for scientific educational and ornamental purposes
	I didn't know that some of trees are alien	I did not know isibindi are found at the garden	I didn't know that it is a place where wide variety of plant are cultivated or scientific, educational and ornamental purpose
2	**What were your perceptions about botanical garden before visiting it?**	**What were your perceptions about botanical garden before visiting it?**	**What were your perceptions about botanical garden before visiting it?**
	I was expecting to see both indigenous and alien plants, but the problem is that I couldn't distinguish between the two	I thought it was just a place without amazing plants	It is a place of a wide variety of plants that are cultivated for scientific, educational and ornamental purposes
	I was expecting to only see indigenous plants, it happen to be also alien plants available which are not controlled by animals	I learn that the garden have all different types of plants and is very beautiful	To tell us more about plants
	I thought I was going to see forest and not used for educational purpose	I did not know that littering can cause damage to plants	I thought it’s just a place not knowing that is an important place, and well-known place
	I thought it was just a forest, I did not know it is also	I thought it was a place where there is only grass and trees	I thought that there were plants which I see also I learn

	educational	for people to meet and hangout	more
	I thought it was just a garden with flowers	It is a huge garden place that has trees and plants	Is that all kinds of plants have different names and their parts also
	I thought it is a place where there are plants	I thought it has plants everywhere	I thought that botanical garden was full of aloes, trees and other plants, not knowing that there were different types of plant
	I thought it was a place that only consisted of plants only	That it had high trees only and small plants do not matter	To see more plants that are interesting and learn more about the botanical garden
	A place where there is a natural forest	That there are different kinds of plants and really long trees	My perception about botanical garden is to see more different plants are there, that I do not know
	I thought that it was just cultivated land	I thought the garden was just for picnics	Is that most plants in the botanical garden are labelled with their botanical names and roman name
	I thought it was just a garden with indigenous plants	I thought it was only about plants	I thought I would learn about that I already knew, but at least there are some plants I learned about that I didn't know
	To see plants that are more common and known by most people	I wanted to know about plants and their roles	I thought I would find a place that is full of river
	Botanic garden is just a place for picnic	I always thought it was just like a park	I learn about different plants that are here in our country
	I always thought it was a boring place full of plants	I thought that the trees and plants were just already	My were that we will see more plants and be told what their names are
	I thought it was just a garden where you can chill and have fun	See more new things that we don't know about plants	It was walking along the garden and shown plants that I did not know
	I simply thought it was a place for relaxing	That it was just a normal garden with fruit and vegetables	My perception was to know about the different plants found at the botanical garden
	I expected to see indigenous plants	I thought it had only grass and few trees	That the garden had less trees
	I thought there were indigenous plants only	I thought it is a simple nursery, where people buy different types of plants	I thought I would only see flowers
	It was to see a place that is having play grounds not interesting things	That it was such a peaceful place, like a park	I thought I will see small flowers
	I thought that it was just	I they were going to show us	I thought I would see bunch

	about indigenous plants	how to produce plants	of flowers only
	I thought the place is overcrowded by the plants and that there was litter all over	I thought plants are just plants they had no names	I thought I would see trees and a dam only
	I thought I was going to see indigenous plants	That there were plants that I have never saw	I was hoping to see many beautiful flowers and learn about them and discover more about them
	I thought that it was just about indigenous plants	That there were plants but did not know the different between them	I thought that it is something that is boring but I was wrong
	That it is garden with full of plants	I thought it is a dull place with flowers	I expected to see more of the plants which I already knew
	That all the trees there grow naturally	It was made for pleasure purposes only, a place where you can chill not knowing that it has plants	I thought botanical garden have animals and other dangerous organism
	I thought that it was just about indigenous plants	I thought we will see all the types of plants which we already knew	I thought we were going to see drawings of plants
		Wanting to know more about plants and animals	Was to see plants and study about those different plants
	I learn about trees and plants	I thought it was just a place for chilling	I expected to see plants and to be thought about function
	I thought it was a place with trees that are common	It was just a beautiful garden for enjoying yourself	I expected to see plants and to be thought about function
3	**What have you learnt about botanic garden trip?**	**What have you learnt about botanic garden trip?**	**What have you learnt about botanic garden trip?**
	I learn about the plants and distinguish between alien and indigenous plants I also learn about how they survive during different seasons and about the type of insects they might have	I learn about different plants and trees also how they can be a beneficiary to human being	It is a beautiful garden where there are many different species of plant
	I have learn that they have alien plants which do not have species/ insect/animal control the plant not to spread and destroy other plants		I learned that plant changes in different ways; it can be turned into a fruit. Yes I liked the botanical garden trip
	I learn that most medicine are made from plants which are conserved from there	Plants need attention and that they have different families	I've learnt about plants and about botanical garden help the public because it has information you need about plants
	I learn that most of the plants are used for medicine and	I like the herbs and natural medicine because they help	I learn that botanical garden is a place of plants which you

	also make habitat for some animals	when one is sick and others help our skin	can do work for it like protea and strelitzia. The thing I like about botanical garden trip, I see everyone there also the plants
	I learn that every tree has to have a name just like me, I like that botanical garden has information about plants, trees and some animals	Plants can make medicine; alien grows faster than indigenous plants, I like the place because it has a lot of beautiful plants	I have learned that in life you must always respect flowers as you respect yourself. Plants have species for resources eventually landscape
	I learn that plants have different names and others have common names, I like it because it teach us about different types of plants	I learned a lot about different kinds of plants and their names	I learned that botanical garden is full of indigenous and alien plants. I like about the garden is that the garden keeps many different types of plants in its land
	I have learn that each plant need insects to control them, and that they have different names	That there are different kinds of plants and that some plants belong to the same family	I learn that botanical garden is indigenous and alien plants. I learn that there are high and low plants like trees and small flowers
	There are many different types of trees and plants with different names	I learn that the plants have families, names and also can be identified by looking at them	I would like to learn more about plants, different plants e.g. aliens plants, genius plants etc. I also do like the beautiful place of botanical garden
	It is safe and clean, ecosystem for birds and insects. I like the environment is calm	I learn that there are many more things that can be done at the garden	Is that our science program on how human activities are affecting plant through climate changes and botanical garden have also some indigenous and alien plants
	I have learnt plants and trees have two names just like humans. There are alien plants in the garden which can spread because we do not have some species eating the plants	Alien plants use a lot of water and resources and also they grow faster than other plants	I have learnt that there are two types of plants which are indigenous and alien plants, and I have learnt about other plants like protea, aloe and wormwood. I did not know that they were very important
	Learn about different types of plants that can be controlled but all of them make the place look nice	I learn that there were different types of plants which are indigenous and alien	I've learnt that there are different types of plants and I like that they did not take nature side away
	I have learnt that there various types of plants and trees which are describe as alien and indigenous plants	Plants have names, surnames and families just like people, they can be used for fruit and medication	I learn about different type of plants and trees
	I've learnt that some of the trees are from different	I have never been to the botanical garden trip before	I have learnt that species are group of organism that are

	continent. I like the environment because its peaceful		reproduced of springs, what I like about botanical garden is we learn so much about plants and their names
	I have learnt that there are alien plants which were brought to South Africa, and the indigenous which are naturally grew here	That we learned about the different plants like Ikala	I've learnt more things about botanical garden, for exampling it is a key of naming plants and also sorting the plants specimens
	I learn that plants have scientific name	I have learnt that there are different kinds of plants and some of the are used for medicine	I learn that there are indigenous plants and alien plant (come from another country).
	I learn that plants have common names	I learn that the garden has all the different plants, high and low and that the plants have names and they look different	Even though plants may look useless it has its own unique use even though people do not see that
	I have learnt that botanical garden is of good use to organism	I learned about plants and their scientific names	It is a good place to go out as a family and chill
	I've learnt the botanical garden has alien plants and even indigenous plant	I have learnt that it is a place where a wide variety of plants are cultivated for scientific and educational purposes	I learn about its names and species
	The fact that there are a lot of tree some are aliens and indigenous	I learn that every plant has a name	I have learnt that plants have names, second names etc. and they come from different places
	I learn that most of the plants have names; they have titles that they are called by. I like that it has different kind of plants	That there are showcase with native and exotic plants and they are educational, I learn that plants are very important	I learnt about different types of plants and their specialised functions and scientific names
	I learn that there are alien plants, also that they have names	I learn about different plants and trees also how they can be a beneficiary to human being like aloe	I learn that there are many flowers and plants there, and they had names and there were three scientific people who name them
	It has different types of plants that can help us in the future	I was told the different between alien and indigenous plants and their impact in humans life	I have learnt different types of plants and their grouping and also learn about how to identify their species
	I learn about the different type of plants	I like that it is quiet to visit	I learn about alien plants and indigenous plants and that these plants can be used to cure certain diseases, I like that they keep plants safe
	I have learn that there are alien plants which were	It is an interesting place, I learned new things about	I learn that there are plants that are used for medicine and

	brought to South Africa, and the indigenous which are naturally grew here e.g. plants that comes from America	plants	face cosmetics
	I learn that alien plants can be controlled by certain insects and is called Bio-Control. I like the fact that I learn a lot about plants	Most of the product which we use today comes from plants	I leant a lot because I didn't know that botanical garden plants are labelled with their botanical names. It was a very good trip
	I learn that there are plants transported to South Africa, I like the fact that botanical garden is clean	I learn more about plants and the difference they have among each other, that plants have scientific names	I learn about different plants and the purpose of the plants. I like the fact that people that were there made us understand more about different plants
	To protect the trees because they play a big role in our lives	I liked the fact that it is educationally, and a place to visit in order to see different types of plants and animals	I learnt more about variety of plants and what they are used for, and I liked
	It's a beautiful place with wonderful nature and is a tourist attraction	I have learnt about the different plants, and the way human can use them	I learnt more about variety of plants and what they are used for and I like when we were thought about some plants which are used for fruit and cosmetics
4	**Why is it important to learn about botanic garden, plant and conservation?**	**Why is it important to learn about botanic garden, plant and conservation?**	**Why is it important to learn about botanic garden, plant and conservation?**
	I get to know about types of insects they have, and also ways of taking care of different plants. How each plant is different from the other	It is important because we have to conserve the garden so that it can save the animals and plants for future use	I have learnt that the botanical garden is educational and helps a lot of scientist to observe different plants, native or exotic plants on how they grown and how their growth in the future
	You can learn about varies plants and the insects that control them		It is important because we have to know that plants can change to fruit, and packages. Because diversity support a unique plant community
	Because plants are beautiful and need to be conserved for other generation	The botanical garden is educational, it showcases both native and exotic plants	It is important because scientists and important people often go to that place and it got everything that we want the relationships between plants and their

			pollination, agricultural and horticultural practices
	It is important to learn about plants because they very important in our lives, also 90% of medicine is from plants	To know about plant life	It's because help us for sick maybe you not well for your sickness
	It is important that everyone has to learn about nature where medicine come from. Knowing how to keep the environment clean	Learning about plants helped me to know more about the environment	You get learn about plants and different shape that they are but therefore people who like plants and the environment that they are in
	It is important because we have to know what plants are there, and know what kind of work they do in our community	Because some people destroy plants	It is for you to know about plants and all that surrounds you in your own land/place
	I think it is so we can know what is expected from us like stop littering	It is important to learn about the botanical garden because it is educational and shows both aliens and indigenous plants	It is important because you have to know about plants and their names and what they mean so that in future a person will ask about the plants and they mean
	We can learn more about plants and animals	Because the garden is educational place, it showcases both native and exotic plants	Important to learn more about botanical garden is that, to know more about cultural plants that you do not know. To see the different of them
	It is important because of conserving the plants	The information assists humans in understanding about plants	Is that the botanical garden manages need to change the public in collecting data on the effects of climates change on plants and ecosystem
	It is important to learn about botanical garden, we need to be aware of the plants or trees in our town	So that we can know the environment and plants that are surrounding us	So that we can know that the plant and our diversity are very important to our nation. Botanical garden is helping us everything about plants
	How to keep it safe and keep plants growing	It is important to learn about plants because some plants are traditional medicines	It is important because there are new plants there that you have never seen before
	Its important to know what population of the plant bring in this world and what must we do to keep them	It is important to know about the garden, plant diversity and conservation efforts	It is important because some of them can help us, when we are ill
	So that people could be aware of the role play by plants	I can advise people and also advocate them on variety of plants	It ids to know their Xhosa names or a key to name plants
	To learn more and more about plants, that we can also	To know what is good for our skins, faces knowing what to	So that you could know how plants were named and also

	teach our peers and other people not to destroy	eat	knowing that the botanical garden is a place where plants a cultivated
	Different plants have different properties and are useful in different categories e.g. medicine	It is important to learn about the botanical garden because it is educational and shows both aliens and indigenous plants	It is important to know what type of plants are found around the world and their names
	It helps to know the different plants and study about them	It is to learn about botanical garden because it has different kinds of plants which some can be helpful to human	it is important because lately in an area the is a lot of carbon dioxide and the only way we can reduce it is by planting more plants and trees
	To understand the beauty it has, how use full it is to human	It is important to learn about botanical garden, plants diversity and conservation	It is important so that we can get to know more about the plants and their uses also their names
	It helps to know about plants and animals	it is harder for us to know plants that can cure us, and the important ones also those in danger	Plants cause variety of forest exchange, more water and carbon dioxide with the atmosphere than any other biome
	It helps so that people may know different type of trees	It is important to learn about the garden so we can come up with our own ways on how to protect the plants	It is important because it help us to have more knowledge about plants / flowers
	It is to know the different between plants and where they come from	That we need to learn that plants are also humans, they are like people	To know about the plants that are surrounding our community
	So that people can be informed about the variety of plants	Because some plants are the same and others are not, they have different kinds of shapes and size	It is highly important to know about them because in the future flowers and plants will be very important to human being
	That there are plants that can help us in the future e.g. medicine	Because we need plants to survive, they provide us with oxygen	It is important to learn about them because they teach us about different types of plants
	To get more knowledge about botanical garden and the plants	So that you can be able to know which type of species are available and how do they grow and the environment they grow in	To know more about the diversity of plants with their functions
	That there are plants that can help us in the future e.g. medical plants	It is very important to know about plants, that are surrounding us because they are very important to our environment	It teaches us about plants and their importance in our daily lives
	So that you can know which plants are useful to people	It is to know the relation between human and plants	It is important to learn about botanical garden so that you may know the different

			flowers
	It is important because I've got new knowledge about plants	Because it helps to know things about plants and their names	Focusing on human activities are affecting plants, through climate change, habitat fragmentation, introduction of invasive species, pollinator loss, pollution and more
	So that we do not kill them	To know about plants more and what they can be used for on humans	
	So that we can keep this beauty for generations	It's important to learn about plants so we can take care of the area they are in, because it plays a huge impact in humans lives	It is important because you have to know about plants and what are their functions so that you can be able to use them
5	**What do you think are the greatest threats to botanic garden, plant diversity and conservation effort?**	**What do you think are the greatest threats to botanic garden, plant diversity and conservation effort?**	**What do you think are the greatest threats to botanic garden, plant diversity and conservation effort?**
	They are very much in danger of pollution, because of decoration some might become extinct	It is humans that damaged plants and the botanical garden by leaving out rubbish	The climate change can affect botanical garden in a bad way and take over, other plants can harm other plants in the botanical garden
	The greatest threat to the botanical garden are people coming to and pollute the environment which can lead to dying of plants		Because it reduces garden that is educational and it can showcase both native
	Littering and not having people to take care of the garden	People: We humans carless about the environment we live in	To focus on how human activities are meeting plants, through climate change. The threats are unlikely to diminish in future
	Alien plants brought from other places without any insects to feed on them invades land	People can cut them for their own use to make herbs at home	Is the conservation which is exchange more water and carbon dioxide with the atmosphere than any other brome and thus play
	Dirt is the threat it could ruin nature, trees would not look good. Cutting down of trees could be the greatest threat	It is humans who visits for having lunch and have picnics that are the threats	I think that the more ecosystem around the green spaces of the botanical garden, also can plant around
	I think these plants have to be kept in a healthy way	Alien plants because they invade and take up a lot of space and water	I think that the threats that are in our gardens it's us people are abusing them in such a way that are unexpected ways like, we do like to pick up the plant just to play with it and throw it on the grounds

	Ground pollution. Alien plants without insects to control and prevent them from invading so much land	Pollution on the botanical garden, Poaching the diversity of the plants and people not caring about plants	Some plants might die or get stolen by people who need money. Much of our science program focuses on how human activities can affect plants. These threats to plants are unlikely to diminish in the foreseeable future and we are working to find ways to conserve plants and challenging environments
	I think we can clean and treat it good	It is alien plants because they take up more space, uses a lot of water	Threats that are great is that people are stole the plants are there to use as the traditional medicine. People throw rubbish because of no protected environment
	The greatest threat is deforestation and fire		Threats to plant are unlikely to diminish in the foreseeable future and we are working to find ways to conserve plants in changing and challenging environments
	Ground pollution. Alien plants without insects to control and prevent them from invading so much land	Alien plants which can use more resources	To introduce the invasive species. These threats to plants are unlikely to diminish in the foreseeable future and are working to find ways to conserve plants in changing and environment
	For deformation of plant, ground pollution, alien without species that will stop them growing	Climate change	Human activities are affecting plant through eliminate change, habitat fragmentation, pollution and pollinator loss
	The litter that is around and what people do to put these plants in danger	The greatest threats are: Ignorance, invasive species, climate change and ecosystem	When the season change some of them get affected, some of them are being eaten by animals
	The rubbish that is there could draw tourist away from the garden	I can educate the youth on the knowledge I know about of plants	It is to know how to name a plant, with their botanical names or common names
	Ground pollution. Alien plants without insects to control and prevent them from invading so much land	People can cut them for their own use to make herbs at home	It is that people touch plants even though they were told to not, and also human activities cause threat to the botanical garden
	I think its human	Human activities can affect to plants which can lead to death. Polluting can make	There will be no botanical garden if people sell the plants outside the city

		plants die	
	There are plants which were put there by mistake	The alien plants because they invade and take up a lot of space which can be used by indigenous plants	I think the threat is that there are alien trees which need more water than our soil can provide
	People may pollute and this can be a great destruction		The greatest threats is the people damaging the area
	There is a lot of plant and green	People - because they harm or damage the place by littering on it which cause the plants to not grow	Conservation
	Always clean the garden	People who visit the area	It is a beautiful place where you can do picnics and rest. The greatest threat is that people throw rubbish and pollute the place
	Human are the threats	Science program focuses on how human activities can affect plants through climate change	I would say animals are threats because they eat these plants and end up being damaged and pollution can damage these plants
	The human activities, such as pollution can have a negative effect	Alien plants are the threats	As much as people visit the botanical garden they find places to sit and when they leave they throw dirty things
	Air pollution and rubbish	Littering, Climate change, pollinator loss and pollution	The greatest threat to botanical garden, plant diversity and conservation effort are polluted
	pollution not looking after the plants	People damaging them	The threat could be pollution, deforestation, climate change, habitat fragmentation. This could lead to extinction of plants and making it to be difficult to the future generation
	Air pollution, smoke in the air and rubbish	Lack of resources to help the plants grow, Not being able to conserve the plants, cutting down and destroying of forest and plants	Throwing of plastics and dirty things such as bottles and also littering can damage plant
	You can lose the beauty of nature	Humans	Much of our science programs focus human activities are affecting plants through climate change example pollinator loss, pollution and more
		Plant habitat is a good place	I would clean the botanical garden so that it can be less polluted

	To keep it clean so people can visit	It is a place where green plants are being planted	
	Some of the alien trees need to be alive	Alien plants are the threat to the environment and the conservation effort, they consume a lot of resources, they invade space for plant we need	Focusing on how human activities are effective to plants, through climate change, habitat fragmentation introduction of invasive species, pollinator loss, pollution and more
6	**How can you personally impact plant habitat?**	**How can you personally impact plant habitat?**	**How can you personally impact plant habitat?**
	I would make sure that no plant is in danger of being extinct	By putting volunteers that can pick up the litter so that the garden can be clean	Stepping on small plants and cutting down trees without replacing them can harm plants habitats
	I could contribute by making sure that the environment is clean, and the plants are taken care of	Will not allow people to damage plants	Plant habitat use as a fluid tissue that has to change plant
	I can take care of the environment by not polluting	By taking cars off the environment so that plants can grow	The place where the plant leaves must be stable and good so that the plant can grow well and it has to be clean
	I would not pollute	Keep the place clean and put fence around the place so plant won't be polluted	The place must a structure and more water for plant so that they can grow well and environment should be safe
	I could contribute by cleaning there, and assist when learners visit the place	Respecting plants, giving life to plants	See by looking at shape, structure also by identifying what are the names and were there environment
	I would make a forest where the is a positive impact	By cleaning the place and put rubbish away	I can do things like watering the plants and give the plants its needs
	By looking out for it, picking up litter, come up with ways to prevent littering, like having posters	Not to pollute the garden, and clean the garden	When plants are introduced to a new location either intentionally or accidentally they can spread prolifically, outcompete native species for resources
	Keep medical plants that can help human with runny nose	Tell people to stop throwing rubbish	I can be protecting the plants as making it healthiest to always pour it some water all the time, to stay alive
	I can make impact on plant habitat by conserving and keeping it clean and safe	To help cleaning the place	When plants are introduced to a new location either intentionally or accidentally they can spread prolifically, outcompete native species for

			resources
	Take care of the plants/trees and never destroy the environment	Making sure that people do not litter	By making sure that I care for the plants, and give the plants what they need also give plants a home
	Take care of the plant and keep the environment clean	Keep the environment clean	By keeping it clean or add some plants in some places so that the cold be life or give up more space for people and animals
	By catering for the plants in my home and around urban area whereby it will bring air	Littering, picking up litter and taking care of the environment	By giving the plants what they need
	Take care of their habitat, keep it clean		By giving the plants more oxygen and more water that they need
	Take care of the plants and not destroy them, and also keep the environment safe	By pulling water in the plant and let it grow after checking on it	By keeping it to a place that it cannot be damaged and also feed it with water
	By reducing carbon dioxide	By watering plants and cleaning	I think to keep the environmental garden clean, and not steal the plants
	Make sure that there are no papers around	By not having many visitors visiting the place, and clean around the plants	By causing pollution in that certain area and cutting down trees not replacing them
	I can make sure I don't pollute the garden	By knowing the plants and making nature difference	Create more species or plants
	By keeping it clean and make people come to it	By cleaning up and taking care of the environment	
	Keeping the garden clean	By getting assistant from other people to clean the place	I can plant more plants
	I could plant more flowers and give some to other people	Habitat fragmentation introduction of invasive species pollinator loss	I would make sure that botanic garden is kept clean
	I could teach other pupils what I learn today about plants	By learning from the plants how they are growing and their size	I would say create a table for picnic and space where people will have much fun
	To take care of them and not litter, for future generation	By watering them, and make sure they are protected	I would clean the area that has plant habitat and tell visitors to not throw rubbish
	Maintaining the plants, looking after the plants and keep the place secured	By keeping the plant habitat clean and ensure that no one steals the plants	I would teach other people about plans and the importance of plants in our everyday of living
	To take care of the museum that in the future the plants can be protected	By keeping plant habitat clean, not littering or polluting	I myself would clean the dirt that is there so that they cannot damage the plants
	I can take care of the plants	By participating on plants	Plant habitat fragmentation

		programmes, and clean the area	introduction of invasive species. My impact is trying to make the botanical garden clean because of plants found there
	I could take care of the plants and look after people who want to destroy them	I can use it for heling people to know the difference in plants	It can be a benefit to the community if they can be thought about the different plants
	By watering the plants so they cannot be destroyed	We can go to different type of environment and test it if it is good for a particular plant	
	I could pick up the litter	We can plant more plants, cleaning up the area	My impact would be to clean the botanical garden so that the garden can be less polluted
7	**How can you use botanical garden for the benefit for the community?**	**How can you use botanical garden for the benefit for the community?**	**How can you use botanical garden for the benefit of the community?**
	By providing more information on how to conserve each plant, what will take to ensure that they survive	I can use the garden for indigenous learning and also general learnings	We can educate the community on different plants and the importance of plants and trees, how caring for them can make better living and make or preserve important plant
	I could use botanical garden for the benefit of the community in the way that there are plants which are used for traditional medicine e.g. for flu and sore throat	For the community to learn about plants and animals	To name species by giving each a name composed of two parts
	If I take care of the garden the community can be able to visit	Plants can be produced and supplied to the communities in need of vegetables and fruits	To help the community by keeping the plants and to take care of them. To know how to use them
		It can be a place for entertainment, where people could socialise and get to know the plants	To help people who are sick like someone who have fever
	I could use it to benefit the community		To always look after their plants not dehydrate the plants or flowers
	It can be a value to plants because they can be a related lesson	By teaching them about the plants	I can pick up some plants and make it a herb in order to help the community, I can make a herb that help people with fever
	In the botanical garden there are plants that could be used	Teach the youth about the diversity of plants it can	Forest exchange have water and carbon dioxide with the

	to cure people	benefit the community	atmosphere from any other biome
	By keeping plants for our oxygen so that we can breathe a healthy oxygen	Judging how botanical garden look, the people might gain a lot by planting their own trees and plants	To make any special place for chilling there and your family. To use as a playing field
	It can be of value because you get to see what the plants look like	If you want to learn about plants and their species also their importance	By giving orders and treat my garden with every water in the roots
	Take some plant and plant them in our community, we need oxygen	By finding information on particular plants and also understanding what they are used for	Yes, I can for the purpose of wanting to plant indigenous plants and maybe I can make them use of traditional uses
	Plant the same plants in our community, so that we can have more nice places	Can help people that have allergies and assist those who are sick	By showing them how natural it is, and that we can learn more about plants
	I could help areas where the is no more trees so that we can breathe fresh air	Planting more trees in the community	For the community to have knowledge of their surroundings and also helping them from illness
	I can use botanical garden by teaching our community the impact of having plants		By telling the community to care about plants
	Take some plants and plant them in our community	Test the plants and see what is used good for people and for their skin	
	By using it as place to learn about plants	It can be used for scientific, educational and ornamental purposes	By making sure that every plant people need is found there
	Educating people in our community about plant and health	I would use the garden for my community, by showing them the place so that they could know the different plants and the place where they are kept	You can provide plants in a certain area, where there is a carbon dioxide and provide fresh air and medicine to sick people
	We can plant more trees in our community	We can use botanical garden for benefit of own community in many ways, by entertaining own community and try to stop polluting	A place where you can go and ease your mind
	The community can learn about plants and keep them alive	By means of education, recreation and entertainment	Picnic with your family and friends
	Other plants help human to survive, they are used as medicine		I would use botanical garden for the benefit of the community, by giving other people the opportunity to plant flowers and have more knowledge about plants
	Making sure that the plants are not lying around the	For projects and school works	We can use botanical garden to learn more about plants and

	street		also use plants for medicine
	You could plant some trees to make your community look beautiful, and also teach your community about plants	You can use them at the funerals	I would use it by making them to learn about flowers and their importance
	It is a beautiful place that one can come and observe, take some pictures and chill	I can use the garden to educate people about plants	Botanical garden can be used for the benefit of our community by teaching them about the importance of plants
	By planting some of the plants and making the community look nice	I could take the community to see the beauty of plants	The community can learn more about the plants and the use of them
	That it is healthy and quiet place to be	It can be used as a place of pleasure and relaxation	We can use botanical garden for the community by teaching them about plants or trees and their importance
	Most plants can make medicine	Decoration, people can benefit from it	The driver conditions support a unique plant community including a number of important endemic and rare species
	I can make sure that plants are getting the care		
	To plant trees in their homes so they can breathe fresh air	It can be used as a place for relaxing and a place where you can visit when you want to have some peace	
	I can teach others on how to keep trees	We can use the garden as a place to enjoy ourselves, academically it can help for students to gain more information about plants	I can use it to make the community know how plants are used for and the variety of them
8	**How can botanical garden be of value to the plant related lesson?**	**How can botanical garden be of value to the plant related lesson?**	**How can botanical garden be of value to the plant related lesson?**
	It will mean more life, as to if the area is more eco- friendly that will be harmless.		It can be a study of different plants, sharing knowledge and growing more of indigenous plants
	Botanical garden can be a value of the plant related lesson		Because of plants that are labelled with their botanical names and common names included
	You can understand more about the plants, It can be useful for students	It can help in taking care of the plants	Everything you want to learn about plants
	Students studying medicine could visit botanical garden to learn about the different	Because the garden is educational place that shows natural and exotic plants	

	types of plants		
			It can be value to the plant that can be used
	It role in urban greening the plants help to breath		It can help us to know the different plants and the season that the plants grow in
	It could help medicine students because of the medical plants	For research and field trip to see the plants	Scientist must do observations of the plants phenology to draw conclusions about how changes in climate will affect the relationships between plants and their pollinators
	It can be a value because of the different plants	It can be an example of how to keep an environment and can lead to more plants being discovered	Value of botanical to keep plants safe
	It can be of value because it has variety of trees/plants		By illustrate the purpose of how we can keep our garden clean and in our community
	It will teach young children more about plants. Help medicine students	These plants are collected and divided into their families thus their structure and the way they look	The botanical garden can be of value by the plants that are planted there in the botanical garden
	Go to different schools and teach students about plants and how to keep them safe	It can be kept clean so that plants can grow	
	The botanical garden is an environment whereby must of the plants are, there for good reason	The garden can be off value for the plants related lessons by making people aware of plants	
	It could be value because it has the plants		I think it's because botanic garden is all about plants
	It will students more about plants, Learners will more experience about plants		
	Its where we can observe plants	The botanical garden is filled with a variety of plants, different plant species that can help identify them	By planting all kinds of plants needed by people
		Most plants at the botanical garden are labelled with names and common names and the plants are related	Because we can use the botanical garden as a viewing point for lessons
	By identifying them when they are tagged		It is a value to plant related lessons, because most plants are labelled
	It keeps them healthy and green	There are variety of plants that we can use for research purposes	A place where most plants are labelled with their botanical names and common names

	It can help with variety of plants		
	By giving people different kind of plants and teach them	People should not be allowed to have picnics at the garden because they destroy the area	
	It is of value due to the fact that it can improve people's lives		It can be a value due to the fact that it keeps plants in a safe environment
	That there are different plants	It can give us a visual of what we are actually talking about	They are connected
	It can be value by making it a place of people or children	It can be of value because they can learn about the plants physically, to know how to take care of them	The botanical garden in plant related lesson is educational and is very important. It is educational showcase for both native and exotic plants
	That there are different plants that have their purpose such as giving us oxygen	It can be of value because we learn while we can see and touch the plants	
	To provide space for many plants that are very useful	It helps people to understand more about plants	The plant purely grow and it's the place where you can just relax your mind
	To learn about the names of the trees		
	People can come and observe the nature	It can be a value as we can see the species that we are being taught about and understand better	
9	**In what way botanical garden can be of value to biodiversity and its role in urban greening?**	**In what way botanical garden can be of value to biodiversity and its role in urban greening?**	**In what way botanical garden can be of value to biodiversity and its role in urban greening?**
	It bring more life		Botanical garden can provide home to many species of plants
			Yes, because other plants we use at our team cricket
		It can take care of the green	In urban greening
			Is that people must still play their role by continue to plant
	Its role in urban greening the plants help		By making the herbs that can help people in the community
	You can choose plants you want to grow in your community	It adds to the number of plants in the BG, for urban greening it makes it a site seeing	By supporting a unique plant community including a number of important endemic and more species
	It has more green plants like false banana tree	By adding as much animals as the plants so we can	

		balance biodiversity	
	It can be of value because of variety of trees/plants		By become invasive in the new or new habitat. To prevent species
	Give you a variety of plants which ca be used as medicine. You can choose the trees you wanna plant in you name		City green spaces are being recognised as important components of the urban ecosystem providing usable habitat for many organisms, including migrating species
	Give us variety of plant so we can grow our own		It gives us oxygen and it reduces climate change
	You can plant the specific tree that you would like at your urban area	It makes the area beautiful and the environment cleaner	To make the urban greening a beautiful place
	Give us variety of plants that could be used for medicine		It will play a role such as kids know how to look after a plant
	Will give you a variety of plants which we can use for medicine		
	It is minimising the amount of carbon dioxide		
	Botanical garden is used as a place to hide plants in order to urban greening		Could be a real value because of buying food you plant and reduce carbon dioxide
	It can help those who are shot of oxygen		We get oxygen and it helps us to reduce climates change
	Is that you could have any of the tree in botanical	It is a home to plants, there are no harmful industrial things	
	It gives you variety of plants so you can choose from		It helps us to be able to breath oxygen
	It gives us variety of plants that we can use in urban greening	Because it is part of urban greening	It releases oxygen which we human can use for breathing and also oxygen is used for reducing climate
	It can be of value because the trees make the place beautiful		The trees help us with oxygen and the oxygen help us to change the climax
	Give us variety of plants in order to create health	It is one of the sauces of oxygen, for urban area it makes it look beautiful	They release oxygen which we breath in
	Give a variety of plants in order to create greening		The role that will be played by the botanical garden will be very big because many people could learn more about plants
	Give variety of plants in		Trees release oxygen which is

	order to have healthy environment		more important to our lives and trees help to reduce the rising of climates change
	It makes it beautiful and can help people to breath fresh oxygen		Its role n urban greening can be very much needed because when the plants are in healthy stage they grow well
	It gives us more information about plants and how they live	We can add large numbers of plants and animals at botanical garden	
	To plant trees that are suitable to people	In allowing people to enter and exit at any time of the day and night and keep on planting plants	
	It is a green place with beautiful plants, and it produce oxygen	It can be a value like helping with research etc., it plays a big role in urban greening	
10	**Using all your senses, how would you describe a botanical garden?**	**Using all your senses, how would you describe a botanical garden?**	**Using all your senses, how would you describe a botanical garden?**
	It has fresh oxygen, air it is soothing. You can feel nature inside you when you are at botanical garden		It is a peaceful, beautiful and fresh place where one can unite with mother nature
	It has fresh oxygen, air it is soothing. You can feel nature inside you when you are at botanical garden		It seems as a large plant and you can use as packaged plant
	It has fresh oxygen, air it is soothing. You can feel nature inside you when you are at botanical garden	A place of healthy plants, good for educational purposes	A botanical garden, I would say it's a library of plants because it has everything that has to do with living organism
		It is beautiful and peaceful, a place where people usually have picnics	A botanical garden is a place where plant have the safe environment
	It is a greatest place to be, it has a lot of beauty e.g. trees, plants, flowers and it smell nice		Describe botanical as a beautiful garden full of things from nature
	I would smell and see how botanical garden plants smell, touch them to see how they are rough or sensitive	It is a beautiful environment with fresh air	I would describe it as a place whereby it is a name to lot of plants
	It is very beautiful and green habitat for insects , and smell of the plants are quite refreshing	I can smell the plants, taste some of the plants, feel the different plants, see different plants and hear harmony of plants in the garden	A great place to learn new things that you did not know and learn about plants
	I can smell some different	A botanical garden is a wide	The place where plants leave.

	types of flowers, can touch leaf so that I can see whether the flower is rough or smooth	garden with lots of different plants from in and out of the country, important for educational purpose	The place where to chill with your family, a beautiful place
	Botanical garden is a beautiful and fresh environment whereby you get to see plants		Botanic garden is for family picnic
	I see green plants with net-veins. When I touch the plants some are rough some are smooth, I could hear birds singing	Botanical garden is a nice place where plants are collected and are used for research	I would say botanical garden is a place where plants are planted. Different types of plants such as indigenous and alien plants short and tall plants
	Place where you can find different plants, that have been taken from other countries	It is a place where plants are kept for scientific research	It is a place full of plants that are different, space for people to come and watch these plants. Some other animals like plants so you could se them there
	You can smell the plants, and see the different from them	It is a place where variety of plants are available for educational and for recreational purposes	A botanical garden is a place where there are different kind of plants and trees
	I saw beautiful plants and I could smell them, It is a place where I could have a peace of mind		it's a huge place that stores plants and look after them
	I saw green plants with net-veins, when I touch the plants some were smooth and others were rough	The botanical garden is beautiful	I would say that botanical garden is a place where plants are stored and also where people visit
	It is green, refreshing and peaceful place	A botanical garden is a place where different plant species can be identified	It is a place where people love to walk around with their partners
	It is a place where there are plants which you will be educated about them	A wide variety of plants are cultivated for scientific, educational and ornamental purposes. It is a nice place that has different animals	The botanical garden is a place filled with indigenous and exotic plants that may help reduce air pollution
	Touch to feel if its rough or smooth, and also hear birds singing	It is a garden where plants are divided by their own names and groups	I would describe botanical garden as a beautiful place whereby you can go and refresh you mind
	I see a lot of different tree, plants and also snakes. They smell in a different way	It is beautiful and refreshing, relaxing, cool and fun place for picnic	A place where wide variety of plants are cultivated for scientific, educational and ornamental purposes
	A place where there is oxygen, beautiful natural		It is a huge place full of plants/ flowers and different

	plants		from each other
	Touch to feel if it's rough or smooth, and also hear birds singing	The botanical garden is a place where you can learn and do school projects	A place where you can learn about plants and their scientific names and also where people can enjoy themselves
	You can identify some plants by looking at them, You can tell you at the botanical garden when you hear birds singing, you can smell some plants, you can taste the fruit of the other plans		I would describe botanical garden as a wonderful place because it is so cool
	It is beautiful place with a lot of green plants	It is a nice quiet place to be, very beautiful and unique	Botanical garden is a place where different plants are cultivated for scientific, educational and environmental purpose
	It is a nice place for both human and animals	It is a place of admiration of plants, Beautiful plants and green and colourful place	The botanical garden is very neat place where plants are kept
	That it is a great place to be, There are different kinds of plants, some can help us survive	Beautiful plants, Green and colourful, Spacious and a place to actually breath fresh air	It is a nice place where you can go and enjoy yourself, looking at nature and learn more about trees
	A place where there is a beautiful smell of plants	An environment which you can get sample of plants, and see different plants also have your picnic	I think it is a garden that have different flowers example alien plants and indigenous plants
	There are smooth plants, also the smell of the plants are not too bad	The garden is a place whereby we learn different kinds of plants and their names	I would describe botanical garden as a place where there are different types of plants and a place where you can get to study about different plants
	Chilling place to be alone	It's a place where you find all different plant of inland and outland	
	It a place with fresh air and a place to chill with nature	It is a beautiful place with a lot of different plants such as alien and indigenous plants	I would describe botanical garden as place where variety of plants are cultivated for scientific, educational, ornamental purposes