Botanical gardens as experiential science and as living art the relocation of the succulent section of the Manie van der Schijff Botanical Garden

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This article argues that the educational power of botanical gardens goes beyond the scientific collection of data but also makes use of the artistic influence of the garden through the perception and experience of the user. The enjoyment of nature and of art is drawn together in a garden. Botanical gardens are unique as gardens in the sense that they have greater scientific than artistic emphasis. They are illustrations of the interdependence of the visual arts and the sciences. The experience of gardens is unique among the arts due to the living, temporal and spatial qualities that also form part of our daily reality. In this sense botanical gardens have the potential to raise awareness on our everyday surroundings and their connection to conservation and the health and survival of life on earth. This gives botanical gardens the ability to expand their educational value as a living form of art through the experience of the user. Experiencing life and art enhances learning. In a fast changing world the value of experiential learning has increased which gives botanical gardens a unique position in the 21st century as a didactic tool.

Key words: botanical garden, experiential, active learning, succulents, landscape architecture

Jardines botánicos como ciencia de experiencia y arte vivo

La reubicación del sección de suculentas del Jardín Botanico Manie van der Schijff
Este artículo sostiene que el poder didáctico de los jardines botánicos va más allá de la colección de información científica, también resalta la influencia artística del jardín a través de la percepción y vivencia. Constituyen un punto de encuentro entre la naturaleza y el arte. Los jardines botánicos son únicos considerando que tienen mayor relevancia científica que artística. Se manifiestan como ejemplos notables de la interdependencia de las ciencias y las artes. La experiencia artística de descubrir estos jardines es única debido a sus cualidades vivas, temporales y espaciales que también reflejan nuestra realidad cotidiana. Los jardines botánicos tienen la habilidad de alertarnos acerca de nuestros entornos inmediatos, sus conexiones con la preservación, con la salud y la supervivencia en esta tierra. Experimentar la vida y el arte potencia el proceso educativo. En un mundo de cambios el valor del aprendizaje práctico ha elevado a los jardines botánicos a una posición prominente como herramienta didáctica en el siglo XXI.
Palabras claves: jardines botánicos, aprendizaje practico, suculentas, arquitectura de paisaje

The garden can be valued and appreciated for its contribution to science and to art. Not only are plants indispensable to our physical survival on earth, they are also priceless in their role in religion, cultural events, celebrations and our emotional well-being. Due to the variety of values attributed to plants, gardens matter to people for different reasons while they have also played distinct cultural roles and served as representations over the ages. In a simplistic sense, the enjoyment of nature and of art is drawn together in a garden; however Cooper (2008: 150) identifies garden appreciation as a special human phenomenon distinct from both the appreciation of art and the appreciation of nature.

Botanical gardens are unique in the sense that they have greater scientific than artistic emphasis as gardens. For more than 450 years botanical gardens have been showcasing the world's botanical diversity and have provided innumerable opportunities for people to do research and learn about plants, their uses and value. Although each botanical garden has a character and purpose of its own, these institutions hold documented and adequately labelled collections of living plants for the purpose of scientific research, conservation, display and education. Some of the first western botanical gardens, associated with Italian Universities in the sixteenth century, were created to integrate and conserve a great diversity of plant species mostly for medicinal interests. In the late sixteenth and seventeenth centuries exploration and the beginning of international trade influenced botanical gardens to become collections and

trade centres of foreign plants from far off destinations. Since the twentieth century the main purpose of botanical gardens has become *ex situ* conservation, awareness and education centres (Wyse Jackson & Sutherland 2000: 10-11).

The educational value of botanical gardens has become especially relevant in the 21st century for two reasons: they are living laboratories for biodiversity studies and conservation and they enhance experiential learning practices. Elaborating first on the latter, in education the constitutive power of language is used to set terms for description and perception (Miller 1993: 4). In that sense experience becomes secondary when language is needed to describe the experience. However in a post industrial society where change has been occurring more and more frequently, experience has become more relevant since experiential learning reveals the application of knowledge and thus allows people to live and function better in a fast changing world (Richards 1992: 157).

According to Miller (1993: 4) art challenges the hegemony of language over experience in the formation of knowledge and consciousness. If we thus maintain that gardens are art (Miller, 1993; Cooper, 2008), then gardens have the power to challenge language as the main formulator of our world and our perceptions. In essence art pushes the boundaries of our understanding, beyond that which we can describe in words, through our experiences that influence our knowledge and conscience. In that sense the educational potential of botanical gardens go beyond the scientific collection of data but also make use of the artistic influence of the garden through the perception and experience of the user. The experience of gardens is unique among the arts due to the living, temporal and spatial qualities that form part of our daily reality and thus strengthen the conviction of their demonstrations (Miller 1993: 178). Ross (2008: 175) further argues that the greening of art through ecological art works represent an interdisciplinary approach and are based on the concepts of collaboration and biodiversity; and place an even greater emphasis on natural processes and time sequences, and provide new ways to synthesise art, science, nature and life, and sensitise the viewer to the fragility of nature. She furthermore argues that "art is imaginative, create environmental awareness and promote a paradigm shift that incorporates concepts of interconnectedness between people and the planet, and that of *living lightly* on the planet"

Although the former argument is forceful enough by itself, the protection of biodiversity as the other mentioned pillar of importance for botanical gardens today, is the only defence against the current threat of climate change. Diversity in nature equals resilience and survival. Surprisingly, out of a total of an estimated 2 178 known botanical gardens in the world, only a few are situated in areas with exceptional species diversity and high levels of endemism such as Africa, South America and Southeast Asia (Wyse Jackson & Sutherland, 2000: 13; Wyse Jackson 2001: 24-25). According to Van Wyk & Smith (2001: 5) an estimated more than 60% of the species of the southern African subcontinent is endemic to the area (meaning they occur nowhere else in the world). There are only 127 (6%) botanical gardens in Africa and the Indian Ocean islands of which 19 are recorded in South Africa (Wyse Jackson 2001: 25).

The Manie van der Schijff Botanical Garden

Similar to Italian Universities in the sixteenth century, the University of Pretoria proudly houses its own botanical garden on the main campus. The Manie van der Schijff Botanical Garden (here after the garden) comprises approximately 3,5 hectare of fragmented area in between the buildings on the west side of the main campus. All areas of the garden are landscaped with no wild or natural areas. It is an academic training facility by nature with mixed plantings consisting of about 80% indigenous plants from all over southern Africa (Middleton & Vosloo

2010). The garden originated as far back as 1924, when *Pavetta* species were planted by prof. C.E.B. Bremekamp, head of the Department of Botany, on the campus for research purposes. It was Prof. Berend Elbrecht, who succeeded him as head of the department, who gave real momentum to the garden. He was a man with passion and enthusiasm for the southern African flora that lives on in the many tree and cycad specimens planted by him during the 1930s. In 1986, the garden was named after Prof. Manie van der Schijff to honour the contributions he made towards the development of the garden and the then Department of Botany (Grobbelaar 1986: 9; Coetzer *circa* 1995: 1).

The garden is an inter-departmental training facility. Outdoor as well as greenhouse space, fresh plant material and other biological materials are provided for the practical training of students (see figure 1). The living specimens in the garden are useful for plant identification courses in plant science, environmental studies, landscaping, forestry and horticulture. The many buildings in and around the garden, representing a multitude of architectural styles, are greatly enhanced by the established garden. As such the garden provides an ideal site for drawing exercises to students in architecture. Layout projects for landscape architectural students can also be done in the garden as well as mapping practice for geography students (Middleton & Vosloo, 2010).

Figure 1
Landscape Architecture students utilizing the greenhouse facilities on the main campus of the University of Pretoria. The physical contact with plant material is important in terms of experiential learning (photograph: L. Middleton, 2009).

The rich bird and insect life, attracted by the many indigenous plants, provide material and on-terrain research opportunities for zoology and entomology students. A culinary herb garden supplies fresh herbs to students in consumer sciences. A substantial number of traditional African medicinal plants can also be found in the garden. This makes access very easy to material needed in studies in ethnobotany and medicinal plants (Middleton & Vosloo 2010). The study of indigenous plants with horticultural potential is one of the ongoing projects of the garden. A comprehensive study of shade-tolerant plants has been done (Middleton 1998) and new projects on succulents with ornamental value have commenced. Current studies show an unprecedented increase in market demand for southern African succulents (Middleton 2010).

The garden boasts several (living) special collections. A living plant collection can be described as a group of plants grown for a defined purpose. Such a collection can be displayed either on its own, or as part of a more general garden collection (Leadlay & Greene 1998: 40). These plant collections in a garden can also be divided into several themes.

According to Leadlay & Greene (1998: 41) thematic collections can be used for educational and scientific purposes, or for public display. Thematic collections may be taxonomically based

(e.g. family or genus), share a common geographical or ecological origin (e.g. forest or alpine), share a specific use (e.g. crops or fibres) or share a habit or life form (e.g. an arboretum or succulents).

A garden may also have conservation collections that aim to conserve and maintain populations of rare and endangered species. Conservation collections are usually held *ex situ* and are valuable for species recovery programmes and to provide protected long-term backup collections of wild plants (Leadlay & Greene 1998). The Manie Van der Schijff Botanical Garden includes the following collections:

The garden route: The garden has an outstanding collection of mature indigenous southern African trees and a garden route was developed to broaden botanical knowledge of students as well as the broader community. A formalized plan for a garden route was laid out in the early 1990's. There was a growing need to send students to a garden to do self-study. The best and most important tree and shrub specimens were identified. A proper walking route had to be worked out that went by specimens closely enough to allow viewing, touching and smelling if necessary. Hundred-and-thirty (130) tree species were identified and name-tagged for this purpose (Coetzer 1995: 1).

The cycad collection: The garden is world famous for its cycad collection and ranks amongst the top cycad gardens of the world. Cycads are primitive gymnosperms and are regarded as relicts from the past. It is evident from plant fossil studies that coniferous plants existed on earth long before the advent of flowering plants and originated about 230 million years ago. As with the dinosaurs, the cycads reached their peak both in numbers and diversity in the Jurassic Period that lasted 57 million years between 193 million years and 136 million years ago (Grobbelaar 2002: 1).

One of the garden's oldest cycad specimens is an *Encephalartos transvenosus* which was collected in the 1930s by prof. Berend Elbrecht. It is a very large cycad, 5 – 8 meters tall, and can reach 13 meters. The trees form natural forests on the mountainsides above the village of the rain queen, Modjadji, east of Duiwelskloof in the Mpumalanga province of South Africa (Coetzer 1995: 7). The southern African species list is contained either in the garden itself, or in the greenhouses and on the experimental farm. Rare and endangered species are kept locked up for protection against theft, which unfortunately is a major problem with keeping plants with collector's value in an open garden (Middleton & Vosloo, 2009).

Figure 2
The rare *Encephalartos woodii* is kept locked up for protection against theft, which unfortunately is a major problem with keeping plants with collector's value in an open garden (photograph: L. Middleton, 2008).

The monocotyledon section: This section of the garden was established in the early 1980s and houses a systematic or taxonomic collection with the theme as monocotyledonous plants. Monocotyledons are an extremely important division of the seed plants (Leistner, 2000: 25) as they include all the grasses and cereals that form the dietary basis of most grazers and human beings. Grasses, aloes, bulbous plants and other representatives from this group are planted in this section (see figure 3). This section is ideal to visually illustrate the very basic difference between dicotyledons and monocotyledons the two groups of flowering plants (angiosperms) to all levels of students (Middleton & Vosloo, 2010).

Figure 3
The Manie van der Schijff monocotyledon garden is renowned for its beauty with its contrasting and highly textured grasses, palms and aloes (photograph: L. Middleton, 2008).

The succulent garden: This area contained some old collections of euphorbia and aloes. The succulent garden was constructed with some interesting tree specimens to resemble a natural *koppie* (rocky outcrop). The old cactus garden was renewed in 2001. Some of the original cacti and agaves were kept and many indigenous plants in the succulent group were introduced. This section contained mixed plantings of indigenous and exotic plants and included some interesting succulents from other parts of the world, notably the Americas and some specimens from Madagascar (Middleton & Vosloo, 2010). This section of the garden came under construction again during February 2009 when a major facility expansion project for the School of Engineering necessitated a campus entrance from University Street in the west.

Figure 4
The former succulent garden constructed like a rocky outcrop on the western boundary of the University of Pretoria main campus (photograph: L. Middleton, 2009).

The expansion project that is currently in process includes the construction of a parking garage for approximately 1000 cars. A new entrance is necessary to accommodate the traffic volumes and security requirements of such a large parking garage. The new entrance and access road to this however cut right across the old succulent garden as well as the section that was renewed during 2001. Relocation of the plants from this area to a site adjacent to the Building Sciences building was investigated and resulted in a new experiential garden allocated between the Visual Arts Department and the Department of Architecture as well as an interesting and lasting learning opportunity.

The succulent garden relocation as experiential learning

The site selected for the relocation of the succulent garden was west of the Building Sciences building (see figure 5) and thus of direct importance to the Department of Architecture and its students. The curator of the Manie van der Schijff Botanical Garden at the time, Lorraine Middleton, was also presenting plant sciences to the second year landscape architecture students. The idea of involving these students in the design and layout of the garden for the relocated succulents as an active learning exercise was conceived. The learning experience would cover two subject modules, namely plant sciences and landscape design. The plant sciences module would lend itself to further learning regarding the scientific aspects related to the identification and research on the species selected for relocation. The landscape design module would allow for the development of an innovative and aesthetically pleasing design and layout of the identified relocation site to accommodate these species in a meaningful display that can be used for didactic purposes.

To engage students in real life scenarios or actual events as part of a learning opportunity would appear to be the most natural and spontaneous way to develop their required knowledge. Traditional methods of teaching often create a dependency of learners on the lecturer. To foster independent learning, it is beneficial and necessary to break away from the structure and discipline of traditional schooling and explore more spontaneous ways to instil learning. Active learning is a way to achieve a greater self-determination in learning. In active learning "The short-term objective of acquiring knowledge should be tempered with the long-term goal of training the mind to think analytically and critically" (Vo & Morris in Kennedy 2007: 184). In this approach the emphasis is moved away from what learners should think and rather placed on how they should think. This approach concentrates less on facts and more on how to use information. Learners are thus better prepared for changing situations and dealing with new information.

Figure 5
The site selected for the relocation of the succulent garden. The Building Sciences building can be seen in the background. The site is exposed to sunlight and is easily accessible to visitors (photograph: L. Middleton, 2008).

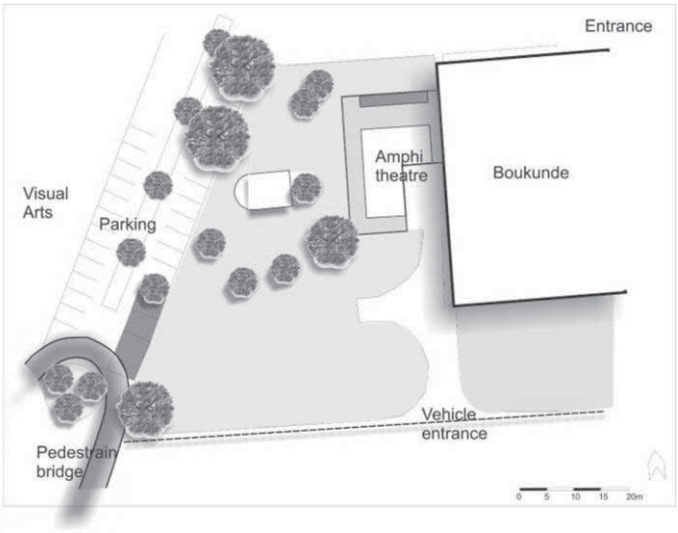

Figure 6
The site selected for the relocation of the succulent garden in plan view, indicating the position of the Building Sciences building (*Boukunde*), amphitheatre and other existing elements are shown (image: I. Breed, 2009).

Research by Kennedy (2007) further indicates that learners value participation more than passively receiving information. Furthermore when information is applied during the learning process, the learning that takes place is increased. This way the relocation of the succulents became a beneficial active learning opportunity for the second year students in landscape architecture. These students already utilised the campus botanical gardens to enhance their plant identification skills and would now become engaged in planning the future layout of a part of the garden for the relocated succulents.

The prescriptions in terms of the botanical gardens were to incorporate these as academic training facilities in essence. They therefore needed to illustrate: botanical concepts e.g. ecological groupings of plants, naming of plants and evolutionary convergence for identification; world diversity (plant diversity and biodiversity) in terms of vegetation in low rainfall areas in separate areas from different continents (in this particular case South Africa, the Americas and Madagascar); information displayed on the species in the garden in terms of: horticultural potential of indigenous South African succulents suitable for the climatic region; environmentally important concepts e.g. resource protection, invasive plants, urban greening and good landscape design principles. Finally access would also be required to the supply of fresh plant material such as flowers and leaves for student training.

The learners had to firstly consider the nature of the plants. Succulents are xerophytes (drought-adapted) and therefore need little water, good drainage, high exposure to sunlight, correct soil preparation (generally poor soils and good drainage), mulch and low maintenance. The accommodation of specific plants had to be considered that would be moved from the old garden and additional species to increase the variety in certain groups. In terms of the plant material use and application the main practical considerations were clear grouping of succulents from different continents i.e. South Africa, Madagascar and the Americas. Secondly the design investigation and development concerned the social function and aesthetics i.e. the accommodation of gathering and seating areas; easy access and walkways to view plants close-up, also for the physically impaired (gradient to accommodate wheelchairs); a pleasing visual display of major feature plants and the generation of a design identity (a sense of place). The design also had to tie in with existing and future planned gardens north of the allocated area.

As part of the design process the students would practice their communication and presentation skills.

In adult learning there is a process of modifying, transforming and integrating knowledge and skills. Transformative learning theory argues that learners should be placed in situations where they can explore options for forming new roles, relationships or actions, followed by a plan for action. The unfamiliar real life scenario that includes individuals that are non lecturers as the client made new roles and relationships possible, which could lead to new action and understanding. According to Groen & Jacob (2006: 76) "…students experience significant shifts in perception and behaviour upon encountering theories and data that diverge from previous knowledge and understanding". Real-life involvement, personal experience, action and reflection all enhance the possibility of transformation.

When learners are engaged in an assignment, it is important to set out the desired learning outcomes from the onset. As an experiential learning project the critical cross field learning outcomes (adapted from HEQC 2006: 42-44) that were desired for the learners included the following: The students had to identify connections between academic concepts and processes and their experience (as well as the context of experience and life in general); they had to experience personal awareness in character and be able to identify approaches for meeting collective objectives and be able to apply them; afterwards they should also be able to apply and analyse the curricular module content in the light of the experiences.

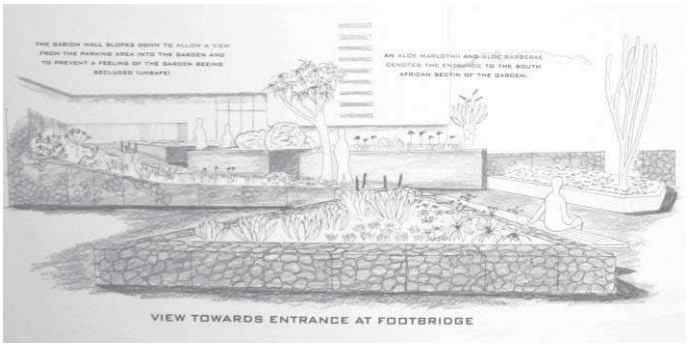

Figure 7
Proposed layout for the future succulent garden by student (E. Meyer). This design was greatly appreciated by the Garden Committee but the difference in level accommodated by retaining walls and several path systems would prove expensive to realize (photograph: L Middleton, 2008).

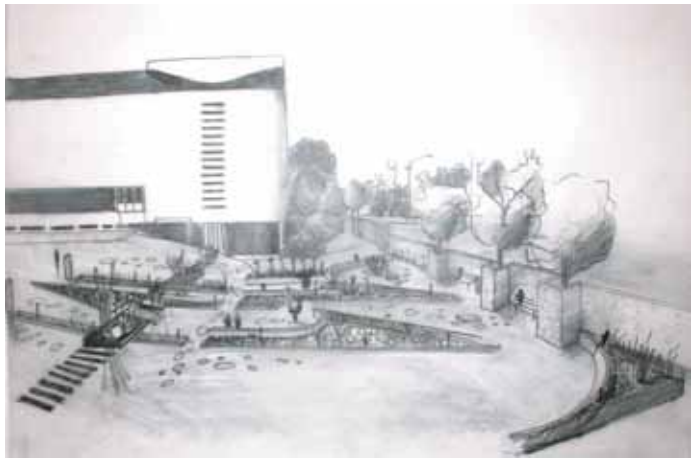

Figure 8
Proposed layout for the future succulent garden by student (image: G. Dimonte, photograph: L. Middleton, 2008).

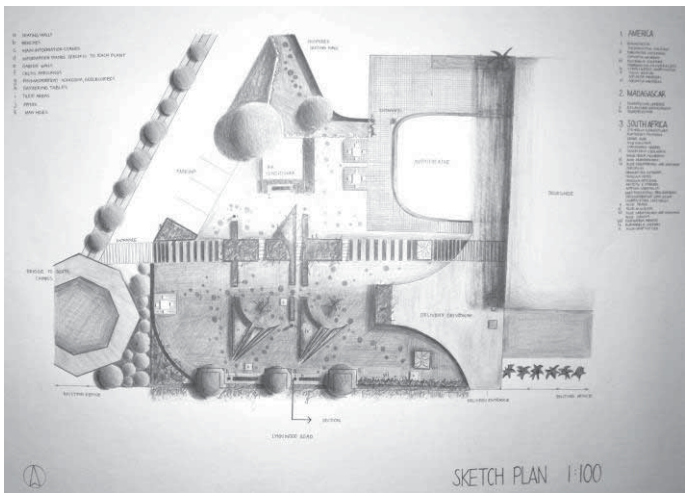

Figure 9
Proposed layout for the future succulent garden by G. Dimonte in plan view (photograph: L. Middleton, 2008).

Two students' designs were favoured by the jury (see figures 7 & 17). The designs were selected and awarded at a small prize giving. Afterwards the design ideas were developed by the lecturers into a feasibly and affordable final layout (see figure 10). The final garden design logic can be summarized as follows: the garden can serve as a gathering area before events that occur in the nearby amphitheatre; the visual exposure was optimised by placing feature plants in prime positions; the aim was to attract visitors to the area and make passers by aware of the unusual garden; the nearby pedestrian bridge also serves as a lookout point over the garden; seating, gathering and access points were carefully provided for allowing wheelchair access, informal and formal gatherings and usage.

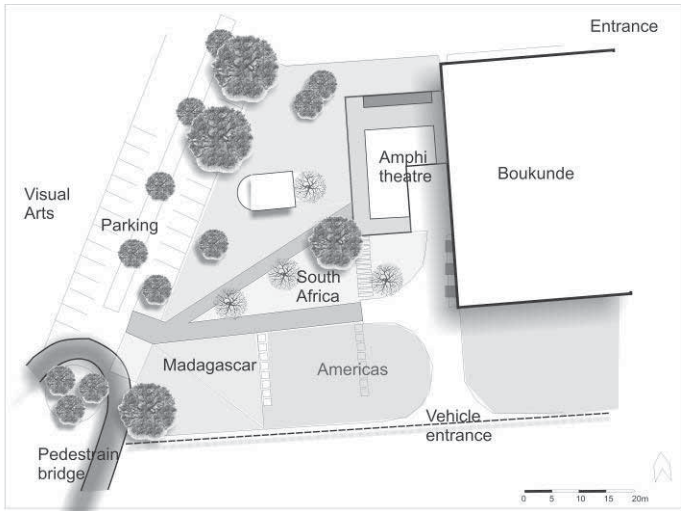

Figure 10
Final adjusted layout in plan view, inspired by student proposals. The pathways have been reduced to give a more simplistic layout with a clear division of planting from different continents. The existing circulation patterns were respected (image: I Breed, 2009).

Experiencing succulent diversity

The very nature of succulents being "soft" as opposed to woody plants with a strong and sturdy physical structure, render them mechanically and structurally difficult to handle, especially the large specimens. This proved to be one of the major challenges during the design implementation

and physical relocation process. Several breakages occurred during transplanting, notably the large columnar cacti and euphorbia specimens (see figure 12). It is advisable to prune and trim down plants as much as allowed by a particular species but still retain its natural shape and growth tips. Furthermore handling these plants need special attention as many are very spiny or contain poisonous milky latex. Special techniques and protective clothing is necessary. Most of the smaller varieties root easily from cuttings and broken pieces can be planted in their final position in the garden.

Figure 11
Good soil preparation was essential and the first step towards implementation. Succulents prefer soils that drain well and generally reside in areas with precipitation rates lower than that of Pretoria (photograph: L. Middleton, 2009).

Figure 12
As succulents are not woody, it was quite difficult to transport and physically handle the specimens as many also contain poisonous latex and thorns. This *Euphorbia* specimen lost several branches when it was offloaded by the TLB (photograph: L. Middleton, 2009).

Another aesthetic concern that needed to be resolved is that there are not many groundcovers in this plant group. This is due to the large growth forms that generally are upright and the many miniature forms that are not suitable for outdoor gardens. This makes weed control and filling of beds extremely difficult. The use of mulch such as gravel, stones and bark chips is the best solution for open soil areas between plants (see figures 13 & 14).

The succulent garden today is still indispensable in its function of supplying fresh material to plant identification courses especially in the important South African succulent families the Mesembryanthemaceae (Ice plant, Mesemb or Vygie family), Crassulaceae (Stonecrop or Plakkie family) and Asphodelaceae (Aloe family) amongst others. These plants provide a spectacular late winter and spring display when in flower (see figure 15).

Figure 13
Mulch (bark chips) was used extensively to fill up open spaces between plants in the current garden. This is a particular problem for non creeping succulents (photograph: D. Schoulund, 2010).

Figure 14
Stone and gravel were used to fill up open soils between individual plants in the current garden. The existing rocks from the former garden were used to represent a dry river bed that currently helps with rapidly draining away rain water during thunderstorms in the section representing plants from the Americas (photograph: D. Schoulund, 2010).

Figure 15
Dorotheanthus bellidiformis **(Livingstone daisy/Bokbaaivygie) provides a spectacular late winter and spring display when in flower in the current garden (photograph: D. Schoulund, 2010).**

It is also aesthetically unmatched in its unusual appearance by most other sections of the campus. This is mainly due to the extraordinary shapes of the plants as well as many accent-plants or form plants found in this group. Aloes, pachypodiums, euphorbias, cacti and agaves all have architecturally strong lines that lead and please the eye (see figure 16).

Figure 16
The tree aloes and euphorbia are among the species with extraordinary shapes that results in the matchless beauty of the current garden. The *Euphrobia sp* in the foreground is a valuable specimen from Zimbabwe. (photograph: I. Breed, 2009).

The secret life of succulents and xerophytes

Succulents are a specialised group in the Plant Kingdom. According to Van Jaarsveld, Van Wyk & Smith (2005: 9-10) there are about 20 000 xerophytes (drought adapted) worldwide of which approximately 10 000 are succulents (plants with fleshy storage organs allowing them to survive dry periods when ground water is not available). Broadly speaking, succulents can be regarded as an ecological grouping of plants adapted to dry conditions. However not all plants found in arid areas are succulents. Xerophytes include all drought adapted plant life forms which may be any of the following (Van Jaarsveld *et al*., 2005: 10):

Resurrection plants: these are adapted to survive in a semi-desiccated/semi-hydrated state rapidly recovering after a rain shower.

Woody Karoo shrubs: have small leathery leaves, deeply sunken breathing pores and deep taproots. Many Fynbos species also fall into this category (schlerophyllous plants)

Annuals: these plants grow and set seed in one season with the seed dormant during dry seasons.

Geophytes: are bulbous plants and include plants with subterranean tubers or bulbs. There are many succulent plants that are also geophytes and some may sit on top of the ground.

Stem succulents: their stems are swollen barrelled-shaped, often angled adapted to shrink or swell according to rainfall. Leaves are usually reduced, scale-like and often drop soon and the stem also takes over the photosynthetic function and become green in colour.

Leaf succulents: the leaves are swollen and may vary greatly in size, shape, arrangement and cover. Most succulents endemic to South Africa fall into this category.

Caudiciform succulents: in these plants the stem and root is fused into a swollen water storage organ called a caudex.

Root succulents: these plants have large swollen rootstocks.

Figure 17
The *Kalanchoe thyrsiflora* (White lady/Geelplakkie) is a leaf succulent in the South African section of the current garden. The plants in the garden can be identified through tags that have been provided for didactic purposes (photograph: D. Schoulund, 2010).

Cryptic succulence can be observed in plants that are not always evidently succulent. This category particularly applies to some trees, in genera such as *Adansonia* (baobab) and *Cussonia* (cabbage trees), where the stems are often fibrous. Stem shrinkage occurs during dry spells and these plants will typically survive transplantation as mature plants (Smith 1997: ii). The development of massive stems is a distinct feature of several Bushveld trees (Van Jaarsveld 2005: 133).

Succulents are highly sought after by humans and animals because of the water stored in their tissues. Special measures to protect themselves have been developed and include one or more of the following survival strategies (Van Jaarsveld 2005: 12):

Mechanical defence: many succulent plants have spines, prickles or harnesses which make them difficult to exploit. Some species have armoured plates to protect damage but also insulates them against fire and sun.

Chemical defence: many succulents are poisonous and animals avoid eating them. The Euphorbiaceae family produces milky latex that is toxic and the Asphodelaceae family (aloes) produces an extremely bitter-tasting yellow sap. Plants of the Apocynaceae family produce highly toxic watery or milky exudates.

Camouflage: some succulent plants, especially the small and miniature forms, are extremely well camouflaged in their environments making them difficult to find. Often called mimicry plants because their bodies are rounded or angular similarly to the stones amongst which they grow. Others are speckled in colour making them difficult to detect in mottled shade of bushes where they are found. Many of these plants are edible and camouflage seems to be their survival strategy against herbivores.

Refuge: The impenetrable thorny thicket that covers part of the Eastern Cape is the habitat of many small and interesting succulent plants such as *Haworthia* species. Thorny nurse plant species provide mechanical protection against herbivores, a shady habitat against the hot rays of the sun and their leaf litter nourishes the soil.

Inaccessible dwelling: some succulent species technically referred to as cremnophilous plants only occur on sheer cliff faces. These cliff-dwellers are well out of reach of larger herbivores and plant collectors. According to Van Jaarsveld (2005: 12) inaccessible sheer cliffs

are amongst the most protected and unspoiled plant habitats on earth and many new species are constantly being discovered on them.

Figure 18
The most well known defence mechanism of succulents are thorns and spines which make their soft water filled flesh difficult to exploit as can be seen on the *Pachypodium lamerei* (stem succulent) in the foreground of the Madagascar section of the garden (photograph: D. Schoulund, 2010).

The rich succulent diversity of South Africa

A significant portion of the world renowned South African flora constitutes succulents and make up about 20% of all recorded plant species of the country (Van Jaarsveld 2005: 6). More than half of the subcontinent is regarded as desert or semi-desert with less than 500mm precipitation per year, but reveal the richest diversity of plant and animal life of all such regions in the world (Van Wyk & Smith 2001: 5). Of the approximately 10 000 succulent species that occur world-wide, nearly 47% (more than 4600) have been recorded in the southern African region, and most of them are endemic, occurring nowhere else in the world (Van Wyk & Smith 2001: 5, Van Jaarsveld *et al.,* 2005: 6). The Mesembryanthemaceae with about 1 800 species is southern Africa's largest succulent family and also one of the three largest flowering plant families on the subcontinent (Van Wyk & Smith 2001: 5).

According to Van Jaarsveld (2005: 14) the African continent is rich in succulents in the Euphorbiaceae, Asclepiadaceae, Crassulaceae and Aizoaceae as well as several other smaller succulent groups. North and South America are the two continents where well-known succulent plant families the Cactaceae, Agavaceae and Crassulaceae are concentrated. The Cactaceae with close to 1 500 species is the second largest of all the succulent plant families (Smith & Van Wyk, 2008: 98). Europe and Asia have comparatively few succulents, but have representatives in the Crassulaceae family. Interestingly Australia, a large country with dry conditions prevailing over two-thirds of its land surface, is poor in succulents (Van Jaarsveld 2005: 14).

The climatic, geological and topographical diversity of South Africa supports its rich plant diversity. According to Van Jaarsveld *et al.,* (2005: 14) the highest concentration of succulents found in the semi-arid regions subject to winter rainfall which include the Richtersveld, Bushmanland, Namaqualand, Knersvlakte, Sandveld, Tanqua Karoo and Fynbos regions. Succulents are also abundant in the dry river valleys of the Eastern Cape and KwaZulu-Natal, as well the eastern and northern parts of the country, particularly the Grasslands and Bushveld regions.

A feature of South African succulents is local endemism where a plant is restricted to a small region, sometimes even a single farm. On the other hand some species are exceptionally abundant and dominate large parts of the landscape for example bushveld succulents such as *Aloe marlothii* (mountain aloe) and *Euphorbia ingens* (naboom). South Africa's long history of aridity is one of the most important reasons for its current rich diversity of succulent flora. The seasonality of its rainfall is perhaps the most important reason for the succulent plant diversity. It is not only the occurrence of winter rainfall along the west coast, but also the regularity and predictability of these rains that contributed to the high succulent plant diversity (Van Jaarsveld *et al.,* 2005: 14).

Recapturing

The outcomes of the shifting of the succulent section project in terms of learning but also in terms of the greater Manie van der Schijff Botanical Garden include: a value-added curriculum with a stimulating learning process for the students; increased subject knowledge - specifically technical considerations as per input from facilities management; plant knowledge and identification; communal space considerations; design and drawing; public speaking and presentation. The relevance of knowledge was confronted in terms of a real life scenario. The students could practice managerial skills to finish work on time and present to a client i.e. planning. Personal skills that were addressed include social responsibility; inspiration and motivation; commitment; self confidence and resourcefulness (Van Niekerk 2009). The oral presentations developed communication and negotiation skills. The real life project inspired teaching for the lecturer and the students in celebrating the winning design (prize-giving). The greater achievement with the project was the consequential public awareness that has been raised by the presence of the garden and subsequent talks that were held explaining the importance of succulents. The garden is a living testimony (and example) to the integration of biodiversity conservation, education and art. Furthermore the intention of this work is on *place making* and the construction of recreational sites of *sociation* (Ross 2008: 177).

The aim of this article has been threefold: It is an attempt to reveal the relationships and interdependence between different subject fields namely the arts (visual art and landscape architecture) and the sciences (i.e. botany, ecology) and education. It raises awareness on our everyday surroundings and their connection to conservation and the health and survival of life on earth; lastly it is an attempt to reveal and emphasize the educational value of experience in the form of art, which in this example is the garden.

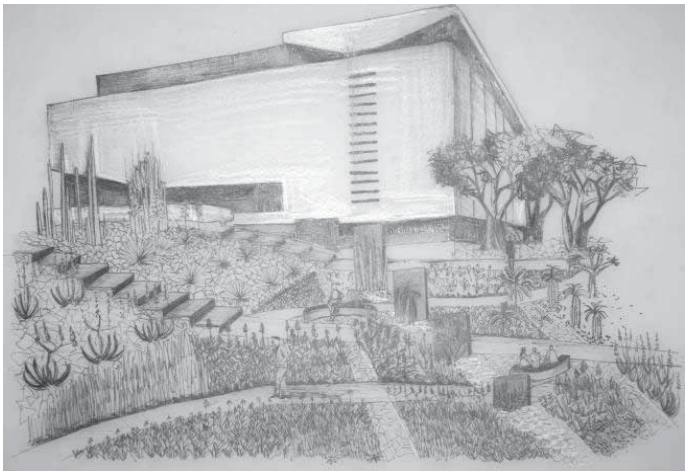

Figure 19
Visionary image created for the succulent garden from the student design the garden committee preferred (image: D. Rossi, photograph: L. Middleton, 2008).

Figure 20
The garden just after implementation in March 2009. Note how in concept the final result remained true to the initial vision (photograph: I. Breed, 2009).

The enrichment of our constantly changing world through the meaning added by artistic and natural beauty and experience is equally important to the scientific knowledge required in terms of our continued existence. Dirkx explains that:

> "… learning continues to be framed within a technical rational view of knowledge, in which we learn instrumentally to adapt to the demands of our outer environment, bubbling just beneath this technical-rational surface is a continual search for meaning, a need to make sense of the changes and the empty spaces we perceive both within ourselves and our world" (in Groen & Jacob, 2006: 75).

The succulent garden is a testimony to the meaning added through experience and art as formal and informal ways to raise awareness and instil learning.

Figure 21
The intense colours, varied textures, unusual and strong shapes of the various succulents displayed in the relocated succulent garden creates an amalgamated work of art and makes it a unique learning experience and a change in consciousness (photograph: I. Breed, 2009).

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