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Journal:	*International Journal of Science Education*
Manuscript ID:	TSED-2006-0063.R2
Manuscript Type:	Research Paper
Keywords:	informal education, biology education, botanical garden
Keywords (user):	

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Abstract

Plants are essential to life on Earth and yet are often deemed invisible by the human populace. Botanic gardens are an under-researched educational context and, as such, have occupied a peripheral arena in biology education discussions. This article seeks to readdress this absence and present the case for a more sustained use of informal learning environments, such as botanic gardens and homes, to make public the private life of plants and their role in sustaining life on Earth. By drawing on empirical data from a doctoral thesis and reviewing relevant research literature, the author argues for a renewed focus on botanical education within science education in both formal and informal contexts.

Introduction

There are over 2,000 botanic gardens in the world today, many of which are situated in urban areas, accessible to schools and families. However, botanic gardens, unlike zoos (Baratay & Hardouin-Fugier, 2002, Galbraith, 2003), were slow to consider the education of school children as a primary aspect of their remit. Notable exceptions are gardens such as Brooklyn Botanical Garden in New York, where children's gardening and teacher training has been a primary feature

since the early twentieth century (Shair, 1999, Shaw, 1930), Kirstenbosch Botanical Garden in Cape Town, which employed its first teacher in 1923 (McCracken & McCracken, 1988) and the New York Botanical Garden which embraced an educational remit at inception (Underwood, 1903). Nonetheless, the situation is rapidly improving; for example education and public awareness feature prominently in the latest set of internationally agreed targets for botanic gardens (Botanic Gardens Conservation International, 2005), and within the last thirty years many gardens worldwide have established education programmes for schools, although their presence remains sparsely documented in the educational literature.

However, within the arena of school biology, the situation regarding the teaching of botany is even less propitious. Tranter (2004) has observed that 'in too many [UK] schools, the wealth of living or once living organisms which pupils are required to study is often reduced to little more than the geranium and the potato' (p. 104) and thus student notions of biology are that it is 'dull, lifeless and boring' (p.104). Besides this dearth of living specimens, experimental plant material in biology textbooks is repeatedly 'drawn from a relatively restricted number of species-geranium, Canadian pond weed, broad bean seeds, tomatoes and mustard and cress' (Collins & Price, 1996, p.29). Moreover, research (for example, Wandersee, 1986, Kinchin, 1999) has demonstrated that teaching with and about plants is considered to be a pedagogical challenge by many biology educators. A key message from these studies is that most children prefer to study animals.

Wandersee studied 136 US public school students from grades 7, 8 and 9, and concluded that students do indeed prefer to study animals to plants. Though, he suggests that:

> Direct experiences with plants attractive to children coupled with explicit delineating of the similarities and differences between plants and animals may increase a student's interest in plants and promote greater meaningful botanical learning too. (Wandersee, 1986, p. 424).

Kinchin investigated girls' preferences for animals or plants and focused on the responses of 162 girls, aged between 12 and 17 from one school. He concluded that the pupils in his study considered that 'plants grow, while animals behave' (Kinchin, 1999, p. 99) and believes that 'in some topics, particularly where plants are the teaching vehicle, teachers may have to work harder to generate enthusiasm among their pupils' (p. 99).

Other commentators, such as Hershey (1990), propose that as plants 'do not bite, run away, or produce odours' (p. 68) their perceived passivity is a positive characteristic in the classroom environment. It has also been suggested that plants are the perfect teaching organism as they can be 'inverted, bent, pinned and regionally subjected to chemical analysis, acid, heat, or knife without torture as they are nerveless' (Taylor, 1965, p. 117) and even in death are no problem as 'their corpses, which are more likely to desiccate then putrefy, may be discarded with paper refuse or kept indefinitely as inexpensively mounted demonstrations

of the effects of certain treatments' (Taylor, 1965, p.117). These statements appear to perpetuate the view that plants are 'seemingly passive organisms' (Lucas in Attenborough, 1995, unnumbered page), and as such might be perceived by learners to be boring and by teachers as difficult organisms to teach about.

A further issue for the teaching of botany is the lack of opportunity for studying plants beyond the classroom as a component of fieldwork. Indeed, biological fieldwork itself is considered by some in the UK to be under threat of extinction (Barker, Slingsby & Tilling 2002).

Parallel to these educational issues and challenges there are social and environmental reasons for drawing greater attention to plants: reasons such as a diminishing biodiversity amidst a burgeoning human populace (Hopper, 1997), and limited biological resources alongside a shrinking community of plant taxonomists to identify them (Radford, 1998). Galbraith has argued that understanding the slogan "plants=life" 'is essential to the modification of human behaviour on this planet in the 21st century' (Galbraith, 2003, p. 279). It is estimated that 'up to 100,000 plants representing more than one third of the world's plant species are currently threatened or face extinction in the wild' (BGCI website, 2006). This prolific loss of plant-life, coupled with current knowledge of the role plants play in sustaining life on Earth, makes Galbraith's argument an imperative one.

Botanic gardens are an under-researched educational context and, as such, have occupied a peripheral arena in biology education discussions.

The aims of this paper are to:

- present the case for botany occupying a more central role in biology education
- situate the botanical garden as an informal education context
- present empirical evidence for this role
- re-present these data in the context of relevant research literature.

Botanical Education: a review of the evidence

The development of botanical education, in both formal and informal contexts, has not been a smooth affair (Hershey, 1996). Indeed, for much of its history the subject content of botany has either been vociferously debated (see Boney, 1991) or visibly demoted within school biology curricula (see for example, Honey, 1987). Furthermore, limited attention has been paid by researchers to children's experiences with plants, as Harvey (1989) has highlighted, 'empirical work regarding biological experiences with animals and children's reactions to them has begun in earnest, but is still rather limited with regard to vegetation' (p. 37). Little has changed in educational research since this observation was made (Hershey, 2002). The exception, as asserted by Colin Wood-Robinson in his literature review on children's ideas about plants (Wood-Robinson, 1991), is the substantial body of research on children's comprehensions of plant nutrition; the process of photosynthesis 'is the most fully researched aspect of children's understanding of plants and their physiology' (p. 123).

Few research studies have been conducted on children's identification and classification of plants. Research that has been undertaken in this field has drawn attention to the following issues and concerns:

- there is a paucity of evidence on children's classification behaviours in outdoor environments using *living* organisms (Askham, 1976; Katz, 1989; Tull, 1994)
- tactile interaction with plants has specific impacts on children's classification behaviours (Askham, 1976)
- mixed research methods, such as accompanied botanical walks, slide shows of locally occurring plants, or one to one interviews can enable researchers to draw out children's 'undemonstrated knowledge' (Katz, 1989, Tull, 1994)
- using drawings rather than live specimens in the research process appears to contribute to the problems pupils have in classifying plants (Ryman, 1974).

Askham's finding that 'availability of the plant to tactile stimulation' affects how many times a plant is included in learners' classification categories (Askham, 1976, p. 52) has profound implications for the ways in which plants are displayed in botanic gardens. One might ask the question, if plants are inaccessible to learners wishing to touch them, what impact does that have on the learning

experienced in a botanic garden? In reality, health and safety issues often preclude tactile interaction with some plant specimens because of poisons, irritants and spines; but for other plants such as *Mimosa pudicum, Drosera rotundifolia* and the hairy bark of *Trachycarpus fortunei*, gentle, occasional, tactile interaction would be an informative experience for the learner. Indeed some botanic gardens, such as New York Botanical Garden, USA and the Eden Project in Cornwall, UK have specific areas of plants for touching by visitors.

Several research studies, (Bell, 1981; Freyberg & Osborne 1985; Russell & Watt 1990; Bianchi, 2000) have demonstrated that many children have 'restricted views' of what plants are. The studies established that 'restricted views' of plants were not limited to a particular age group or culture. Of great concern to botanical educators is the corpus of published work highlighting the 'relative neglect' (Honey, 1997, Hershey, 2002) of botanical topics in school science curricula and science education research (Hershey, 1996, 2002). Moreover, scant attention has been paid to the role of education in botanic gardens, as Tunnicliffe has noted (Tunnicliffe, 2001). However, there are encouraging signs that this situation is changing (for example, Peacock & Bowker, 2001; Atiti 2002; Stewart 2002; Sanders, 2004 PhD). Recently, Eberbach and Crowley have conducted studies in a botanic garden in Pittsburgh, USA comparing parent/child interactions at virtual, model and living plant exhibits, in regard to the process of pollination (Eberbach & Crowley, 2005). Significantly, in relation to this article, they found that use of the living plant supported more references to everyday experiences than the virtual

plant, and the model plant supported more references to school than connections to everyday or informal contexts (Eberbach & Crowley, 2005, p. 317). These findings have implications for the learning contexts in which living plant collections might be most appropriately situated.

In summary, there is a lack of evidence on children's experiences with plants and the ways in which they identify and classify them. Some attention has been paid to children's perceptions of what a plant is, however, little of this research is recent. Other evidence, as noted previously, indicates that there is also a need for more research on the varied contexts (school, home, botanic garden), the variety of plant forms (living, model, virtual), and how these are mediated e.g. tactile interaction, to develop children's botanical learning. In addition, further research attention is needed to examine teachers' and learners' perceptions of plants as experienced within school biology curricula.

Cultural Contexts and Doorways

In Victorian and Edwardian England, botany was culturally embedded in everyday life, as Shteir (1996) and Secord (1996) have observed. In addition, it was explicit in the literature of the time, see for example 'Mary Barton -a tale of Manchester

life' by Elizabeth Gaskell (1848). However, this historical period was also a point when avid collectors searching for plants, such as ferns (an obsession known as Pteridomania) and orchids, decimated whole tracts of land.

In the 21st century similar paradoxes also exist; gardening is one of the most subscribed to pastimes in England (Hoyles, 1994, Evans, 2002) and yet awareness of the native flora continues to decrease, particularly among children and young people (Bebbington, 2005). The Linnean Society of London has recently encouraged debates concerning these issues among botanists and educators. This is not a debate limited to England: botanical educators in other countries have related concerns. New York Botanical Garden, in the US for example, involves children in the work of their botanists on the local metropolitan flora. In Thiruvananthapuram, Kerala, India, the Tropical Botanical Research Institute has conducted studies with local children on their recognition of common medicinal plant species before and after educational experiences in their botanic garden (Valsala, Ravi & Pushpangadan 1999).

The cultural contexts in which children are situated can also influence both their relationship with plants and their construction of plant knowledge. This is particularly the case in rural contexts in developing countries where plants can be an important source of food, fodder, medicine and firewood (see for example Katz 1989, Valsala *et al* 1999). In these contexts, plant recognition and wider plant knowledge is an essential part of children's emerging identity and, indeed, their

ability to survive as adults subsisting within their local ecosystems (Schücking & Anderson, 1991). Some have argued that it is equally important for children in urban environments to have opportunities to forage (Chipeniuk, 1995). Chipeniuk's work has implications for the design of learning opportunities in botanic gardens and the effect that foraging might have on pupils' awareness and notions of biodiversity. The common activity of constructing 'petal palettes', (a collect and stick activity focusing on small-scale objects such as petals and leaves), in botanic garden education programmes, may provide the type of artefact foraging that urban children need to embark upon if they are, as Chipeniuk states, to develop their own 'sense of biodiversity' (p. 509).

Numerous commentators have made observations on the relationships between nature and culture, for example Wilson, 1992; Shiva, Anderson, Schücking, Gray, Lohman & Cooper 1995, Simmons, 1997. The design of botanic gardens is such that they invite discussion on the role(s) of 'culture' in relation to 'nature'. Certainly, by their physical framing of the plant collections, botanic gardens can act as a metaphor for the complex relationships that humanity has with the environment and its associated flora and fauna. Children coming to these gardens also bring a range of cultural interests with them, often enriched by peer group culture. In recent years at Chelsea Physic Garden, two specific cultural influences on children building relationships with plants have emerged namely, '*Pokemon cards*' and '*Harry Potter*' books. Children were found to be naming certain carnivorous plants 'Pokemon Plants' by calling out during video showings of the

BBC programme 'The Private Life of Plants' in the Physic Garden education room.

The following Pokemon cards: number 69 'Bellsprout', number 70 'Wheepinbell' and number 71 'Victreebel' (Barbo, 1999), are directly influenced by carnivorous plants, both aesthetically and in their fighting characteristics. As Barbo informs us:

> Bellsprout are plant Pokemon that trap and eat bugs, like a Venus FlyTrap. Their roots dig under the dirt to soak up needed moisture. If you're thinking about collecting a wild Bellsprout, use your most powerful technique before it has a chance to use Growth technique on you. (Barbo, 1999 p.68)

The second cultural influence to emerge at the Physic Garden is that children from a variety of schools started asking where the poisonous plants were, and were curious to see the Mandrake plant (*Mandragora officinarum*). These botanical interests were informed by the *Harry Potter* series of books by J. K. Rowling. Here is Professor Sprout speaking during a lesson on Mandrakes in '*Harry Potter and the Chamber of Secrets*':

> As our mandrakes are only seedlings, their cries won't kill yet, she said calmly as though she'd done nothing more exciting than water a begonia.

> 'However, they will knock you out for several hours, and as I'm sure none of you want to miss your first day back, make sure your earmuffs are securely in place while you work. I will attract your attention when it is time to pack up. 'Four to a tray-there is a large supply of pots here-compost in the sacks over there-and be careful of the Venomous tentacula, it's teething' (Rowling, 1998, p. 73).

Such cultural influences can be important catalysts for children's interests in plants, from which to develop their botanical knowledge. If offered the opportunity to use these literary and cultural doorways into botanic gardens children might then be able to, 'open a gate by chance', and find themselves 'on the other side of the wall' (Winterson, 2001, p.120).

The language of botany and the role of live specimens

In these socio-educational contexts it is valuable to view past and present practices through a critical lens and re-consider what messages they might offer contemporary biology education. How botany is taught, specifically how the naming of plants is taught to children is a pedagogical debate that has a long history. Brightwen was concerned that, 'many young people are apt to consider botany a very dry study. They are naturally repelled by the long words and many technical terms used in describing plants' (1913, p. 28). In contrast, the American naturalist and author Anna Comstock, noted that, 'most children like a word that is a mouthful' (Comstock, 1925, p. 51). She advised teaching with both the Latin

binomial names and the English common names, thus giving children the opportunity to savour a 'mouthful' when they were interested (Henson, 1997). Daglish (1932) considered the learning of a long list of plant names a, 'dull and unsatisfying affair' (p. 2). He was concerned that when botany lessons emphasised this process, as a large part of the lesson, the subject remained 'a dreary science', especially when using 'dry and often dusty' pressed specimens (p. 2). Daglish advocated, as many other botanical educators had (for example Lindley, 1858, Stopes, 1906), and still do (Walker & Allen 1999), observing fresh, living plant specimens and through exploring these, ascertains that the learner will remember the name by becoming intimate with the plant's shape and colour and other characteristics such as smell. He stated that this personal association with the plant would have far greater meaningfulness than the rote learning of a list of disassociated names. It must be remembered that during the period (1930's England) Daglish was writing, the predominate botanical teaching and learning culture was a didactic one, which emphasised rote learning utilising preserved plants, described by some as 'botanical cadavers' (Pool, 1919). In experiencing an inquiry-based relationship with fresh, living specimens, rather than a botanical mausoleum, children visiting botanic gardens are offered the opportunity to examine the physical characteristics of plants and explore the richly descriptive, and precise language that is botanical Latin (Stearn, 1992). In doing so they might then develop their own language for identifying and classifying plants.

Teaching approaches at Chelsea Physic Garden

The predominant teaching approaches used with visiting school children at Chelsea Physic Garden are:

- guided walks by the botanic garden educators
- handling artefacts, such as seed pods and objects made from plants
- utilising observational drawing
- watching, and responding to video clips, particularly from the BBC documentary 'The Private Life of Plants' (BBC, 1995)
- using microscopes to look at, for example, the parts of a flower and different seed types
- designing and making mini-greenhouses for seeds and cuttings
- basic gardening activities such as planting a seed or cutting
- open question sessions between the learners and the botanic garden educators

These teaching approaches utilise a mixture of traditional and inquiry based learning environments. A key aim of these learning experiences is to encourage and support children to develop a language for plants. Part of this article will consider the types of classifications children used in their descriptions of plants, as evidenced by their impression sheet responses.

Research Design and Methodology

The primary study used to inform this article utilised a mixed methods approach. The study consisted of two distinct strands, one historical and the other contemporary. The historical strand predominantly used documentary evidence taken from 'grey literature' complemented by oral history sources. The contemporary strand focused on 75 children (ages 7 to 11) from three primary (elementary) schools visiting an inner London botanic garden between 1997 and 2001. The main method used to gather data on their experiences was a series of 'impressions sheets', which required both written and drawn responses. Further discussion of this method is given in the next section. In addition, semi-structured interviews were undertaken with teachers who were either using their local botanic garden or receiving training there, as well as botanic garden education staff. Three botanic gardens in three cities: Chelsea Physic Garden, London, New York Botanical Garden, New York, and Kirstenbosch Botanical Garden, Cape Town, were the focus of this part of the study. This article considers data from Chelsea Physic Garden and the New York Botanical Garden.

Why 'impression sheets'?

Field notebooks, journals, diaries and letters, filled with both written and drawn impressions of flora and fauna have been used extensively in botanical and

natural history traditions. From renowned scientists such as Charles Darwin, through to amateur naturalists such as Reverend Gilbert White, this historical practice has left the study of biology with a rich legacy of narrative documentation. In choosing to use 'impression sheets' rather than questionnaires, in order to gather learners' observations of the botanic garden experience, the author sought to continue in this narrative tradition. The use of 'impression sheets' also draws on research methods commonly found in geography education studies in which learner experiences of their lessons are of paramount concern (see for example, Rickinson, 1999, Martin, Reid, Bullock & Bishop 2002).

Each child in the participating classes completed impression sheets after their visits, which were structured school visits to Chelsea Physic Garden where they experienced a guided tour and additional educational activities. These sheets contained a wide range of questions, focusing on different aspects of their visit to the garden and the topic of nurturing of plants at home. This activity was undertaken some months, rather than weeks, after their last visit to the garden. The timing was chosen in order to engage with 'embedded' impressions of the garden, rather than transient ones. Children worked on their impression sheets in their school classrooms, away from the garden, with the support of their class teacher and the garden teacher/researcher acting as facilitators. The impression sheets differed from questionnaires in that they encouraged children to give both written and/or drawn responses to the questions. The impression sheets contained 17 questions developed by the author that encouraged learners to consider two

main environments, the botanic garden and their home environment, along with one question that asked about their visit preferences to destinations such as museums, botanic gardens and zoos (see appendix for a list of the questions).

Findings: Describing Plants

The children in the research sample utilised extensive terminology for the plants they experienced in the botanic garden and at home. These identifying phrases can be divided into six main classifications:

- **Generalist** when children have categorised a collection of plants into a general plant category, for example 'weeds' or 'trees'
- **Populist** when children have used the popular English name for a plant for example, 'Elephants Ear' (*Bergenia cordifolia*)
- **Family** when children have categorised the plant into the botanical family name, for example 'Cactos' (*Cactaceae*)
- **Genus** when children have categorised the plant into the botanical genus, for example '*Pinguicula*'
- **Descriptive** when children have categorised the plant by describing particular characteristics, for example 'The prickly one', 'the big smelly tree'
- **Personal** when children have categorised the plant by using an imaginary name, for example 'Sticker' or 'Joe'.

As evidenced by the examples given above, overlapping relationships are possible between some of the categories, particularly those that are descriptive or personal. Indeed, in one boy's representation, 'Sticker' is an epithet for the sticky substance *Pinguicula sp*. use to capture prey, making this boy's choice of plant name one which could be placed in either the descriptive, or the personal categories. Whereas 'Joe' on the other hand is a personal name unique to the child who chose it and the plant to which it alludes. Whilst some children named plants,

many chose to give descriptions of particular features, such as 'the big smelly tree' (the female *Ginkgo biloba*) or 'the prickly one'. This approach to describing plants was particularly noticeable with specimens from carnivorous groups and the plant family *Cactaceae*, possibly because both groups of plants have adaptive characteristics, such as trapping mechanisms or spines that are visually explicit.

Drawing plants at home

Botany has traditionally been a science that has utilised drawn illustrations to assist taxonomists in the identification of plants (Blunt & Stearn, 1994). In reflection of this tradition, and Karlan's (1994) comment that, 'children's ability to illustrate their ideas will provide data that is not limited to their oral language', the questions on plants at home offered children the opportunity to reflect on their thoughts using the drawn image in addition to the written. As Hammersley and Atkinson note (1996, p.189), visual imagery can be problematical for the researcher using this material, as 'we still tend to think of the written language as the privileged medium of scholarly communication. There are, therefore, some tensions in the use of visual materials in a discipline of words'. However, in the field of geography and environmental education research, visual data is used extensively (see for example, Schneekloth 1989, Matthews 1995), and in the author's study offered valuable data. Many of the children participating in the featured study clearly showed knowledge of the morphological characteristics of

some plants, (Figure 1), particularly those they knew well from the indoor home environment, plants such as different types of Cacti and 'spider plants'. Some of these drawings suggest an overt concern to render anatomical characteristics within a plant family such as *Cactaceae*, (Figure 2). Furthermore, others were keen to iterate their involvement in the care or ownership of these plants, as Figure 3 demonstrates.

Figure 1 Rendition of plants at home taken from impression sheet Year 6 pupil (age 10 – 11) School B (2000)

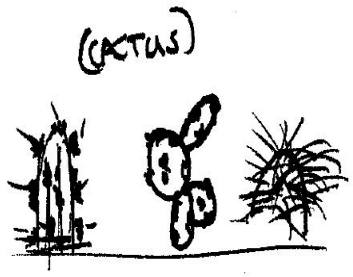

Figure 2 Rendition of plants at home taken from impression sheet Year 6 pupil (age 10 – 11) School B (2000)

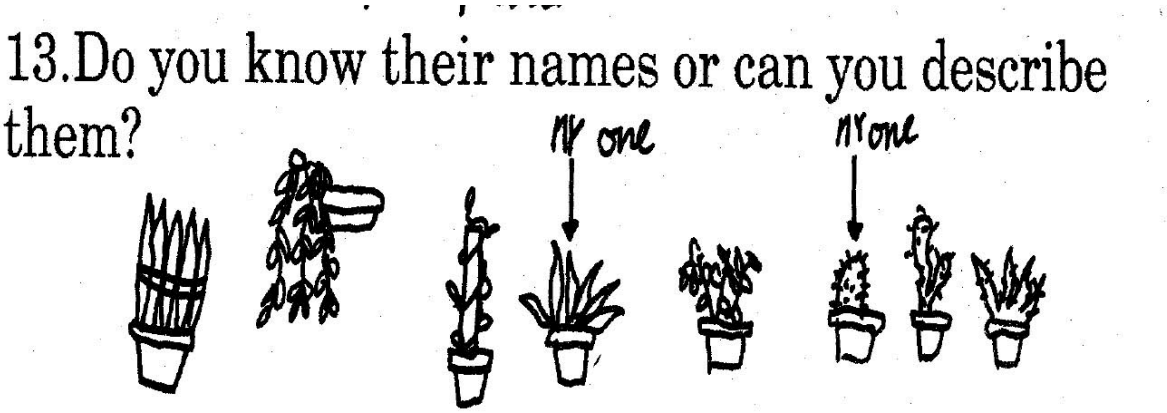

Figure 3 Rendition of plants at home taken from impression sheet of Year 5 pupil (age 9-10) School C (1998)

Observational drawing appears to be an important skill not only for recording plant structure, but also for communicating plant information that children may not have a written or oral language for, as Tull (1994) has also observed. This drawn evidence suggests that interacting with plants at home, either as a passive observer, or as an active carer, does seem to be a contributory factor in building notions of plant morphology.

Plants at home and botanic garden experiences

It was not uncommon, in British nineteenth century life, to give children 'small plots to inculcate patience, care, tenderness and reverence along with practical science lessons' (Davidoff & Hall, 1987, p. 373). More recently, Harvey (1989) has suggested that for children between the ages of eight and 11, 'new and additional experiences with vegetation are harder to come by' (p. 39). This

statement, along with the plants at home data from this study, has implications for the ways in which botanic garden visits are contextualised within school programmes and how botanic gardens approach the more informal family learning sector. Botanic garden educators and those in allied institutions, such as field study centres, might wish to consider what kinds of plant experiences and knowledge children are bringing from their home environment to such centres and how these might contribute to the learning experiences they offer their younger visitors.

Learning contexts

The contexts in which botanical studies, by both teachers and students, are undertaken have received a great deal of attention over an extensive period of time (see for example Lindley, 1858; Stopes, 1906; Brightwen, 1913; Clarke 1922 & 1935; Daglish, 1930; Shaw, 1930; Hutchinson 1947; Montessori, 1962; Tranter, 2004). Much of this attention has focused on using living rather than preserved plant material within a discovery-based pedagogy. Some of these past commentaries have highlighted the role that botanic gardens can have in the teaching and learning of botany.

Stopes in her publication *'Young People and Plant Life'* (Stopes, 1906) extolled the virtues of taking young people 'to the plants themselves and asking them to teach us' (p.196). Lilian Clarke, working in a South London girls' school also

prioritised the use of living specimens (Clarke, 1922 & 1935), and encouraged her girls to create their own books from their observations in the school botanic garden. In her book *Botany as an Experimental Science in Laboratory and Garden* (Clarke, 1935), which was published posthumously, Clarke highlighted two key elements of her philosophy on botany teaching, elements that are particularly pertinent to the challenges of botanical education today. She observes that 'since the end of the last century more importance has been paid at the James Allen's Girls' School to the plant as a living organism than to any other branch of botany' (p. vi). Significantly, in the context of botanic gardens, she considered that:

> The experimental method of studying botany has been greatly helped by the development of botany gardens. The gardens have been made gradually in response to the needs of the work. They have become, in many cases, out-of-door laboratories, and the work indoors and out of doors is one (Clarke, 1935, p. vii).

In the wider context of botanic gardens supporting education, it is important to note here that the curator of Chelsea Physic Garden at the time, William Hales, gave Clarke many plant specimens and much advice (Sanders, 2004 PhD).

Montessori, in her work 'The Discovery of the Child' also advocated a dynamic engagement with plants: 'Children indeed love flowers, but they need to do something more than remain among them and contemplate their coloured blossoms. They find their greatest pleasure in acting, in knowing, in exploring'

(Montessori, 1962, p. 74). Her philosophy is still embraced today in school gardens such as those developed in partnership with Learning Through Landscapes in the UK, (see discussion in Rickinson & Sanders, 2005) and projects such as the Edible Schoolyard in California, USA (Green, 2006).

In contrast, many educators have little opportunity to experiment with plant-life pedagogies beyond the laboratory or classroom. For these educators, choices are often limited by environmental constraints, such as small classrooms, a lack of light and little external landscaping, or the institutional restrictions of curriculum and timetabling of lessons in relation to planting cycles. Teacher knowledge can also be a limiting factor (see Scott, Reid & Jones 2004). In schools where access to living plant material is restricted, one option is to visit a botanic garden. Botanic garden staff can also provide additional specialist knowledge particularly when a teacher is primarily a zoologist (Hershey, 1996, 2002).

Honey has suggested that, 'as animals draw attention to themselves, plants need to have attention drawn to them and there is a need to show things related to plants which are interesting and varied' (Honey, 1987, p.187). By undertaking training in botanic gardens teachers can observe educators demonstrating the process of 'drawing attention to plants' and as such begin to model this practice for themselves. Reichel and Rossman's (1995) commentary on research undertaken at Chicago Botanic Garden, suggests a strong correlation between the experience of teacher training in a botanic garden and teachers changing their practice. Evidence from teachers attending teacher-training courses at New York

Botanical Garden (Sanders, 2004 PhD), also suggests that the experience of the course(s) provokes new perceptions of using plants in a pedagogical setting. For example, one teacher commented, 'I don't use plants in the classroom, but I will start using them after today's session'. Another teacher, also attending the same training session, enjoyed 'the fact that it is hands on, I will definitely be using it in the classroom because it enables the children to move around, and they need to move around'. A third teacher suggested that by talking about:

> fruits and vegetables, the things they can see on an everyday basis, it makes it more interesting for them... I like the questioning. I like the idea of getting the kids to ask questions. That's why I was coming to the botanical garden.

These comments suggest that the courses are not only catalysts for changing the ways in which teachers think about using plants in the classroom, but also how they think about the dynamics of learning spaces and different modalities of teaching. On reflection, teachers, are considering the ecology of the classroom as a place where children move around, ask questions and handle living plants, a learning environment that mirrors the one provided by botanic gardens. Perhaps, aspects of the 'outdoor classroom' are being brought 'indoors' into the school classroom, a shift in classroom life that might support a retreat from the current dominant culture of 'monologues and tests', (Erickson & Shultz, 1992) present in many classrooms today.

Zoos or botanic gardens: which institution do children prefer to visit?

As discussed earlier, research has indicated that most children prefer studying animals to plants. With this issue in mind, one of the questions on the impression sheets focused on children's preferred venues for a visit with family, friends or school. Learners were asked to rate, on a preferential scale of 1 to 5 (where 1 is least enjoyed/liked and 5 most enjoyed/liked), visits to five venues, two of which were zoo and botanic garden, the others being museum, cinema and supermarket, and to explain why they had chosen their most favourite or least favourite venue. Chi-squared tests were carried out on the data collected from the impression sheets, relating to pupils' rankings of visit preferences to zoos and botanic gardens, but due to the small cell numbers there was not enough evidence of statistical significance to make any definitive quantitative statements. However, the data did yield qualitative evidence on which elements of zoo and botanic garden visits attract or deter the attention of children. For the zoo visit the following reasons were given as positives:

- •'love/like animals'
- •'variety of animals'
- •'see animals you have never seen before'

The main negative reasons given for a zoo visit were:

- •'smells'
- •'seeing animals in cages'
- •'too old' for this type of activity
- •the presence of 'spiders'

For the botanic garden visit, children considered the following reasons to be the main factor for ranking a botanic garden as their most favourite visit preference:

- •'it's fun'

- •'learned lots of things'
- •'it's large'

The main negative reasons for the botanic garden were given as:

- •'you only look at plants'
- •'it's boring'
- •'you can't see anything and you can't do anything'
- •'it is very quiet and green'

For one boy, who ranked both venues equally as favourite, the botanic garden and the zoo being 'full of animals and big plants' was his reason. The most valuable message for botanical educators from these data is that the reasons for liking the zoo focused on the organisms contained within that institution, whereas for the botanic garden the positive reasons focused on place, activity and children's feelings whilst there. If the majority of pupils cite the place and activity as the primary reasons for valuing a visit to a botanic garden, then how learning programmes are structured and how the place is perceived becomes even more important in determining/affecting learner impacts. This also suggests that more work needs to be done on the type of plant specimens that draw children's attention.

'Marquee Plants'

The American biology educators, Wandersee and Schussler (2001) use the term 'marquee plants', that is plants that draw attention to themselves and capture the imagination, to describe plants to be used in educational contexts. They suggest that these are plants that: attract the public's attention during some or all of their

life-cycles, are capable of drawing a crowd at a botanic garden or may serve as a doorway to greater public understanding of plants (Wandersee & Schussler, 2001, p. 3). They propose, that by using 'marquee plants', educators will draw attention to plants that have previously been overlooked by teachers and learners alike. Recent crowds at flowerings of the Titan Arum (*Titanum amorphophallus*) in Kew and Cambridge botanic gardens demonstrate the continued attraction of floristically spectacular, odorous and unusually large plants (Sanders, 2005).

'Favourite' Plants

No evidence generated by the impression sheets clearly identified gender-specific patterns of affiliation for certain plant groups, other than boys seem to prefer carnivorous plants. Carnivorous plants rely on modified leaf structures for their trapping mechanisms, and it is this structural feature that boys focused on, whereas girls predominantly focused on floristic features such as colour when choosing a plant as favourite.

Throughout this study, very few girls chose carnivorous plants as favourites. In the light of this evidence, it could be said that carnivorous plants, as a group of plant specimens, might be used effectively to inspire boys to be more interested in the study of plants. Indeed, Darwin himself enthused about carnivorous plants, 'this plant, commonly called Venus' Fly-Trap, from the rapidity and force of its movement, is one of the most wonderful in the world' (1875, p. 286). However, caution should be practiced in assuming that boys are solely attracted to certain

plants, as one teacher interviewee commented after her class visited New York Botanical Garden,

> I was amazed how much they liked the rose garden, that I never expected, and the boys... 'This one smells better', 'What do you think of this one?' 'This one is pinker!' That was something I didn't think they would be interested in.

First impressions

All the children participating in the study were asked, as part of the impression sheet questions, what their first impressions of the Physic Garden were. The significant message from the collected data is that, for the majority of children visiting the Physic Garden, it was the living organisms, 'the vivid colours of the flowers' or the 'strange plants' that made a strong initial impact. For a minority of both boys and girls taking part in this study, it was the inanimate 'stones on the floor' or the 'statue, glass window and path', which leave their traces on children's memories. So once in the garden and orientated what were children's favourite places?

Favourite places in the Botanic Garden

When asked about their favourite places in the Chelsea Physic Garden, the pupils involved in this study focused on a diverse range of places, but two key

distinctions occurred:

- children enjoyed 'secret places', for example the small pond in the cool fernery and 'the foresty bit'
- children highlighted the greenhouses, because they contained 'interesting' or 'exciting' plants.

The evidence from these pupils suggests that children not only enjoy the 'secret garden' aspects of the botanic garden, but also the range of living plant specimens that these environments offer. Teachers, too, appreciated the scope of experiential opportunities that botanic gardens afford and the variety of plants their pupils could observe during their visits, as these two extracts from interviews with elementary teachers visiting the New York Botanical Garden demonstrate:

> Teacher 1. 'I let them roll down the hills just to experience nature. I want it to be fun for them, I don't want it always, you know, to be like a learning goal, because I think that is learning also'.
>
> Teacher 2.'They were amazed at the differences in the sizes of leaves in The Haupt Conservatory.'

A place for being

As demonstrated, the botanic garden can provide opportunities for children to explore diverse ways of interacting with place, but as Malone and Tranter (2003, p. 299) in their study on school grounds commented, 'the philosophical value of the outdoor environment expressed by the school community is impacted by a number of variables'. Significantly, for botanic gardens, Malone and Tranter

highlighted one variable in schools as being 'the historical and policy orientated cultural norms': 'norms' which are not only visible in the school community context, but are also embedded in the culture of many botanic gardens. These past practices still resonate clearly in some contemporary botanic garden attitudes to school visits, attitudes that focus on behaviour management and controlled didactic teaching and learning models (Sanders, 2004, PhD.). Giving children the space to 'discover for themselves the patterns and order that exist in the natural world', a space which, 'supports the link between experience and environmental cognition' (Malone & Tranter, 2003, p. 300) may assist botanic garden educators to reflect on how learners perceive the nature and quality of their experiences. In considering these relationships, botanic garden staff may also wish to review the balance between formal study and freer self-exploration. These reflections have implications for outdoor teaching and learning practices used in the botanic garden and other allied institutions.

Conclusion

Research evidence, as documented in this article, suggests that informal learning contexts, such as botanic gardens and learners' home environs, can contribute to children's botanical learning. Furthermore, the critical role that children's drawn representations of plants played in this research study has implications both for botanical education research methods and botanical pedagogy. It also provides a strong argument for drawing as a useful process for both developing, and

providing evidence of taxonomic thinking in learners. However, in spite of escalating concerns for a decreasing plant population and an ever-increasing body of information on the contribution plants make to life on Earth, research on children's knowledge of plants, other than the process of photosynthesis, remains the focus of few studies. Disappointingly, given current environmental imperatives, botanic gardens continue to be under-researched environments for learning.

This work was supported by the National Science Foundation - Centre for Teaching and Learning, grant ESI-0119787 - awarded to King's College London in collaboration with the Exploratorium and UC-Santa Cruz.

I would like to acknowledge the contributions of my colleagues, Justin Dillon and Ellen McCallie, in the Centre for Informal Learning and Schools at King's College London in commenting on earlier drafts of this article.

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Appendix

Impression sheet questions:

1. What are some of the FIRST things you noticed about the Chelsea Physic Garden?
2. In this space please draw a map of the garden FROM MEMORY
3. What was your favourite place?

4. Why?
5. Which plants do you remember from your visit?
6. How do you feel in the garden?
7. Had you been before? Please tick: never/once/two or three times/ more than three
8. How would you rate a visit to the Chelsea physic Garden? Please number from the following list which places you have enjoyed visiting in order of favourite place = 1☺, place you did not like visiting = 5☹ (museum, zoo, botanic garden, cinema, supermarket)
9. Please tell me why you liked your **favourite** place
10. Why you **did not like** the place **last** on your list
11. Do you have plants at home? Please tick yes/no
12. Do you look after any of them Please tick yes/no
13. Do you know their names? Can you describe or draw them?
14. What would you tell a friend who **didn't go to the garden, about plants?**
15. What is your favourite plant?
16. Why?
17. If you went back to the Chelsea Physic Garden what would you **most** like to do?