Chapter 19
Engaging Children in Learning Ecological Science: Two Botanic Garden Educators' Pedagogical Practices

Junqing Zhai

19.1 Introduction

In recent years, researchers and policy makers around the world have increasingly called for greater attention to be paid to the educational potential of out-of-school settings, citing the many benefits and the necessity of learning in settings other than the classroom. For example, the Manifesto for Learning Outside the Classroom introduced by the British government, encourages schools to provide children with learning opportunities beyond the classroom (DfES 2006). A significant body of research has indicated that school visits to informal settings such as science museums, botanic gardens and zoos are valuable in growing students' understanding of and interest in science (e.g. Malone 2008; Rickinson et al. 2004; Slingsby 2006).

The botanic garden is one of the most popular settings for school excursions. In England, botanic garden educators' lesson for school groups is one of the most important components of botanic garden education (BGEN 2009). Unlike classroom teachers who may lack confidence in teaching beyond the classroom (Glackin 2007; O'Donnell et al. 2006), the botanic garden educators are experienced in delivering outdoor learning activities to different age groups of children. In particular, they effectively offer students an environment that supports inspirational learning about plants and their importance as they serve as the communicators of ecological science and plant conservations to the garden visitors. With respect to school groups, these educators help students to connect their normal daily life experiences to the knowledge about the plants on display in botanic gardens (Sanders 2004). In addition,

J. Zhai (✉)
Natural Sciences and Science Education, National Institute of Education,
Nanyang Technological University, Singapore
e-mail: junqing.zhai@nie.edu.sg

K.C.D. Tan and M. Kim (eds.), *Issues and Challenges in Science Education Research: Moving Forward*, DOI 10.1007/978-94-007-3980-2_19,

previous research on education carried out in botanic gardens has suggested that the botanic garden educators fulfill a variety of roles, such as those of 'professional educator, tour guide, and a source of information' (Stewart 2003, p. 354).

To explore the pedagogical practices of the botanic garden educators in England, two research questions guided this study. First, what was the structure of the botanic garden educators' lessons? Second, how did the botanic garden educators support students' learning? The study reported in this chapter has emerged from a doctoral research project and offered a brief picture about botanic garden educators' pedagogical practices.

19.2 Botanic Gardens as Teaching and Learning Environments

Research on museum visitors has suggested that young people's museum visiting experiences have positive impacts on their cognitive, affective, physical, and social development (Anderson et al. Anderson et al. 2003; Falk and Dierking 2000; Hein 1998). The limited literature on learning in botanic gardens has highlighted the importance of early learning experience in forming children's attitudes and active concern for the environment (Bowker 2004; Sanders 2007; Tunnicliffe 2001).

School trips to botanic gardens take place for many reasons (Jones 2000). For many schoolteachers, the most important one is the opportunity to address topics in science and geography curricula. Either often the learning activities organized by schoolteachers or botanic garden educators are focused on investigating plant adaptation, measuring temperature and humidity, and observing plants from all over the world. During the visits, students not only obtain the knowledge regarding science and geography, but also develop their sense of social justice and moral responsibility and begin to understand that their own choices and behaviour can affect local, national and global issues. With respect to this, research has suggested that school trips to botanic gardens should include 'not only knowledge and understanding of animals or plants groups, but also the process of science and general aspects such as care for the environment and communication' (Tunnicliffe 2001, p. 33).

Most school trips to botanic gardens are 1-day trips or just a few hours in duration, and because of this limited period of time the question arises as to how can such a short experience impact on their learning, both cognitively and affectively. In order to discover whether attitudes towards plants can be changed by visiting a botanic garden on a school trip, South (1999) asked elementary students to draw a leaf at the beginning of a visit and again after it. She found that 'there was an increase in the percentage of atypical leaves in the second set of drawings in all the classes' (South 1999, p. 72) which she concluded that the botanic garden visiting experience had expanded students' observational view about plants. From this research, South (1999) suggested that if the botanic garden experience is to produce any significant impact on students' environmental awareness, botanic garden educators need to stimulate student interest by challenging their conceptual thinking.

Similarly, Stewart (2003) has investigated the experience of seven groups of elementary and secondary children aged from 5 to 18 during their school excursion to the Royal Botanic Gardens in Sydney. Both pre- and post-visit interviews with students ($n=50$) were conducted and a survey about their visit experience ($n=284$) was carried out. The author reported that school trips to botanic gardens usually involve two types of learning: learning for cognitive gains and for 'scheme-building' with the former referring to the measurable cognitive outcomes that students can achieve during tightly structured activities such as visits to specific displays to conduct specific tasks, whereas the latter is achieved when students demonstrate long term recall of plants, plant displays and specific locations at a botanic garden. Furthermore, these recollections are linked to specific outcomes sought by the classroom teacher and can contribute to the students' deeper understandings of plants, especially plant structure and biodiversity. Stewart (2003) proposed that practical activities, especially sensory experiences form part of students' long-term recall of their botanic garden experience.

Although botanic garden visiting experiences have a positive impact on students' cognitive learning, some researchers have found that inappropriate teaching may lead to a low level of learning. For example, Bowker (2004) studied a group of 7–11-years-old children who were led by a schoolteacher to the Eden Project in Cornwall. The purpose of his study was to elicit the most effective methods of utilizing a teacher-led school trip so as to enhance children's perceptions of plants and their understanding of people's relationship with them. In total, 72 participating students were interviewed within 1 month of the initial visit and the researcher discovered that they were affected by the sensory experience of being immersed in the garden with such a profusion of plants from around the world. Although most of the students showed an interest in the plants that were relevant to their lives, it emerged that they were often unsure of the relationship between plants, people and resources. In light of this outcome, the researcher contended that to facilitate the understanding of plants and the relationship that human society has with them, it was essential for the educator who is guiding the group during the visit to challenge the students' ideas. This can be achieved by asking 'quality questions that will focus children's attention on important aspects of plants such as plant adaptations to their climate or how people have used and cultivated certain plants' (Bowker 2004, p. 240).

19.3 Research Methods

19.3.1 Research Context

Two botanic gardens, Garden A and Garden B, from two cities in England were selected for this study based on their accessibility, representation of an outdoor classroom in botanic garden settings, and reputation of the education service to the public. Both sites are well-known education institutions in local communities and offer a variety of educational programmes to schools and resources for classroom teachers.

The participating gardens have diverse collections, including plants that live in arid, tropical, and Mediterranean environments.

The education programmes in both sites shared some similarities, and the topics they provided to schools were comparable and consistent with those offered by most botanic gardens in England (Bowker 2002; Sanders 2007; South 1999). The botanic garden educators' lessons observed for this study were pre-planned, one-off lessons to students. The schoolteachers were required to book and prepare the visit in advance. Most teachers selected the topics that the gardens had advertised although sometimes they may have made special requests, such as integrating different subjects into one lesson. As the botanic garden educators explained, each lesson topic was designed in order to suit the requirements stated in the English National Curriculum and the need of the students.

19.3.2 Research Participants

Two botanic garden educators were recruited for this study. By the time of data collection in 2009, Mark had been working as an outdoor educator in Garden A for 15 years. Mark held a BSc degree in ecology, but he had never received formal teacher education. He started his botanic garden educator career after 3 years observing other outdoor educators' teaching. In contrast, Simon, the botanic garden educator from Garden B, was trained to be a teacher as he held a BSc degree in physics and PGCE in secondary science. Prior to becoming a botanic garden educator 6 years ago, he had taught in several urban schools for 20 years.

19.3.3 Data Collection

Before data collection, I spent at least 1 week with Mark and Simon to build rapport and get familiar with their education programmes. Through filed observations and casual talk with the participants, basic information about their background and teaching experiences were obtained. Five lessons led by each educator were observed as initial fieldwork, which provided a brief picture of their teaching procedures and approaches. The data analyzed for this chapter was collected between May and October 2009 (see Table 19.1).

The lessons observed in Garden A were video recorded. I held the camcorder at the back of the class or at the back of the group when they were outside in order to minimize the intrusiveness of the research. The camera always focused on the educator to record discourse and behaviour when he was interacting with students. The camcorder does not work well all the time especially when the educator and students were outdoors due to the noise and movement reduces the video quality, thus I gave the educator an audio-recorder with a clipped microphone to back up the discourse data.

Table 19.1 Details of lesson observed in Garden A and Garden B

	Garden A (Mark)		Garden B (Simon)	
Lesson code	AM-Y5-26/6	AM-Y5-29/6	BS-Y3-07/5	BS-Y3-15/6
Topic	Plants and habitats	Plants and habitats	Plant adaptation	Plant adaptation
Year group	Year 5	Year 5	Year 3	Year 3
No. of students	40	19	19	19
Data type	Audio, video	Audio, video	Audio, note	Audio, note
Length of lesson (minute)	95	94	97	95

Garden B did not give permission to film the visits. Thus, I only used an audio-recorder to capture the discourse between the educator and students. Because the microphone linked to the audio-recorder was clipped on the garden educator's cloth, sometimes it was difficult to hear the recordings from the students who were far away from the educator. As a result, a field note was taken to record students' voices, especially when they were talking to the educator. All the audio-recordings were transcribed verbatim.

The participating educators were interviewed 2 weeks after the lesson observations once I had finished data transcription. During the interview, I showed the educators the transcribed data and audio/video clips to help them to reflect on their teaching practices. The interviews lasted 20–40 min depending on their availability.

19.3.4 Data Analysis

The transcribed interviews were analyzed using open-coding procedures (Strauss and Corbin 1990). The interviews were designed to support the interpretation of botanic garden educators' talk. The combination of educator–student interactions and educator interviews offers a triangulation which enriches the understanding of the teaching and learning practices in botanic gardens. The transcribed discourse data collected from observations were analyzed by applying Mortimer and Scott's (2003) analytical framework, which combines two dimensions of classroom discourse and constructs a matrix that classified the classroom communication into four classes. The four classes of communicative approaches defined by Scott et al. (2006, pp. 612–613) as follows:

- Interactive/dialogic: Teacher and students consider a range of ideas.
- Non-interactive/dialogic: Teacher revisits and summarizes different points of view, either simply listening them or exploring similarities and differences.
- Interactive/authoritative: Teacher focuses on one specific point of view and leads students through a question and answer routine with the aim of establishing and consolidating that point of view.
- Non-interactive/authoritative: Teacher presents a specific point of view.

All the discourse data were analyzed line by line so as to discover the nature of the interaction between the botanic garden educator and students.

19.4 Research Findings

19.4.1 What Was the Structure of the Botanic Garden Educators' Lessons?

Typically, Mark and Simon's lessons involved a structured, narrative-style, and educator-directed experience, in which students and their schoolteachers moved together as a whole group. This finding is consistent with museum docent guided tours to school visiting groups (Cox-Petersen et al. 2003). Both educators appeared to use time well. Mark spent only 9.5% of lesson time in delivering health and safety issues, managing the group, and walking the students from the classroom to glasshouses. The class management time for Simon's lessons was a little longer—11.6% of the whole visiting time—which was, perhaps, due to the fact that the students in his groups were much younger (7 years old) and it would be easier for them to lose their concentration.

The observational data suggests that there is a balance between whole class teaching and students' exploratory work within the 'effective lesson phase' when educators focused on teaching instead of managing the group. Students spent 48% of their time doing exploratory activities in Mark's lessons and 52% in Simon's. It seems that students have sufficient time to discover the garden by themselves as well as listen to the educators' explanations. In this sense, the structure of Simon and Mark's lessons, to a large extent, was educator-directed and student exploratory-based.

The analysis of discourse data has shown that Mark and Simon's talk dominated the lesson discourse, as the student to educator utterance ratio was approximately 1–6. Most of the educators' talk was authoritative/non-interactive in nature and devoted to lecturing type of presentations and demonstrations. Although a relatively large proportion of the educators' talk involved interactions with students (on average, 39% of Mark's talk and 54% of Simon's talk), this interactive discourse was mainly triadic (initiation-response-evaluation) in pattern, which indicates an authoritative role of the educator during the process of exchanging ideas with students. In contrast, the discourse occurred in a chain of interactions (I-R-F-R-F- in pattern), where 'the elaborative feedback from the educator is followed by a further response from the student and so on' (Mortimer and Scott 2003, p. 41) was not broadly observed. In this pattern of discourse, the educator encouraged the students to contribute more to the discussion by engaging them in extended sequences of dialogue. Scott et al. (2006) argued that the dialogic process of and working on ideas has a greater potential to support meaningful learning of disciplinary knowledge. In this regard, Mark and Simon need to further elicit the students' thinking to enable them to articulate, reflect upon and modify their own understanding.

19.4.2 How Did the Botanic Garden Educators Support Students' Learning?

Four prominent teaching strategies that motivate, interest, and support students' learning were found in Mark and Simon's pedagogical practices. These strategies are: (1) using questions to support intellectual engagement; (2) using astounding piece of information to support emotive focus; (3) focusing on learning the language of science; and (4) learning about plants through sensory engagement.

19.4.2.1 Using Questions to Support Intellectual Engagement

Questioning is an effective way to engage students in thinking for understanding (Chin 2007). By analyzing the class discourse, I found that both botanic garden educators preferred to use questions to start their teaching though the amount of questions they asked varied. In the four observed lessons, Mark asked questions 25 times and Simon 102 times.

Mark started his lesson *Plants* by asking 'Did anyone have breakfast?' and then 'Who had plants for breakfast?' The purpose of Mark asking these questions was to check students' understanding about plants. By asking 'Who had plants for breakfast?' 'he cued students' understanding so they could begin to connect plants with food. This question engaged students in thinking about which plants are edible for food. As Mark explained in his interview, the guiding principle for his lesson design was to help children to learn about useful plants, such as those used for food, clothing and medicine. For Mark, connecting teaching and the curriculum with the experiences of learners' home and daily life facilitated the process of meaning making.

Compared to Mark's classes, Simon asked more open-ended questions. Questions such as 'What do the roots do for the plants?', 'What bit of the plant grows up from the roots and reach to the sky?', 'Why do you think flowers have petals?' challenged students' prior knowledge about plants and encouraged them to speculate. These questions provide students with the opportunity to predict, to describe and to explain. The following excerpt is a good example to demonstrate how Simon used questions to support learners' higher-order thinking when teaching plant growth to a group of Year 3 students.

Excerpt 1 The function of roots (BS-Y3-15/6)

1	Simon:	What do the roots do for the plants? What's their job? What do they
2		do?
3	S4:	To make the plants growing bigger.
4	Simon:	They do. I think at the end of Year 3 we need should know exactly what they do to
5		make it grow bigger. What do the roots actually do?
6	S1:	They grow.
7	Simon:	What are they doing when they are growing? They must be doing something.
8		Every part has a job.

(continued)

Excerpt 1 (continued)

9	S6:	When there's the wind it keeps the flower in.
10	Simon:	When the wind blows it keeps the flower in. Good girl. It's quite like
11		that because it anchors down to the ground. If it grows in the soil then
12		the roots anchor that plant down to the ground. So it's very important.
13		This afternoon you may see some roots that do not grow under the ground:
14		some grow in the water maybe and some grow and climb up the walls.
15		So that's one of their important jobs. To hold that plant, to anchor it.
16		What else do the roots do?
17	S7:	They suck the water.

Simon proposed three questions consecutively to challenge students' understanding about the root's function. The first answer 'to make the plants growing bigger' (line 3) is, to some extent, acceptable but Simon has higher expectation from this Year 3 group. Simon prompted the students' idea again by asking 'what do the roots actually do' (lines 4–5) to seek the proper answer to his question. Student 1 answered 'They grow' (line 6), but this is an unclear statement about the function of roots because it could be interpreted as 'the roots help the plant grow' or 'the roots are growing'. This ambiguity might explain why Simon did not comment on S1's answer. Instead, he reformulated the question into 'What are they doing when they are growing?' (lines 7–8) which makes the question easier to understand. 'When there's the wind it keeps the flower in' (line 9), the answer from S6 met Simon's expectation as he repeated that student's answer to confirm her contribution. After explaining how roots anchor the plant, Simon cued students to think about the function of the roots. During the interview, Simon explained why he used the strategy of prompting children by asking questions constantly:

> It's very interesting to listen into the kids talking. It's always very interesting to me. I try to get the chance to listen to the kids because it's obviously they construct information, they have to think. So, one of the big things about visit botanic gardens like this is to give them some spaces to think. (Interview with Simon)

Using questions to engage students in knowledge construction is a popular pedagogical approach adapted by classroom teachers (Chin 2007). The data above suggests that questioning could also be an efficient pedagogical strategy for outdoor educators to engage students in thinking about what they have noticed on the visit and finding connections with their daily life experiences. In short, questions are a key component in teaching-learning discourse which educators from different learning contexts can use as a psychological tool to mediate students' knowledge construction and support them to move towards their 'zone of proximal development' (Vygotsky 1978), which represents current potential learning and leads to new development. To achieve this process, educators need to engage students in student-centred discussions by asking conceptual questions to elicit students' ideas and facilitate productive thinking. The discourse in such a class is educator-led but not educator-dominated and the educator's talk is more like 'talk-scaffolding' (Westgate and Hughes 1997) rather than knowledge transmission.

19.4.2.2 Using Astounding Piece of Information to Support Emotive Focus

Research carried out in museums has suggested that affective talk is a common behaviour for visitors to use to express their pleasure, displeasure or surprise about the exhibition (Allen 2002). The plant kingdom is a world full of exotic things for people to discover. On a school excursion to a botanic garden, students can get access to the exotic part of the natural world and experience different living environments which may affect their emotions and feelings. As Carson (1998) suggested, feelings towards the natural world are antecedents to intellectual growth:

> Once the emotions have been aroused—a sense of the beautiful, the excitement of the new and the unknown, a feeling of sympathy, pity, admiration or love—then we wish for knowledge about the object of our emotional response. Once found, it has lasting meaning. (p. 56)

The astounding piece of information is powerful motivation and stimuli for learning and development. It is more than factual information. It could provide students with long-term memories and facilitate situational interest being developed into personal interest, which may engage them in learning ecological science to a higher level (Hidi and Renninger 2006).

Young people are normally interested in watching, hearing and talking about wild facts. Mark, the educator from Garden A, thought that talking about an astounding piece of information to students was a part of his ideal lesson. The following two excerpts illustrate how Mark supported the student emotional engagement.

When Mark was teaching about living habitats to a group of Year 5 students, he showed them the living creatures in the pond water through a microscope (see Excerpt 2). When he magnified the image, the cell-shaped moving creatures surprised students. It turned out that those students had never thought pond water harboured many tiny animals. During lunchtime, a student reminded his partners to wash their hands by referring to the scenario of moving cells**.**

Excerpt 2 Pond lives under microscope (AM-Y5-26/6)

1	Mark:	What I've done is put four drops of it underneath the microscope here and that's on
2		what you can see through the screen. These are tiny creatures they are living
3		there. This is their home. [Mark adjusted the microscope to enlarge the image
4		the screen]
5	Mark:	What you see now is magnified by 650 times.
6	Mark:	[Many living creatures showed up on the screen] If I zoom it in, it is magnified
7		by 1,500 times.
8	Ss:	[There are some cell live things are moving around on the screen] Whoa.

In another Year 5 class, Mark presented the biggest and smallest seed in the world (see Excerpt 3). Students were amazed by seeing the real object and were surprised by getting the information that the smallest seed can weigh only one thousandth of a gram. When I contacted the class teacher of the Year 5 group 2 weeks after the visit, the teacher told me that students talked a lot about seeds dispersal when they went back school.

Excerpt 3 The giant Coco de Mer (AM-Y5-29/6)

1	Mark:	[Mark put a Coco de Mer on the table] It is a double coconut. It's the
2		heaviest seed in the world.
3	Ss:	Whoa.
4	S7:	It's so big.
5	Mark:	The heaviest one in the world, bear in mind it is a seed, I heard is
6		22 kilo grams.
7	Mark:	[Mark showed students a Petri dish with orchid seeds in] These are the seeds
8		from a type of plant called orchid, its actual name is Vanda. These are
9		so small they might even be floating in the air around us right now.
10		They weigh one thousandth of a gram.
11	S3:	Seriously?
12	Mark:	Yes.

Another example of using astounding piece of information to support emotive focus was when Mark explained how Venus flytraps capture insects to get minerals for living to a group of Year 5 students. Some of the students used their hands to model how a Venus flytrap trapped insects, which indicates that they were engaged in learning how carnivorous plants are adapted to a wet and poor soil environment.

19.4.2.3 Focusing on Learning the Language of Science

Science is rich in words and terms. Wellington and Osborne (2001) suggested that learning the language of science is a major part of science education. In the 1998 National Curriculum for England, there was a section on the use of language across the curriculum which requires teachers to teach students to 'use language precisely and cogently' when talking about science (DfEE 1999, p. 69). The 2008 National Curriculum continues this focus, which suggested that the development of essential literacy skills, through discussion and the use of scientific vocabulary and terminology as one of educational aims of secondary science curricula (QCDA 2008). School trips to botanic gardens offer an excellent opportunity for students to develop the language of science.

The students taught by Simon were from inner city schools where a large proportion of the children do not have English as a home language. To help these students to develop their communication skills was an important task for Simon. What he focused on during his teaching was to facilitate students by using proper words to describe plants, and he stated this as his educational goal to the students and class teachers at the very beginning of his lesson. During the course of the lesson, Simon reminded the students several times to use the scientific words to describe plants. For instance, when a Year 3 boy referred to 'roots' and 'leaves' as 'the bottom bit' and 'the green bit', Simon asked the whole class to repeat the correct words to describe those specific parts of a plant.

The next excerpt shows how the language of science was taught to the students in some detail. Before getting into the acid glasshouse, Simon demonstrated to the

students how to read the mark on a thermometer by using the science word 'Celsius'. Excerpt 4 was taken from the teaching session in the acid glasshouse where students were requested to find the temperature of the room by themselves. Simon checked a student's fieldwork and asked her about the reading on the thermometer. The girl gave the answer immediately, but she only reported the number showed on the equipment. Because her answer '18' did not make any sense, Simon told her the answer should be '18 Celsius'. Simon gave a daily life example to help students to understand that a unit can make sense of the number (lines 5–6). This case highlights the importance of teaching children the meaning of science words rather than simply giving the words themselves. Children's understanding of words can be developed through appropriate teaching and authentic real world experiences (Wellington and Ireson 2008).

Excerpt 4 The Celsius scale of temperature (BS-Y3-07/5)

1	Simon:	What temperature is it?
2	S9:	18
3	Simon:	18 Celsius
4	S9:	Celsius
5	Simon:	Remember to put a unit. Ok? If you go to a shop somebody doesn't say 18 but
6		they say 18 pence or 18 pounds, so we have to say 18 Celsius

Teaching children the language of science is a big challenge for botanic garden educators. Simon complained, during the interview, according to his working experience in mainstream schools and local education authority, that the schoolteachers seldom focus their teaching goals on the development of children's language. So a challenge for botanic garden educator is to teach proper science words to young children, especially those whose first language is not English.

19.4.2.4 Learning About Plants Through Sensory Engagement

According to Vygotsky (1978), 'children solve practical tasks with the help of their speech as well as their eyes and hands' (p. 26). Children can not only develop their language of ecological science on a botanic garden visit, but also the direct interactions with plants may increase their interest in plants and attitudes to appreciate the wonder of nature. It is important for students to be able to see, hear, touch, smell and live the experience during the visit (Ballantyne and Packer 2009). However, the health and safety concerns are the barriers for them to be encouraged to interact with plants through their multisensory modalities. Botanic garden educators usually have enough knowledge of botany to know which plants are harmful for touching, smelling, or tasting. They can guide the students in a safe way to interact with plants by touching or smelling them.

Collecting specimens was an important method for Darwin to develop his famous theory of natural selection (Kohn 2008). Botanic garden educators have designed various hands-on activities to support their young visitors' interaction with plant artifices. In Garden A, students were encouraged to collect leaves, flowers, and feathers

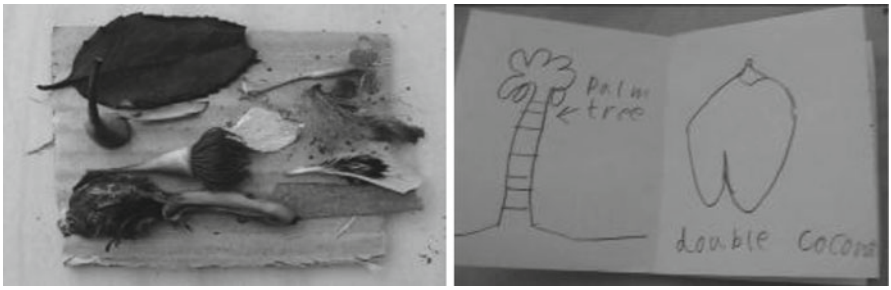

Fig. 19.1 Students' art products

from the ground in the garden and stick their collections onto a sticky card to make different pictures as they wish (see Fig. 19.1). In the activity named Sketching, Mark suggested that students do an observational drawing of the plant artifices displayed on their table. When Mark led the students into the Tropical Glasshouse, he recommended that they recorded what they found interesting in their books. The observational drawing and specimen collecting activities were designed to increase the students' interest in exploring the botanic garden and also developed their observation skills.

When Mark channelled students across the lawn, he suggested that they pick up a Eucalyptus leaf from the ground and crush it up to smell. Mark found that the students liked the smell, and he explained that the leaf is the favourite food of the Koala and the leaf can be used to flavour toothpaste and chewing gum. The students were also allowed to touch and smell the leaves when they were looking at the perfume plants. Most of the students identified mint and lemon from other plants according to their fragrant smell. By using their sense of smell, the students linked their daily life experiences to the botanic garden visit, which enhanced their direct experience of and knowledge about plants.

19.5 Discussion and Implications

Although Mark and Simon's teaching experiences and working contexts varied, there were some shared features in their observed lessons. First of all, Mark and Simon managed the visiting school groups in an effective way so that much of time was spent on learning rather than disciplinary issues. Moreover, both of them intended to control the conversations with students and dialogic interactions were rarely observed. Last but not least, they emphasized the direct experiences of the students and engaged them with hands-on activities such as pond dipping, observational drawings and plant collage. The findings of this study suggest that learning in botanic gardens is experience-oriented and the garden educators may benefit great from appropriate continuing professional development.

19.5.1 Learning in a Botanic Garden Is Experientially Based

Learning outside the classroom can provide students with an authentic experience of their real-life world (Ofsted 2008). School trips to botanic gardens can enable children to interact with the plants, gain first-hand information about different living environments, and increase their understandings of the natural world (Ballantyne and Packer 2002; Brody 2005). The findings from this study suggest how botanic garden educators support students' experience-based learning through adapting different teaching strategies. Kolb (1984) noted that 'the process whereby knowledge is created through the transformation of experience' (p. 41), thus knowledge is constructed through a combination of grasping and transforming that experience. Education in the botanic garden context might benefit from focusing on providing the students with concrete experiences and interactions with plants. Therefore, the educators have the responsibility to facilitate students to integrate their botanic garden experience with ongoing school subject knowledge. During and after observations of plants, educators might elicit students' thinking and assist them to conceptualise abstract concepts. The social constructivist theory of learning emphasises that knowledge is 'socially co-constructed as new ideas emerge from the blending of voices and gradually meshed to produce a dialogic outcome' (Chin 2007, p. 837). In this sense, the garden educators can ask a series of open-ended questions to prompt and guide students thinking and thus promote conceptual learning.

19.5.2 Supporting Botanic Garden Educators' Professional Development

Compared to their counterparts in schools, the botanic garden educators have to work with different students. There is a short time for them to assess students' prior knowledge and the academic level they are working at. Because the education programmes are designed based on the English National Curriculum, botanic garden educators have to update their knowledge about governmental documents and recent education research findings. As a result, botanic garden educators need support from their institutions to develop their professional knowledge and skills. The Botanic Garden Conservation International carried out an online survey recently and found that half the botanic gardens or ecological education sites responding required their education staff to have ongoing professional development. The findings of this study suggest that the botanic garden educators need to be given sufficient opportunities to further develop their subject knowledge and pedagogical skills constantly. The botanic gardens may establish a collaborative partnership with teacher training institutes to enable botanic garden educators to receive continuous professional development. In addition, frequent networking opportunities might facilitate these educators to share teaching experiences and thus to reflect on their own practices.

References

Allen, S. (2002). Looking for learning in visitor talk: A methodological exploration. In G. Leinhardt, K. Crowley, & K. Knutson (Eds.), *Learning conversations in museums* (pp. 259–303). Mahwah: Lawrence Erlbaum Associates.

Anderson, D., Lucas, K. B., & Ginns, I. S. (2003). Theoretical perspectives on learning in an informal setting. *Journal of Research in Science Teaching, 40*(2), 177–199.

Ballantyne, R., & Packer, J. (2002). Nature-based excursions: School students' perceptions of learning in natural environments. *International Research in Geographical and Environmental Education, 11*(3), 218–236.

Ballantyne, R., & Packer, J. (2009). Introducing a fifth pedagogy: Experience-based strategies for facilitating learning in natural environments. *Environmental Education Research, 15*(2), 243–262.

BGEN. (2009). Supporting inspirational learning about plants and their importance. Botanic Garden Education Network (BGEN). http://bgen.org.uk. Accessed 16 July 2009.

Bowker, R. (2002). Evaluating teaching and learning strategies at the Eden Project. *Evaluation and Research in Education, 16*(3), 123–136.

Bowker, R. (2004). Children's perceptions of plants following their visit to the Eden Project. *Research in Science and Technological Education, 22*(2), 227–243.

Brody, M. (2005). Learning in nature. *Environmental Education Research, 11*(5), 603–621.

Carson, R. (1998). *The sense of wonder*. New York: HarperCollins.

Chin, C. (2007). Teacher questioning in science classrooms: Approaches that stimulate productive thinking. *Journal of Research in Science Teaching, 44*(6), 815–843.

Cox-Petersen, A. M., Marsh, D. D., Kisiel, J., & Melber, L. M. (2003). Investigation of guided school tours, student learning, and science reform recommendations at a museum of natural history. *Journal of Research in Science Teaching, 40*(2), 200–218.

DfEE. (1999). *Science: Key stages 1–4: The National Curriculum for England*. London: Department for Education and Employment (DfEE).

DfEE. (2006). *Learning outside the classroom manifesto*. Nottingham: Department for Education and Skills (DfES) Publications.

Falk, J. H., & Dierking, L. D. (2000). *Learning from museums: Visitor experiences and the making of meaning*. Walnut Creek: AltaMira Press.

Glackin, M. (2007). Using urban green space to teach science. *School Science Review, 89*(327), 1–8.

Hein, G. E. (1998). *Learning in the museum*. New York: Routledge.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111–127.

Jones, V. (2000). *More than just plants: Engaging with the politics of identity at botanical gardens*. Paper presented at the Making sense of teaching and learning through environmental education research, Chelsea Physic Garden, London.

Kohn, D. (2008). Darwin the botanist. *Roots, 5*(2), 5–8.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs: Prentice-Hall.

Malone, K. (2008). *Every experience matters: Learning outside the classroom*. London: Farming and Countryside Education (FACE) and Department for Children, Schools and Families (DCSF).

Mortimer, E. F., & Scott, P. H. (2003). *Meaning making in secondary science classroom*. Maidenhead: Open University Press.

O'Donnell, L., Morris, M., & Wilson, R. (2006). *Education outside the classroom: An assessment of activity and practice in schools and local authorities*. London: Department for Education and Skills (DfES).

Ofsted. (2008). *Learning outside the classroom: How far should we go?* (No. NR-2008-30). London: Office for Standards in Education, Children's Services and Skills (Ofsted).

QCDA. (2008). *Science and the national curriculum aims*. Retrieved October 27, 2009, from http://curriculum.qcda.gov.uk

Rickinson, M., Dillon, J., Teamey, K., Morris, M., Choi, M. Y., Sanders, D., et al. (2004). *A review of research on outdoor learning*. London: National Foundation for Educational Research & King's College London.

Sanders, D. (2004). *Botanic gardens: 'Walled, stranded arks' or environments for learning?* Unpublished PhD thesis, University of Sussex, Brighton.

Sanders, D. (2007). Making public the private life of plants: The contribution of informal learning environments. *International Journal of Science Education, 29*(10), 1209–1228.

Scott, P. H., Mortimer, E. F., & Aguiar, O. G. (2006). The tension between authoritative and dialogic discourse: A fundamental characteristic of meaning making interactions in high school science lessons. *Science Education, 90*(4), 605–631.

Slingsby, D. R. (2006). The future of school science lies outdoors. *Journal of Biological Education, 40*(2), 51–52.

South, M. (1999). *Can a botanic garden education visit increase children's environmental awareness?* Paper presented at the 4th International Congress on Education in Botanic Gardens, Kerala, India.

Stewart, K. M. (2003). *Learning in a botanic garden: The excursion experiences of school students and their teachers.* Unpublished PhD thesis, University of Sydney, Sydney, Australia.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. London: Sage.

Tunnicliffe, S. D. (2001). Talking about plants: Comments of primary school groups looking at plant exhibits in a botanical garden. *Journal of Biological Education, 36*(1), 27–34.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wellington, J., & Ireson, G. (2008). *Science learning, science teaching*. London: Routledge.

Wellington, J., & Osborne, J. (2001). *Language and literacy in science education*. Buckingham: Open University Press.

Westgate, D., & Hughes, M. (1997). Identifying 'quality' in classroom talk: An enduring research task. *Language and Education, 11*(2), 125–139.