Chapter 2
How Preschools Environments Afford Science Learning

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Abstract This chapter specifically examines how science learning is afforded as a result of children being in preschool environments. Wondering is introduced as a way of conceptualizing how young children and teachers can interact to support science learning. The literature is examined in order to determine what science learning is possible through the different areas within the outdoor area, and the different areas within the centre. The concept of sciencing is drawn out of the literature and is used for analysis in a study of 3–5 year old children's learning science. Formal sciencing [composting (decomposition]), informal sciencing (prism on window sill [refracting light]) and incidental sciencing (textured path and chalk [force]), are discussed. The research introduced also noted how science can be foregrounded as part of the traditional areas within the preschool (Sensory garden [herbs – use, growth and care]). In addition, it was noted that science areas can be specifically organised through building science infrastructure into the centre (light area [blocking light, light reflecting and refracting]). Importantly, this chapter also shows how the using of science in everyday life in the centre (e.g. weather watching) affording science learning amongst preschool children.

Keywords Everyday concepts and scientific concepts • Light • Sciencing • Wondering

2.1 Introduction

In most play-based settings, teachers draw upon the centre environment (indoors and outdoors) for supporting children's learning. In these settings there are already many opportunities for science exploration to occur, without the need for specifically planned and organized science experience. How children experience this environment is central for determining if and how children are oriented to science learning.

In keeping with the theoretical focus of this book, we examine this central question of experience from a cultural-historical perspective. To do this we begin by drawing upon the theoretical concepts from a lecture given by Vygotsky, and originally published in 1935, that specifically examines 'the problem of the environment' (Vygotsky, 1994). Environment refers to both the material and social context

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of the child, where affective relations to science are featured. This is followed by a broader conceptual discussion, which uses more contemporary sources, and empirical material to illustrate how preschools afford science learning.

2.2 Cultural-Historical Development of Science

In the previous chapter it has been argued that scientific knowledge is a human construction which is passed from one generation to the next, where humans transform, reject, evolve and apply these knowledge systems to everyday life and research. For instance, when a mother says to an 8-year-old child that the colours in a rainbow that they can see are the result of light being refracting through a series of rain droplets, then she is passing on scientific knowledge acquired historically. The mother has not personally invented this explanation, but has herself acquired this explanation through her own interactions within the social world. It is argued by Bozhovich (2004) that "when a person operates with real world objects that were created by human culture throughout history, he [sic] assimilates objectified psychological reality" and this reality as represented through the social and material artifacts and interactions "provides the context for an individual's assimilation of the cultural attainments of past generations" (p. 25). This perspective foregrounds scientific knowledge as not just a cultural construction by society (and as argued in Chap. 1), but also as historically evolving, where this history of knowledge is located in the present moment. This means that for children to access this knowledge system, they need to be oriented to scientific knowledge as an explanatory system for what they experience in everyday life – such as when they see a rainbow in the sky. In this reading of science, scientific thinking is about experiencing their world differently. That is, the children's environment does not change, but their relationship to it does as a result of science teaching. The child who learns about refraction will think very differently about what s/he sees in her or his environment. A rainbow will no longer represent an intangible image that somehow affords looking for the 'end' to yield a pot of gold (as noted in some children's books). In this example, the rainbow is still the same, but the child's relationship to the rainbow has changed, as s/he will think and act differently in relation to the rainbows observed.

Vygotsky (1994) argued that "one should always approach environment from the point of view of the relationship which exists between the child and its environment at a given stage of his [sic] development" (p. 338). What is central here is determining the relation between the child and the social and material environment. This relationship, when expressed from a cultural-historical perspective, takes into account what the child brings to the interaction, and what the activity setting affords for the child. This dialectical view of experiencing the environment means that we can both examine the child's affective attitude as refracted through their previous experience (discussed further below and in Chap. 3), whilst at the same time noting the child's cognitive engagement or orientation to the environment as a source of science learning. Vygotsky referred to this as the interaction between the 'ideal' and 'rudimentary' form. He uses the example of speech to illustrate this concept. For instance, for children to learn to speak a language, regardless of which country they live in, they must be in an environment where people are talking – this representing the ideal form of speech. The child who has rudimentary language, such as an infant, needs to experience the 'ideal form' of language if s/he is to learn to speak. The same argument can be applied to science learning in early childhood centres. If children are to learn to think and act scientifically, they too need to experience a scientific environment – however that is constituted. They will bring, like the language learner, their rudimentary knowledge of how the world works, and through their interactions of the ideal form as an interaction of scientific activity, observation, and explanation with others, will develop higher forms of scientific thinking and acting. Social mediation is central. Vygotsky (1994) stated that "*without social interaction he [sic] can never develop in himself any of the attributes and characteristics which have developed as a result of the historical evolution of all humankind*" (p. 348; original emphasis) including scientific explanations of the world.

A fundamental principle within all of Vygotsky's writings is the view that "*the child's higher psychological functions, his [sic] higher attributes which are specific to humans, originally manifest themselves as forms of the child's collective behaviour, as a form of co-operation with other people, and it is only afterwards that they become the internal individual functions of the child himself* (Vygotsky, 1994, p. 349; original emphasis). This suggests that in science learning, science activity in early childhood centres should be represented in their ideal form, in complete rich and meaningful situations, where children collectively engage in scientific interactions, not as sites for recitation and delivering facts, as is often presented in 'science lessons', but as authentic encounters in the everyday world needing scientific explanation. Here experiencing the preschool environment becomes a scientific orientation, encounter and explanation co-constructed between children and early childhood teachers. Explanation here does not mean 'explaining' but rather is symbolic of an explanatory system for making meaning, and in this particular case, as the cultural knowledge system of science explaining the environment. However, this does not mean that all children will experience the same environment in exactly the same way. Vygotsky's concept of the *social situation of development* is useful here for better understanding why children experience *the same scientific environment differently*.

Vygotsky (1998) introduced the concept of the *social situation of development* through a clinical example from his original research where he discussed how three children from the same family where substance abuse was taking place, experienced their same dysfunctional family differently. What Vygotsky's (1994) research reveals is that the youngest child develops neurotic symptoms, and is simply overwhelmed by the particular environment in which he finds himself. The second youngest child develops an ambivalent attitude to his mother. To Vygotsky's surprise the eldest child (aged 10) who understood that his mother was ill had taken on a special kind of role, of taking on the caregiving for his younger siblings, demonstrating great maturity, seriousness and solicitude. Vygotsky asked "How can one explain why exactly the same environmental conditions exert three different types of influence on these three different children?" (p. 339).

In Vygotsky's case study he argued that the youngest child could not understand what was going on, and therefore felt powerless to affect change, resulting in neurotic symptoms, whilst the eldest child had understanding of the situation, and was therefore able to relate to the same situation that all three children were experiencing in quite a different way. That is, each child brought to their experience of the same environment a different level of psychological development, with the eldest child developing skills way beyond what one might expect of a 10-year-old child. The main point is that each child has their *own special relationship with the environment*, experiencing the same environment differently based on what they bring. We suggest this is the same when a child experiences their scientific environment, each child will already have developed everyday conceptions of their experiences (sometimes referred to as alternative views, see Chap. 1) that they will use to interpret the environment. Different everyday conceptions will yield a very different experience of the same scientific activity and interaction for children.

Bozhovich (2009) in elaborating the social situation of development further, provides an interesting explanation that is worthy of consideration for science education. She argues that "understanding depends (like all other mental processes) on children's affective attitude toward the circumstance affecting them", born out in everyday "observation and analysis of countless pedagogical phenomena" and these observations "attest to the fact that given the same understanding, children often have different attitudes toward one and the same reality, experience it differently, and react to it differently" (p. 68). She goes on to argue that "experiences are products of the reflection of our relationship with surrounding reality" (p. 74). That is, "reflections impels people to act in such a way so as to regulate their interrelationships" and "experiences, once they have taken place and formed a complex system of feelings, affects, and moods, begin to take on significance for people in and of themselves" (p. 74). An example of a child's reflection on their environment and affective attitude in science in early childhood is 'wonder'.

Haddzigeorgiou (2001) puts forward the view that 'wonder' as an emotional quality captures an important relationship between the child and their environment and that this can be pedagogically supported in preschools by teachers. Haddzigeorgiou argues that in building a strong conceptual base through science learning "cannot take place without the establishment of a long-term relationship between the world of science and the child. This relationship can be established only if children are helped to develop certain attitudes towards science"" (p. 64).

A cultural-historical reading of wonder can be conceptualized as an emotional and relational quality that acts as a prism through which the world is experienced by the child. This view of wonder is supportive of Haddzigeorgiou's (2001) comment that "Wonder, in fact, gives things their meaning and reveals their significance" (p. 65). But here, we invest a more dialectical reading by stating that wonder is *not* something that is naturally *within* the child as a scientific way of interacting with the environment, but rather *wonder is socially produced in collective communities*, such as preschool settings, where the ideal form must already be in existence. As with language development occurring as a result of a child being in a language environment, albeit above what the child may fully understand, wonder must also be present within the child's environment as a culturally constructed phenomenon.

In undertaking a cultural-historical reading of the concept of environment from the perspective of early childhood science education, we have noted that the child's experience of the environment demands that an affective relationship not only exist, but as in the case of Haddzigeorgiou (2001) concept of 'wonder' (as a scientific attitude or relationship to the environment), must also be actively developed. We notice this affective relationship of wonder in a study by Siry and Kremer (2011) where Isabella (the teacher) supports two kindergarten children's sense of wonder by actively engaging in their ideas:

> Isabelle: *If you want to touch a rainbow, how does I feel?*
> Leyla: *If [the rainbow] quickly disappears. And when a child wants to touch it, it quickly disappears so no child can catch it.*
> Julia: *I know what Leyla wants to say, when you touch it then you feel nothing at all because then the hand is through it. Because the rainbow I out of nothing.*
> Leyla: *So, invisible, right?*
> Julia: *No, how could we see the rainbow then?* (p. 648; children are 5 and 6 years old)

An affective relationship between the children and their environment is being built here as the teacher and the children explore rainbows, something that is not only visually appealing, but also intriguing to them. Wonder is being privileged by the teacher as a form of scientific engagement with their environment, as the children explore the different attributes of rainbows through their own physical and imagined interface with the rainbows. Science as a cultural knowledge system is being privileged by the teacher in her encouragement of collective wondering. Here an emotional quality to the children's interactions with their environment is being established by the teacher. *What we see is that the environment is refracted through the lens of scientific wondering.* In Siry and Kremer's (2011) study, wonder was being collectively constructed through particular dialogue, with the following questions asked by the teacher throughout the children's exploration of rainbows:

> What do you see on the picture? … Have you seen a rainbow before? When and where? … How does a rainbow arise? … What does a rainbow feel like? … Can you stand on a rainbow or use it as a slide? … What happened when the rainbow isn't there anymore (Siry & Kremer, 2011, p. 654).

Vygotsky (1994) argued that "*Something that is supposed to take shape at the very end of development, somehow influences the very first steps in this development*" (p. 346; original emphasis). That is:

> The greatest characteristic feature of child development is that this development is achieved under particular conditions of interaction with the environment, where this ideal and final form (that form which is going to appear only at the end of the process of development) is

> not only already there in the environment and from the very start in contact with the child, but actually interacts and exerts a real influence on the primary form, on the first steps of the child's development (p. 346).

In early childhood science, a collective sense of wondering represents the ideal form, which children can take up later at a more personal level when experiencing their environment, and through this 'wondering relationship with their environment', a more scientific approach to thinking and learning can be achieved. We see this in the example of Isabella (the teacher) framing the collectively wondering of the children, but also giving conceptual direction to the children's wondering so it leads to a more scientific explanation of rainbows:

Leyla:	Rain and sun.
Julia:	Then it is mixed.
Leyla:	Yes then it is mixed together an there the rainbow comes.
Isabella:	How do you think, the colours arise?
Julia:	The sun has lots of colours in it and then that gets mixed with the rain and then that becomes colours.
Leyla:	Sun and rain. (Siry & Kremer, 2011, p. 653)

Wondering is the affective scientific lens that children use in experiencing their environment. However, only ever wondering without moving conceptually forward means many missed opportunities for science learning feature. We now turn to the work of Tu (2006), who has examined early childhood settings to determine how preschool environments afford science learning for children.

2.3 Preschool Science Environments

Tu (2006) has argued that "as soon as children realize that they can discover things for themselves, their first encounter with science has occurred" (p. 245). In drawing upon Chalufour and Worth (2003, p. 4), Tu states that "wondering, questioning, and formulating ideas and theories" (Tu, p. 245) are part of scientific enquiry into the world surrounding children, and this is a form of 'sciencing'. In a study which sought to examine the opportunities for sciencing in 20 preschool settings in the US, Tu video recorded two consecutive days of morning free play time and analysed both the environment and the activities against two checklists and a coding form. Tu was particularly interested in how preschool settings naturally afford science learning for children. Tu used Neuman's (1972) categories of formal sciencing, informal sciencing and incidental sciencing to examine the environment of the preschool settings.

Here *formal sciencing* refers to specifically planned science activities that are deliberately organized by the teacher, such as providing a cooking activity or introducing a pet into the centre. *Informal sciencing* captures the way in which a teacher might organize a space within the centre for promoting scientific interactions and explorations, such as a science table, or science corner. *Incidental sciencing* refers to interactions that occur between children and the teacher as a result of an occurrence in the centre, such as the weather suddenly changing or a child bringing into the centre a dried seahorse they have found on the weekend, and the teacher in drawing upon scientific concepts elaborates on the child's comments.

In using Neuman's (1972) categories of formal sciencing, informal sciencing and incidental sciencing to analyse the 20 centres, Tu (2006) found that the "activities that the preschool teachers engaged were mostly unrelated to science activities (86.8 %), 4.5 % of the activities were related to formal sciencing, and 8.8 % of the activities were related to informal sciencing" (p. 245). The results show that although half of the preschools had a science area, the teachers mostly spent their time in the art area. Of particular interest is the analysis made by Tu of the materials and equipment for science within the preschool centres. Tu noted that the most common natural materials available to children were plants, seashells, fossils, and pinecones. In addition, vinegar, baking soda, sensory bottles, toad tank, fish tank and tornado bottles were also commonly found in the preschools studied. Tu found that none of these materials were used by the teacher or the children. Interestingly the preschools also had available for children prisms, timers, flower pots, and binoculars, affording a great many possibilities for scientific wondering. None of which were utilized during the data gathering period.

Other opportunities for informal sciencing were reported by Tu (2006) including the provision of a sensory table by 65 % of the centres and a sand or water area in 55 % of centres.

These results would tend to suggest that while there were many opportunities for science learning and a collective sense of wondering about the everyday environment to be created by the preschool teachers, this did not happen. Tu (2006) suggests that "teachers can model with their children a passion for discovery that is common in the world of science. It is acceptable for educators to say "I don't know, why don't we find out together "(p. 251). Tu also suggests that teachers need to exploit the existing science opportunities already available in the centre environments, and argues that if we are "to improve science teaching in the preschool classrooms, teachers need to reflect more on their own practices and utilize the science materials that are available in their environment" (p. 251).

In a study designed specifically for teachers to reflect upon the science opportunities afforded by the preschool environment, Fleer, Gomes, and March (2012) invited teachers to walk with the researchers as they filmed the preschool environment, discussing how children were experiencing science. In using the categories of formal sciencing, informal sciencing and incidental sciencing, and everyday and scientific concept formation (see Chap. 1) to examine the data, they noted:

- As with Tu's findings, science opportunities existed within the constant traditional areas within the preschool (e.g., blocks, sand, water)
- Teachers build science infrastructure into the centre (e.g., light area)
- Teachers and children collectively used science in the everyday life of the centre

A summary of their findings is shown in Table 2.1 and discussed further below.

Table 2.1 Teacher reflections of a scientific experiencing of the preschool environment

Type of science related activity	Sciencing found	Everyday and scientific concept formation found
Formal sciencing	Cooking (Heating, chemical change, change of state of matter)	Composting (decomposition)
Informal sciencing	Overhead projector and coloured blocks (light)	Light area (blocking light, light reflecting and refracting)
		Prism on window sill (refracting light)
		Coloured containers, rainbow stained glass (colour absorption)
		Windmill with coloured blades (white light and spectrum)
		Colour mixing at painting easel (colour absorption)
Science within the constant traditional areas within the preschool	Supporting block building, making concepts explicit for successful building (force)	Water trolley (water wheel – force)
		Sandpit (sand adhering together when wet – force)
		See-saw (force)
Building science infrastructure into the centre		Sensory garden (herbs – use, growth and care)
		Vegetable garden (plant growth and care)
		Flower garden (bulb growth)
Incidental sciencing	Possums in the centre grounds	
	Textured path and chalk (force)	
	Weeding (plant classification in everyday life)	
	Observing birds in the trees (eco-system in centre)	
	Observing flowering of the gum trees in centre (study of plants)	
Using science in everyday life in the centre		Weather watch (Range of concepts)
		Bureau of Meteorology (BOM)
		Rain gauge
		Windmill
		Observing the moon (Earth and beyond)

Adapted from Fleer et al. (2012)

2.3.1 *Science as Part of the Traditional Areas Within the Preschool*

Tu's (2006) analysis of preschools provided evidence of the pervasiveness of opportunities for science learning in early childhood centres, even though teacher-child scientific interactions rarely featured. In the study by Fleer et al. (2012) when teachers were interviewed about the possibilities for science learning within the traditional areas within a preschool, they found not only could the teachers instantly give examples of scientific interactions, but indicated they actively supported a scientific dialogue. An example follows where the teacher stops near the water trolley that is in the outdoor area of the preschool and explains what she commonly observes:

> `They will be pouring` (shows with hands what the children will be doing in the water trolley), `and they will watch the wheels go, so there is a conversation about how the water is able to push the wheel and turn the wheel, and we have a lot of chats, we had a couple of children here yesterday afternoon, and we were having a long chat with, about that` (Fleer et al., 2012, p. 13).

Siry and Kremer (2011) suggest that science opportunities tend to present themselves in relation to what is of interest to children, and that these interests become the resource for supporting the teaching of science in a more informal way. A cultural-historical reading of this would focus on the motive being created, and how motives do not come from within the child, but are developed as a result of children's collective participation in activity settings. In these contexts, not only are children demonstrating a motive for learning, but they are actively encouraged to learn science through teacher-child interactions. Unfortunately, Hedges and Cullen (2005, 2011) have found that in most play-based programs that teachers organise experiences for children as open-ended activities, where the acquisition of content knowledge occurs through osmosis rather than through teaching. Actively focusing on science interactions is generally limited due to teachers being more oriented to other areas of development, than science.

Having a science attitude as part of a teacher's way of interacting with children in the centre means that it is more likely that a motive for science can develop, rather than being observed as a process of osmosis, because as was noted in the study by Fleer et al.'s (2012) the teachers continually and collectively created a sense of scientific wonder and conceptual engagement within the centre. We see this also in other early childhood learning contexts, such as that of Howitt, Upson, and Lewis (2011) who implemented and evaluated forensic science in preschool as scientific inquiry.

2.3.2 *Creating a Science Area – Building Science Infrastructure*

Despite the fact that science areas are common in preschools, the content of these areas tends to focus on the natural environment, and are used mostly to provide interesting objects to explore, but as found by Tu (2006) teachers did not spend time in the area supporting children's wonder, curiosity or conceptual scientific development. However, in the study reported by Fleer et al. (2012) they found that their focus teacher had deliberately set up a physics area within preschool environment (light area) and ensured that it was available all year round for the children. In their study, high levels of teacher-child scientific engagement were noted as occurring from time to time over the 8 week period documented. In the example that follows, the teacher and the 3-year-old child (Henry) are using cellophane blocks which have a wooden frame on the overhead projector (as shown in Fig. 2.1) and are exploring light:

Teacher: Remember you need to lay it flat (pointing to the coloured block) so that that colour (child lays the block flat)… That's it. What colour are you getting now?

Henry: What?

Henry looks to the blocks and then to the wall where the coloured blocks are projecting. He then turns back to the teacher and smiles saying:

Henry: Purple (continuing to smile broadly).

Teacher: It is a purple (nodding at Henry). What about if you try putting one of them on the yellow in the middle? What colour could you put on the yellow one in the middle.

Fig. 2.1 Exploring light

Henry observes the teachers pointed finger, and then takes the block that is in his hand and places it over the yellow block. He then leans over the projector to look closely at the two coloured blocks that are stacked on top of each other.

Teacher: OK. Did you put blue on it or green?

Henry looks to the blocks and also the wall where the colours are being projected. He looks back and forth. Eventually the teacher points to the blocks and says:

Teacher: It is this one, in the middle (tapping with her finger; as Henry looks to her finger and to the wall). What's it done to the colour on the wall?

Teacher: Made it green. It has too. So yellow and blue make green don't they?

Henry smiles and then places two more blocks on top of each other and looks to the what the teacher is doing

Teacher: So what have you put on it?

Henry: Green and red.

Teacher: What colour does that make in the middle?

Henry: Orange.

Teacher: It is a funny kind of green colour on the wall. But it does look orange there (pointing to blocks stacked on the projector) though. So when it's reflected the colour is different.

The teacher then turns to the researcher and says:

The other point about this, is that they are learning that you can't put them up like that (shows block on wooden edge and not flat), that they have to lay them flat. We have had whole conversations about how there is, mirrors and reflections, and the light casting shadows, so a whole lot of learning about light involved in having these (projector and coloured blocks). There is always in this space (pointing to the area) some type of light box, overhead projector, something to do with light and reflection (Fleer et al., 2012, pp. 11–12).

What is special about this example is that the teacher quite deliberately set up a light area as a constant part of the centre. The organization of a specific science focused area to promote high level adult-child dialogue in relation to concepts is rarely featured (see Hedges & Cullen, 2011). The approach adopted, although atypical, provides evidence of explicitly examining scientific concepts in meaningful and iterative ways.

The study by Fleer et al. (2012) found that a *sciencing attitude* was demonstrated through the teacher creating new science infrastructure in the centre along with the traditional areas within the preschool (e.g., block corner) and through making science visible to the children through using it purposefully and in the everyday life of the centre. Their study has shown that a sciencing attitude is something that is important for maximising the science opportunities available to children within early childhood centres.

2.3.3 Using Science in Everyday Life in the Centre

In line with the content of Chap. 1, the study by Fleer et al. (2012) showed that the teacher used science in the everyday life of the centre. We see this took place in many different ways. Two examples are featured, and these examples are drawn from the broader data set (Fleer, 2011–2013):

1. Weather watching
2. Compositing and growing vegetables

2.3.4 Example 1: Weather Watching

The teacher is outside with the researchers and she discusses the extensive weather watching that they do together in the centre, by gesturing to both the natural environment (e.g., clouds), but also to the tools she has in the outdoor area available to the children (e.g., windmill, rain gauge):

> We do a lot of weather watching. We look at the sky. We talk about the sign shining, the wind blowing, makes the 'thingos' go around' (points to the windmill blades), we look at the clouds, so if they are rain clouds coming over, we will talk about the different colours of the different clouds, and what that means, and then we will go in and look at BOM (Bureau of Meteorology). So the children are really familiar with going and looking at BOM, the Bureau of Meteorology web site, at the radar picture, and this is where we live on the map (draws with finger in the air a map symbol, then points), these white and blue spots are the clouds (makes wave movement with arm indicating image on radar), and rain is coming across (motions with hand), they will be over us soon, so let's finish playing outside, and we need to pack up before the rain, then when the rain comes "See, the computer told us the rain was coming, now here it is". So a lot of that sort of thing happens.
>
> BOM helps us plan, what we are going to do, when to get things in, so they don't get wet, but, also the children love it. Certain ones. Not all of them. The ones that ask, we come and sit and we look and talk about it. They just have concepts of computers so well.
>
> We have got the rain gauge (pointing to the gauge). We talk about that occasionally. And we have got the rainbow wind chime (windmill). So there is LOTS of conversation about those, and how the winds pushing it to go round (Fleer, 2011–2013).

In returning to the theoretical arguments put forward at the beginning of this chapter, we see that this teacher had the 'ideal form' of science in the centre. Not only were the artefacts or objects of science available, but the teacher used these tools and the associated scientific concepts for the smooth and effective running of the program in the centre. The children and the teacher collectively studied the clouds, with the purpose of making judgements about if they were rain clouds, and then used the Bureau of Meteorology website to examine the radar in order to determine when it might rain, and what that might mean for playing outside. The teacher is actively orienting the children to their natural environment in a scientific way with a real purpose that is relevant to both the teacher and the children.

The children's experiences of their environment changes as a result of what the teacher points out, discusses, and comments on. Weather watching clearly changes the children's relationship to their environment. The children's experiences of their environment are filtered through a scientific lens. The tools available to the children and the teacher are used to read their environment in scientific ways by measuring rainfall, noticing wind direction, analysing cloud formation, and determining on the radar when it will rain. These events and scientific activities are experienced collectively, with the purpose of deciding if, and when, they can continue to play outside.

2.3.5 Example 2: Composting and Growing Vegetables

The teacher is outside and is in close proximity to the vegetable garden. She shows the researchers the garden that is looking quite spent, and discusses the energy cycle from eating fruit, to composting, fertilizing and harvesting vegetables. Although she is interrupted many times during the interview, the intent of her explanation is still evident:

> The vegy [vegetable] garden. You have seen we have compost. They have to divide their food up between compostable and citrus, and rubbish, so what goes into the compost, what goes into the rubbish bin, what we feed the birds, what we feed the possum [to stop him eating the vegetables from the vegetable garden], and we put food down for the ravens, and the cheeky birds [introduced species to Australia], so there is all the composting and then using it.
>
> On Monday we will be digging up the vegy patch, pulling out the things that have had it, digging it over, weeding it, planting some new vegetables. . . [interruption] dig it over, weed it, we talk about what are weeds, and what are plants we want to keep. . . [interruption] so we will plant them, we will water them, I will get another bale of straw, and fertilizer [in addition to using the compost], and then it is all about growing them, I am desperate to get something harvested… (Fleer, 2011–2013).

In having the 'ideal' or authentic form of scientific activity in the child's environment, we see that Bozhovich's (2004) claim that when a child operates with concrete objects that have been created by human culture throughout history, that the child can assimilate not just the scientific concept, but understands how scientific concepts are used to inform actions in everyday life, such as energy transfer as a result of composting all the fruit scraps generated through 'fruit time' in the centre. It is through the teacher-child interactions in collecting the fruit scraps, in putting these into the compost bin, in observing the compositing process, and in using the organic matter for the vegetable garden, that this social and material artifacts and interactions related to energy transfer "provides the context for an individual's assimilation of the cultural attainments of past generations" (Bozhovich, p. 25).

In European heritage communities, most early childhood centres will look similar, and essentially follow the original Froebelian Kindergarten design of 100 plus years ago. Most preschools will be equipped with the traditional child sized furniture and equipment, and be organsised into areas, such as the block corner, the home corner, the puzzle area, the sand pit, painting area, book area, collage area, box construction area, and will have outdoor equipment, such as trestles and balancing beams and a water trolley. This is essentially an imaginary world that really does not represent the child's home or community. These specialized spaces for children's play and learning have remained essentially unchanged. Consciously bringing science into these contexts, either through adding to the traditional areas, such as a physics area, or by using science to run the program, such as using Bureau of Meteorology, afford a very new way of working for early childhood teachers and children. A sciencing attitude affords not just a new way of experiencing the environment for early childhood children, but it gives the possibility for a new way of understanding the environment, as children and teachers collectively draw upon scientific explanations to understand their world.

Imagination in science is clearly an important attribute in learning scientific concepts. In the next chapter we explicitly examine this important area.

References

Bozhovich, L. I. (2004). L. S. Vygotsky's historical and cultural theory and its significance of contemporary studies of the psychology of personality. *Journal of Russian and East European Psychology, 42*(4), 20–34.

Bozhovich, L. I. (2009). The social situation of child development. *Journal of Russian and East European Psychology, 47*(4), 59–86.

Chalufour, I., & Worth, K. (2003). *Discovering nature with young children*. St. Paul, MN: Redleaf Press.

Fleer, M. (2011–2013). *Australian Research Council Discovery Grant*, Unpublished Data. Monash University.

Fleer, M., Gomes, J., & March, S. (2012). A cultural-historical reading of scientific concept formation: Affordances for science learning in preschools. *International Journal of Science Education* (under review).

Haddzigeorgiou, Y. (2001). The role of wonder and 'romance' in early childhood education. *International Journal of Early Years Education, 9*(1), 63–69.

Hedges, H., & Cullen, J. (2005). Subject knowledge in early childhood curriculum and pedagogy: Beliefs and practices. *Contemporary Issues in Early Childhood, 6*(1), 66–79.

Hedges, H., & Cullen, J. (2011). Participatory learning theories: A framework for early childhood pedagogy. *Early Child Development and Care*. doi:10.1080/03004430.2011.597504.

Howitt, C., Upson, E., & Lewis, S. (2011). 'It's a mystery!' A case study of implementing forensic science in preschool as scientific inquiry. *Australasian Journal of Early Childhood, 36*(3), 45–55.

Neuman, D. (1972). Sciencing for young children. In K. R. Baker (Ed.), *Ideas that work with young children*. Washington, DC: National Association for the Education of Young Children.

Siry, C., & Kremer, I. (2011). Children explain the rainbow: Using young children's ideas to guide science curricula. *Journal of Science Education and Technology, 20*, 643–655.

Tu, T. (2006). Preschool science environment: What is available in a preschool classroom? *Early Childhood Education Journal, 33*(4), 245–251. doi:10.1007/s10643-005-0049-8.

Vygotsky, L. S. (1994). The problem of the environment. In R. van der Veer & J. Valsiner (Eds.), *The Vygotsky reader* (pp. 338–354). Oxford, UK: Blackwell.

Vygotsky, L. S. (1998). *The collected works of L. S. Vygotsky, Volume 5: Child psychology* (R. W. Rieber, Ed., & M. J. Hall, Trans.). New York: Plenum.