European Journal of Educational Research
Volume 4, Issue 3, 105 - 117.
ISSN: 2165-8714
http://www.eurojedu.com/

Concepts of Plants Held by Young Brazilian Children: An Exploratory Study

Amauri Betini Bartoszeck*
University of Paraná, BRAZIL

Claudete Rosa Cosmo
Escola Municipal Maringá, BRAZIL

Bernadete Rocha da Silva
Francisca Aragão School, BRAZIL

Sue Dale Tunnicliffe
University College London, Institute of Education, UNITED KINGDOM

Abstract: Children from southern and northern Brazil have a basic knowledge of plants, which they observe during their everyday life. Children ages between 3 to 10 years old (kindergarten & primary school), but the majority of them in the age group of 4-5 (total 145) were asked to draw what they think is a plant (total sample=332). Afterwards, a equal number of boys and girls randomly chosen were interviewed individually (mix ability) to list plants they said they knew and where they had seen them. Then they were asked to give exemplars of the local plants which they had seen. These data from the exploratory study show that pupils are in touch with their environment and recognize plants that are part of it. The everyday experiences of these children in school and out of school, at home and in leisure activities with family and friends, contribute to their knowledge about plants and such knowledge is complemented in the preschool and primary school classes by appropriate teaching. Educational implications of these findings are discussed.

Keywords: *plant conception, preschool and primary school pupils, mental model, drawings*

To cite this article: Bartoszeck, A.B., Cosmo, C.R., Silva, B.R. da, & Tunnicliffe, S.D. (2015). Concepts of Plants Held by Young Brazilian Children: An Exploratory Study. *European Journal of Educational Research*, 4(3), 105-117.

Introduction

Animals, and to a lesser extent plants, are an important part of the scenery noticed by young children in their everyday (Chen and Ku, 1999; Tunnicliffe et al., 2008; Patrick and Tunnicliffe, 2011). Pupils often learn particularly about plants in their early years from their family, be it when they watch someone trying to eradicate weeds from the lawn, planting out flower beds, hanging baskets, cultivate flowers for vases or noticing plants seeing everyday on walks or on special visits to Botanical Gardens or city Arboreta and in the media (Gatt et al., 2007; Louv, 2008; Knight, 2009; Toomer, 2013).

However, research about plants in the early years (kindergarten and primary school) has focused in Brazil more for the purpose of learning environmental education, Carneiro (2001), and are more concerned with, for example, children´s explanations of plant growth and the formation of rain, Christidou & Hatzinikita (2005), other studies explored how the ecosystem is represented and the diversity of flora illustrated , Martinho and Talamoni (2007), through drawings of trees and animals, Schwarz et al., (2007). and either on the life cycle of plants beginning from seeds (Cherubini et al., 2008). Focusing more on concepts of living things from aspects of plant life which are influenced by the sun, rainfall and clouds represented by drawings as reported from Portugal Villarroel and Infante, (2013) than on the concept of plant i. e. the names of the specimens, the morphological aspects of the specimens identification.

Teaching basic science and language literacy i. e. reading and writing the mother tongue, still represents a difficult task for many primary school teachers, particularly how to teach elementary science in the kindergarten and first grades of primary school (Kramer, 1994; 2006; Moraes, 1995; Blanquet, 2010). Childcare centers (nurseries) play an important role in the acquisition of language, literacy, and social skill such how to use toilet and playful activities with other children from the same age (Carvalho et al., 2006). Elementary science in the earlier grades (3 to 7 year olds) enables children to explore and understand the natural world by means of simple observations and investigation based on what the child already knows, as a firm foundation for science literacy as the learner progresses through formal education (Rowlands, 2001; Oliveira, 2002; Johnston, 2005; Tunnicliffe, 2013).

Children are innately interested in living things. A fundamental concept that emerges very early is the sorting of organisms (Braund, 1991; Greene, 2005;

* **Corresponding author:**
Amauri Betini Bartoszeck, Laboratory of Cellular Metabolism, Neuroscience and Emergent Science Education, University of Paraná, PR Brazil.
E-mail: abbartoszeck@gmail.com

Martínez-Losada et al., 2014). How to explore, identify and classify living things forms a set of abilities that start with very young children at school as they develop further the first learning experiences of science at school (Keil, 2003). Children form their own "scientific ideas" very early in their neuronal and cognitive development and sometimes these concepts are different from accepted science knowledge and may conflict with accepted scientific learning (Driver, 1989; Kuhn, 1989; Fischer and Rose, 1989; Colinvaux, 2004; Inagaki and Hatano, 2006; Sumida, 2013).

Plants are essential for all kinds of living beings on Earth. However, plant study in all levels of schooling is relatively neglected. Children are very enthusiastic when they talk about instances where they observe and collect insects and "mini-beasts" instead of plants which apparently do not produce such response to stimuli. Some people have "plant blindness" Wandersee and Schussler, (2001) that is probably because humans show little affinity for plants in general, but prefer animals instead because they move and usually react quickly to stimuli (Tunnicliffe and Reiss, 2000; Lindemann-Matthies, 2005; Barman et al., 2006).

Learners of various ages have difficulties in dealing with the concept of "plant" to name them or even whether they are living organisms (Stavy and Wax, 1989; Wood-Robinson, 1991; Tamer et al., 1991; Barman et al., 2002; Bebbington, 2005). New Zealand children 7, 9 and 11 year olds did not classify grass, carrots or oak trees as plants (Bell, 1981). However, children do develop their own strategies for identifying plants such as observing shapes and colour of leaves which belong mainly to know species of trees and shrubs (Dougherty, 1979; Rymell, 1989; Tull, 1994; Angoro et al., 2008).

On the other hand, plants are part of the children´s world. A knowledge of children understanding of a variety of plants demands from their first hand observation. It does not matter whether they are ornamental, in the backyard gardens, parks, in vases, inside aquaria, edible as food or crop pests (Gatt et al., 2007; Ashbrook, 2008). Moreover, children eat plants which contributes to the understanding children have of vegetation derived from such informal daily observation, enable educators to develop further understanding and develop a deeper integration with the researchable local environment (Harvey, 1989; Bianchi, 2000; Barraza, 2001; Bowker, 2004, Carrier, 2007).

Recent studies about which ideas children have about plants and their habitats are scarce and few culturally comparative (Gatt et al., 2007; Patrick and Tunnicliffe, 2011). Introductory studies in Brazil and Portugal are aiming to integrate practical classes with careful observation of plants as for instance comparative studies of species as well as textbook analysis of the botanical contents covered in texts during primary school (Klein et al., 2001; Kinoshita et al., 2006; Azul et al., 2007; Guimarães and Santos, 2011). Researchers in emergent science education may have access to pupil´s mental models of plants by means of drawings collected in a classroom activity. Mental models develop according to the age of a child. A mental model can be considered an analogue of how people perceive or make a conception of what is the world where they live (Johnson-Laird, 1983; Rapp, 2007).

Another approach to mental models refers to what is the contents of human knowledge and how the world works or certain areas of knowledge (Gentner and Stevens, 1983). However, Tiberghein, (1994) sees modelling as a kind of knowledge processing and on the other hand, Gilbert and Boulter, (1998) view that a model represents a target as an object or a process. These latter authors stress that a mental model is private and thus for a researcher to glean what is the child thinking about a topic in science, they created the cognitive construct "expressed model" which manifest itself as a drawing representing a concept as for instance what a pupil thinks is a plant

Theoretical background

Children from the earliest years notice plants in their everyday lives and construct a bank of knowledge gradually acquiring an understanding of adaptation to habitats. Research may reveal cultural influences in this incidental learning. Children in both developing countries and industrial societies are thought to be increasingly out of touch with nature. Moreover, it is claimed that they acquire their information concerning the natural world mostly through the media (Louv, 2008). However, it has been argued that in some cultures local plants are an important part of the lives of the inhabitants. Thus, children from such cultures as countries in tropical areas as for instance Brazil, Mexico and other countries in South America it is claimed to have an ecological understanding superior to that of urban children from "developed" countries (Barraza, 2001; Kinoshita et al. 2006; Bang et al., 2007). Furthermore, children do encounter some real plants, parts or representations thereof in their daily lives as well as in their food. These children notice plants in their home gardens, in parks or even during walks through the streets in the towns or on the way to school where they live or in the beaches (Hatano, 1993; Tunnicliffe, 2001; Schussler and Olzak, 2008).

Sometimes, family, social groups and schools take children on outings or field work. Some children are exposed to endemic or exotic plants by family members, friends and schools through trips to Botanical Gardens, Nature Centers and nearby forests (Lorenzi and Souza, 2001; Lorenzi et al., 2006; Sipinski and Hoffmann, 2010). External identifiers of plants such as shape, colour, flowers, scent, whether edible and where the plant is found naturally, are criteria used by children in building the concept of plant which is embodied as related to different species of the Plantae kingdom (Tunnicliffe and Reiss, 2000; Tunnicliffe, 2001; Boulter et al., 2004; Mauseth, 2009).

Learning about plants and their habitats may also be acquired by many children from narratives and stories in cartoons, which sometimes will be recalled later during formal science classes (Moen, 2006).

Drawing is a tool used to elicit the understanding of the natural world and useful to elicit the understanding a child may have of a plant (Anning, 2004, Chang, 2012). The child´s inner mind representations are her "mental model" of information and experiences from the outside world (Rapp, 2007). There is a relationship between mental model organisms and, habitats and what the child comments by means of a drawing, the expressed model (Brooks, 2009). Thus, drawings channel graphic information and communicate children´s ideas or development of concepts, sometimes in a naïve and confused way (Hopperstad, 2008).

Analysis of the drawings collected intended to elicit the mental model they may have of a "plant" on the perspective of Luquet´s (1927/1979) through this drawn expressed model. Luquet introduced the construct "intellectual realism" which is characterized by the child drawing what he/she knows rather than what the child sees but conveying meaning by symbolism and intellectual realism also in science concepts (Barrett and Light, 1976; Symington et al., 1981; Tunnicliffe, 2001).

Children´s drawings evolve according to how motor skills and cognition improve. About two to three year olds children begin to "scribble" which are the first purposeful marks representing a pattern even in the absence of the object (Yang and Noel, 2006). Between 4 to 6 years olds children tend to draw pictures, most children arrive at the early pictorial stage and represent rudimentary trees, flowers and leaves, and create human figures and animals. Between 7 to 10 year olds children through their drawings, begin to reveal how they perceive the world around them with more details (Krampen, 1991; Brooks, 2009).

Semi-structured interview is an easy tool to ask children to name different types of plants they may know, where is the source of this information. All learning is done by personal processing of information, takes place in a local context of social interaction and is influenced by culture (Solomon, 1987; Ward, 2007). Therefore, by determining children´s plant knowledge by asking them to talk about where they have seen such a kind of organism is a sign of social situation and participation and starting point for learning (Eshach, 2006).

Research questions

Children from 4 to 10 years of age were asked the following questions in the interview:

1. What plants do children know about from everyday life?

2. What is the source of this knowledge?

3. What other plants children can name from their surroundings?

4. What plants they can name from specific habitats?

5. What children can tell about these sources?

Methodology

The aim of this exploratory study is to discover what children across the age range of 3 to 10 year olds think intuitively as a "plant", from the sources that knowledge was acquired and what, if any, socio cultural influences affected their ideas. We asked children, ranging from 3 to 10 year olds, to draw what they think is a plant and analyzed the mental models of plant (expressed model) they may have depicted in their drawings. Thus, we were able to identify basic plant botanical characteristics. It also sought to elicit with which plants these children were familiar, with which plants children notice of their everyday environment, location of plants mentioned and from where they gleaned their knowledge about plants through further data obtained through the transcripts of semi-structured interviews.

Fifty children 3 year olds, eighty-two 4 year olds, sixty-three 5 year olds, twenty-six 6 year olds, thirty-one 7 year olds, forty-three 8 year olds, seventeen 9 year olds, and thirteen 10 year olds both genders were just asked what a "plant" means to them and responded by means of a drawing. Thus, it allowed the researchers to see what image they held of a plant. Furthermore, the analysis of the drawings also took into consideration differences by age, and gender, on the level of understanding of "plant" and botanical characteristics as leaves, flowers, fruit, stem, roots. A rubric scale of levels of plant characteristics (Table 1) was compiled based on researchers´ previous experiences in other biological fields, where level zero refers to "nothing recognizable" to level 5 a drawing which represents a tree with leaves, flowers, fruit, stem and roots (e. g. Tunnicliffe and Reiss, 1999; Bartoszeck et al., 2011).

Table 1. Plant drawings rubric scoring levels.

Level	Plant botanical characteristics
0	Nothing recognizable (unable to understand the task).
1	Scribble I (awareness of pattern).
2	Scribble II (recognizable as a plant).
3	Represents a flowering plant (angiosperm with leaves, stem or a gymnosperm with leaves, trunk, cones)
4	Represents flower/shrub angiosperm with leaves, stem, roots.
5	Represents angiosperm tree with leaves, flowers and or fruit, stem, roots .

Children were asked (during a session at school setting) to draw on an A4 sheet of paper what they think was a plant, during the school session. They were

told that it was not expected an artistic drawing. They were allowed 15 minutes to perform the drawing. The fieldwork was carried out at 5 schools of infancy education (kindergarten) and 2 primary schools. The schools were located in urban, suburban, rural and regional areas of the country as to reflect the social and cultural strata of the population sampled in southern Brazilian towns (Curitiba, Piraquara, Araucária, Dorizon, Mallet (Paraná State); Porangaba (São Paulo State) , Camboriú Resort (Santa Catarina State) and an Amazonian area northern town Rio Branco (Acre State). Drawings were analyzed carefully by the researchers.

The specific questions the randomly selected children, who were away from the other children in a separated room, after all drawings were collected and did not have their drawings in front of them (four to ten years old) were asked individually in the semi-structured interview were:

a- Name as many plants as you know in one minute;

b- Where did you notice them; where did you find about them?

c- Name the plants you noticed near home, on the way to school?

d- Tell from a list of 15 local plants which ones you know or not?

e- Tell the source (e. g. from TV, books, live) of these observations .

Twelve children, 2 boys and 2 girls from each of low (weak), middle (regular) and high ability (gifted) bands, were chosen randomly by schools´ teachers from the class (kindergarten to primary school) of 4 , 6 years, 8 years, 10 years olds. Each child was interviewed individually in the school setting. Ethical issues of parental consent were dealt with according to school protocols and procedures, and the questions being asked of the children were discussed with the Head master and teachers. Interviews were carried out with 80 children (40 boys and 40 girls) Ages ranged from nursery (4 year olds) school to primary (10 year olds) school of compulsory education in Brazil attending no fee paying public schools.

Responses were tape-recorded and at the same time written on a pre-designed interview sheet by the interviewer and each took about 20 minutes. The data sheets were read and re-read. Plant identification which emerged from the responses were divided into gymnosperms (e. g. pine trees), angiosperms (monocots e. g. grass, rice; dicots e. g. apple tree) from this interactive process. The goal was to identify the category order in a hierarchical organization and a transcript count. Children´s responses for each question in the interview were place into the Excel and totaled. A qualitative analysis was taken instead as there was not enough data to perform a quantitative analysis. However, experiences of viewing plants in museums exhibits or National Geographic films, tends to provide children with a "paradise" view of reality. Thus, it is such experiences and knowledge acquiring by children from their everyday lives that the authors wished to elicit in order to establish the factors that affect their understanding of the notion of "plant".

Findings

Exemplars of drawings and grades allocated are shown in Figures 1 to 6.

Figure 1. A drawing by a 5 years-old boy which scored level 0 (zero) according to grades in Table 1 (nothing recognizable).

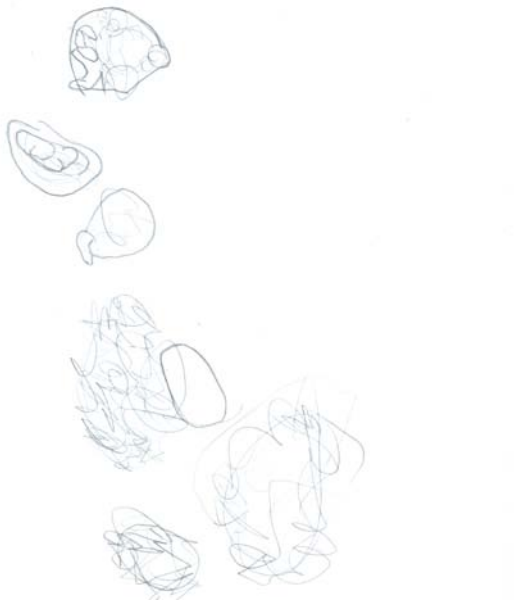

Figure 2. A drawing by a 4 years-old girl which scored level 1 according to grades in Table 1 (awareness of a pattern).

The first two authors examined and scored each drawing independently and very few disagreements occurred and were settled accordingly and results are presented in Table 2. From a total of 50 children aged 3

(25 boys and 25 girls) 40% of the boys and 42% of the girls achieved level 0 (zero) respectively. From a total of 145 children in the age range of 4 (42 boys and 40 girls) to 5 (29 boys and 34 girls) year olds achieved similar scores on the levels 3 and 4. Thus, 28.5% of the boys and 25.0% of the girls, both 4 year olds, and 44.8% of the boys and 61.7 of the girls, both 5 year olds, achieved level 3 respectively.

Figure 3. A drawing by a 3 years-old girl which scored level 2 according to grades in Table 1 (recognizable as a plant).

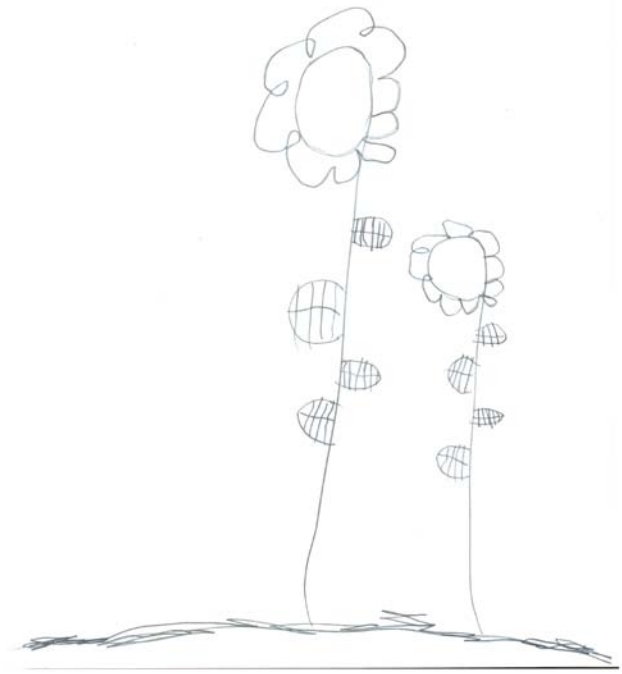

Figure 4. A drawing by a 5 years-old girl which scored level 3 according to grades in Table 1 (depiction of a sun-flower).

From a total 74 children in the age range 7 (21 boys and 10 girls) to 8 (22 boys and 21 girls) year olds. Thus, 71.4 % of boys 7 and 8 year olds and 90.0% of the girls 7 year olds and 66.6% of the girls 8 year olds achieved level 3 in the plant drawing rubric scoring levels respectively (Table 2).

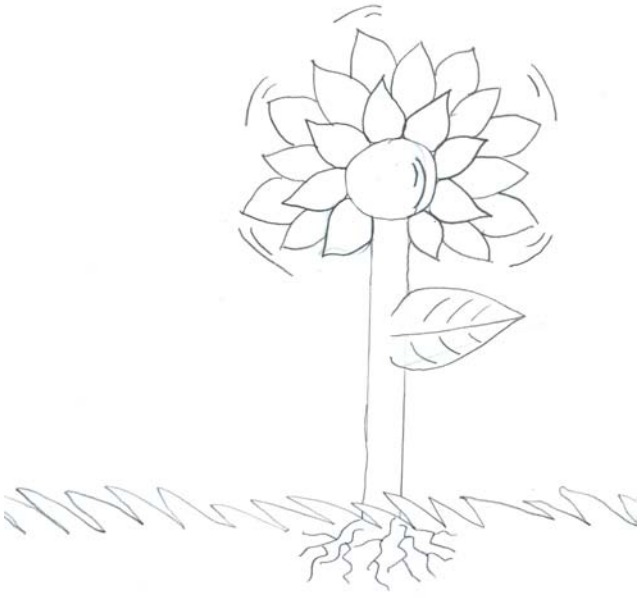

Figure 5. A drawing by a 8 years-old boy which scored level 4 according to grades in Table 1 (a plant).

Figure 6. A drawing by a 8 years-old boy which scored level 4 according to grades in Table 1 (a plant).

The same trend was noticed from a total of 30 children in the age range of 8 (22 boys and 21 girls) years old and 13 children 10 years old (8 boys and 5 girls) relative to levels 3. Very few children from this sample achieved level 5 (9 boys and 13 girls) representing plant botanical characteristics as leaves, flowers fruit stem and roots as described in Table 1.

During the first question in the interview children in the range of 4 to 10-11year olds (especially those 8 to 10 year olds) mentioned fruit more often (e. g. water melon, blackberry, strawberry) than vegetables (e. g. lettuce, onion) or grains (beans, rice) perhaps reflecting the kind of snack or lunch children have in school where they are enrolled which they remember as name of plants they know (Table 3).

Table 3. Number of times plants (vegetables, fruit, grains) were mentioned by children in the interview (pupils in the range of 4 to 10 year olds).

Plants	No. of times mentioned
Lettuce	3
Bean	4
Rice	1
Kale	3
Cucumber	1
Onion	3
Savoy cabbage	1
Parsley	1
Water melon	8
Blackberry	5
Peach	2
Strawberry	5
Coconut	3
Pinepple	1
Avocado	1
Total	42

The same trend was observed as children mentioned trees as the most often named plants, especially by older children, for instance apple-trees, orange-trees, banana and Surinam cherry (Table 4). The same trend as well for flowering plants where rose, (Dicot) sunflower and daisy were mentioned most often but also grass (Monocot) was mentioned (Table 5).

Table 2. Plant drawing rubric grade levels achieved by children by age and gender (M=male, F=female).

Age	M.						F.						Total+ %
Level	0	1	2	3	4	5	0	1	2	3	4	5	
3 year olds	20	3	2	0	0	0	21	2	2	0	0	0	50
4 year olds	6	8	9	12	6	1	7	8	9	15	1	0	82
5 year olds	5	2	6	13	3	0	1	0	3	21	8	1	63
6 year olds	0	0	0	7	1	2	0	0	0	4	6	6	26
7 year olds	0	0	0	15	4	2	0	0	0	9	0	1	31
8 year olds	0	1	0	15	2	4	0	0	0	14	2	5	43
9 year olds	0	0	0	2	1	0	0	0	0	13	1	0	17
10 year olds	0	0	0	8	0	0	0	0	0	3	0	2	13/332

Table 4. Number of times trees were mentioned by children in the interview (pupils in the range of 4 to 10 year olds).

Plants (trees angiosperm and gymnosperm)	No. of times mentioned
Banana	7
Apple	13
Orange	10
Lemon	5
Palm	3
Pine	2
Surinam cherry	8
Eucalyptus	2
Pear	3
Mimosa	2
Papaya	2
Grape shrub	5
Rubber tree	1
Total	63

Table 5. Number of times flowers were mentioned by children in the interview (pupils in the range 4 to 10 year olds).

Plants (flowers)	No. of times mentioned
Rose	18
Dayse	9
Sunflower	10
Grass	16
Orchid	3
Vitoria-regia	2
Mil glass flower	2
Violet	2
Total	62

The second question in the interview asked children where they had noticed those plants mentioned in first question of the interview. Younger children mention more often relative home´s and rely on school and teachers and direct observation (on the way to school), whereas older pupils pointed out media and visit to natural areas as more relevant. Books were seldom mentioned (Table 6).

The third question inquired pupils whether they had seen and remembered the name of plants living near, on the way to school (as many children walk to school or a bus take them up to the entrance of their schools) or in their home back yard. The plants named by children where sorted out into scientific classification. Children were vague in specifying where they had seen the plants mentioned, most just said "around". The most frequently named monocotyledon (a major group of flowering plants) was grass (in all ages) and the most named dicotyledon was rose, Surinam cherry, blackberry tree, and sun flower. The most mentioned gymnosperm was the pine tree (which is the symbol of Paraná State whose seeds are edible, called "pinhão", which may be compared to the Portuguese chestnut as a nutritious food. No bryophytes or vascular seedless plants (pteridophytes) were mentioned although there are many in the local country flora such as "Xaxim" (Dicksonia sellowiana), "Samambaia " (ferns)(Table 7).

The fourth question in the interview asked children from this sample if they were familiar with, or if they knew, any of the 15 plants whose names from a list (spoken) were usually found in the local environment. The selected random items are intended to be representative of distinct areas of vegetation as for instance from the Amazonian rainforest which is made up of thousands of species of plants and animals (data from Rio Branco, Acre). Additionally, included exemplars towards the South of the country (data from Paraná and Saint Catarina States) where pine forests are mostly found and the pine seeds are popular as a winter snacks. Occasionally, small shrubs and trees, grasses and herbs are found in subtropical grasslands or pastures (Oliveira et al., 1986; Sipinski et al., 2010; Gil and Fanizzi, 2011)

The most mentioned plant in the interview was grass and flowers such as rose, daisy and carnation but also cactus. Very young children (4 to 5 year olds) did not know the "daisy" to be a flower but recognized it was a Walt Disney character, a person in the movie. Among fruit trees the most mentioned were banana tree, orange tree, pear tree and a shrub (passion fruit) but also other kind of trees such as pine tree and eucalyptus [exotic to the country] (Table 8).

Table 6. Total number of mentions by pupils (named in 1 min) where they have seen plants.

Type of source/age	4 year olds N=26	5 year olds N=22	6 year olds N=10	8 year olds N=11	9 year olds N=6	10 year olds N=4	Total N=79 and %
Relative homes	0	5	6	5	1	4	21
School/teachers	5	5	0	5	3	1	19
Media (TV, DVD, Internet)	2	6	0	9	1	3	21
Direct observation (home, garden, yard)	1	6	9	20	9	7	52
Visit to natural areas (parks, beach, woods)	1	1	0	3	4	1	10
Book	2	0	1	0	1	0	4
Total	11	23	16	42	19	16	127

Table 7. Names of plants mentioned by pupils (interview) as living near/on the way to school, around/in their home.

Plants/age	4 year olds N=26	5year olds N=22	6 year olds N=10	8 year olds N=11	9 year olds N=6	10 year olds N=4	Total=82
Flower	3	1	0	0	0	0	4
Grass	2	1	0	12	8	9	32
Medlar tree (*Eriobothrya sp.*)	1	0	0	0	0	0	1
Blackberry tree	1	0	0	1	1	0	3
Pine tree	0	0	1	5	0	1	7
Rubber tree	0	0	1	0	0	0	1
Ipe tree (*Tabebuia sp.*)	0	0	0	2	1	0	3
Lemon tree	0	0	0	1	0	0	1
Orange tree	0	0	0	1	1	0	2
Apple tree	0	0	0	1	0	0	1
Banana tree	0	0	0	1	0	0	1
Peach tree	0	0	0	0	1	0	1
Palm tree	0	0	0	0	1	0	1
Dayse	0	0	1	1	0	0	2
Milk glass flower	0	0	0	0	1	0	1
Rose	0	0	0	4	2	1	7
Orchid	0	0	0	0	1	0	1
Sun-flower	0	0	0	2	1	0	3
Carnation	0	0	0	0	1	0	1
Dandelion	0	0	0	0	1	0	1
Surinam cherry	0	0	0	5	0	0	5
Pine-apple	0	0	0	0	1	0	1
Spinach	0	0	0	1	0	0	1
Parsley	0	0	0	1	0	0	1
Total	7	2	3	38	21	11	82/82

Table 8. Total number of mentions by pupils (interview) from a read list of plants to access their mental models of the item.

List of plants/age	4 year olds N=26	5 year olds N=22	6 year olds N=10	8 year olds N=11	9 year olds N=6	10 year olds N=4	Total= 79 and %
Rose	17	11	8	10	5	3	53
Carnation	1	2	3	6	5	3	20
Daisy	10	9	4	9	5	3	40
Dandelion	0	0	3	4	2	0	9
Violet	2	3	0	9	3	2	19
Fern/bracken	2	2	0	2	2	1	9
Grass	20	17	6	11	5	4	63
Cactus	7	7	2	5	2	2	25
Banana tree	10	13	6	12	3	4	48
Passion fruit	5	7	5	10	2	4	33
Orange tree	9	12	4	11	6	4	46
Pear tree	8	7	1	8	1	4	29
Eucalyptus	9	3	0	4	3	3	22
Pine tree	10	11	6	10	5	4	46
Oliver tree	2	2	0	0	0	0	4
Total	94	105	48	111	49	41	466

Table 9. Type of source and number of mentions by pupils (interview) in response for a read list of plants (Table 8).

Type of source/no. of mentions	4 year olds N=26	5 year olds N=22	6 year olds N=10	8 year olds N= 11	9 year olds N=6	10 year olds N=4	Total=79 and %
Direct observation	93	22	72	80	59	21	404
Media (TV/DVD/films)	3	0	9	1	2	0	15
Books	4	3	2	0	0	0	9
School teachers	2	1	0	7	1	1	12
Botanical garden	1	0	0	7	1	0	9
Relatives	0	0	0	0	3	16	19
Total	103	83	83	95	66	38	468

The last question in the interview asked children from where they had seen the plants listed in question four, as for instance from books, TV, real life. The most mentioned source was direct observation mainly from children 4 to 6 year olds, followed by the influence of relatives, TV, DVD, films and school teachers but very few from books and Botanical Garden (Table 9).

Discussion and Conclusions

We hypothesize that the findings suggest that there are similarities as well as differences in children´s ideas on the concept of plant according to their age-range and cognitive development. However, this exploratory study has limitations. The numbers of pupils in the age-range is limited, especially those of 3 years of age. Just a few country areas were sampled. Further studies should have to cover other areas of Brazil and explore the diversity of the flora known by children.

These differences may be culturally influenced, for example, the role of Botanical Gardens, arboreta, field trips and the existence of orchards and gardens in their school backyard, at home or, where they live in urban or suburban towns or in the rural area (Sipinski and Hoffmann, 2010). Children´s learning is socially and culturally constructed and influenced by home, school and community where they live (Anning et al., 2004). It seems that school snacks and lunches which are integrated into other aspects of the food system, as for example, schools which are supposed to buy the seasonal produce from local farms like water melons and strawberries mentioned by children in the interviews may influence the plants they knew (Table 3) which is in contrast to other nutritional survey in Brazil such as mentioned by Kuntz et al., (2012). If this healthy trend expanded to other schools countrywide it should be an important measure against children obesity (Duffey et al., 2013). Most of the Brazilian nurseries and preschools provide services all day long whereas primary schools offer morning or afternoon period of studies.

On the other hand, drawings can help children make their scientific ideas visible to teachers, who may provide remedial work to correct faulty knowledge about biological concepts and scientific thinking, contributing to avoiding non scientific concepts in elementary botanical studies (Bartoszeck and Tunnicliffe, 2013). Besides, drawing is a natural way to help pupils build up or improve their mental models of basic biological concepts as well as a "mind-on" and "hands-on" classroom activity which do not need any equipment or reagents, except pencil and paper (Richardson 1998).

Although some findings we anticipate may suggest that children of different ages could be considered as a homogeneous group and taught about plants accordingly, it is necessary if we are to personalize learning in different school grades to maximize children´s potential, be aware of various socio-cultural influences affecting their ideas Lindmann-Matthies, 2006). In spite of these collected drawings (express models) are simple mental representations which children consider to be a plant these mental models may have the potential to evolve into a more complex description as soon as children grasp a better understanding of organisms in the environment.

Educational implications

Classrooms are regarded as appropriate place for kindergarten children and the first years of primary school to have formal learning of plants but the outside must also be explored for first hand observations for informal learning to occur. Research from neuroscience, psychology, and education argue positively that what happens in the early years is critical to their lifelong learning (Ward, 2007). This study has shown that direct observation was the main means from which children learn about plants. Either they have seen plants outside or have been shown specimens from relatives or teachers at school. Thus, early years children parents could be given usefully (in terms of their child´s science education background) leaflets, workshops and encouraged to cultivate vegetables, flowers, herbaceous plants and trees in their backyards with the full participation of children in this outdoor activity.

This investigation has also shown that even very young children (3 year olds) are able to represent their ideas of what is a plant by means of scribbles which are rudimentary concepts of objects found in the ecosystem but progressively will take a more concrete form (Krampen, 1991, Chang, 2012). Therefore, to reinforce their existing knowledge for everyday activities and develop their observation to at least 9 plants, schools and head teachers should take full advantage of this natural gift children already have and organize facilities whereby children may grow vegetables, fruit and flowers, care and observe when they were growing, harvest them and use in the dishes serve in school snacks and lunch or offer at Harvest Festival. Whenever possible, propose oriented visits to the Botanical Garden, Parks, taken by safe transportation and offering an opportunity for a lively interaction with a variety of plants of all sizes, shapes and particularly those used as spices, teas and pharmacological uses as an entrance to fundamental botanical learning (Oliveira and Akissue, 1989; Crepaldi et al., 2009).

Early years and primary education in Brazil could focus more on scientific aspects of living world, at least in the basic skills of observation and classification of organisms, such as are proposed by local state and municipality science curriculum under the prescription "nature and society". As young children have special interest in animals, it is suggested that teachers, when teaching elementary biological concepts, could use examples from animal kingdom for instance, insects emphasizing the interaction between animals and plants to highlight the importance of the

plant world. Plants names, adaptation to habitats, for example if plants develop better on shady places or outdoor conditions could be an appropriate starting point to develop children´s inherent interest in plants and provide an occasion for meaningful learning. We seek to bring to the attention of educators the ability of young children to learn about plant biodiversity and encourage educators to pay greater attention to this vital aspect of science learning (Lindmann-Matthies, 2002; Stgar, 2007).

Acknowledgements

The authors acknowledge comments and suggestions by Dr. Elizabeth Schwarz, Department of Botany, University of Paraná, Brazil.

References

Anggoro, F. K., Waxman, S. R., and Medin, D. L. (2008). Naming practices and the acquisition of key biological concepts. Evidence from English and Indonesian. *Psychological Science*, 19(4): 314-319.

Anning, A., Ring, K. (2004). *Making sense of children´s drawings*. Maidenhead: Open University Press.

Anning, A., Cullen, J., and Fleer, M. (2004). *Early childhood education: society and culture. London: Sage.*

Ashbrook, P. (2008). First explorations in flower anatomy. *Science and Children*, 45(8):18-19.

Azul, A. M., Reis, C. S., and Pimenta, M. C. (2007). *Da semente ao fruto: à descoberta do mundo das plantas*. Ciência Viva: Ministério da Ciência, Tecnologia e Ensino Superior, Coimbra, Portugal. (From seed to fruit: discovery of the world of plants).

Bang, M., Medin, D., and Atran, S. (2007). Cultural mosaics and mental models of nature. *Proceedings of the National Academy of Sciences*, 1004(35): 13868-13874.

Barman, C. R., Stein, M., Barman, N. S., and McNair, S. (2002). Assessing students´ ideas about plants. *Science & Children*, 10(1): 25-29.

Barman, C. R., Stein, M., McNair, S., and Barman, N. S. (2006). Students´ ideas about plants & plant growth. *The American Biology Teacher*, 68(2):73-79.

Barraza, L. (2001). Environmental education in Mexican schools: the primary level. *Journal of Environmental Education*, 32(3): 31-36.

Barrett, M. D., Light, P. H. (1976). Symbolism and intellectual realism in children´s drawings. *British Journal of Educational Psychology*, 46:198-202.

Bartoszeck, A. B., Silva, I. G. Da, and Tunnicliffe, S. D. (2011). Brazilian children´s concept of bird: an exploratory study. Poster presented at the 9th Conference of the European Science Education Research Association (ESERA), Lyon, France, September 5th-9th.

Bartoszeck, A. B., Tunnicliffe, S. D. (2013). What do early years children think is inside a tree. *Journal of Emergent Science*, Winter, 21-25.

Bebbington, A. (2005). The ability of A-level students to name plants. *Journal of Biological Education*, 39:63-67.

Bell, B. (1981). What is a plant? Some children´s ideas. *New Zealand Science Teacher*, 31(3):10-14.

Bianchi, L. (2000). So what do you think a plant is? *Primary Science Review*, 61:15-17.

Blanquet, E. (2010). *Sciences à l´école, Côte jardin-le guide practique de l´enseignant*. Nice : Éditions du Somnium. (Science at school, a practical guide in the kindergarten).

Boulter, C., Tunnicliffe, S. D., Reiss, and M. J., Selles, S. (2004). *The social relevance of pupils´responses to cues from the natural world.* Proceedings from the Commonwealth Association for Science, Technology and Mathematics Educators Conference, Cyprus, April 15th -18th .

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

Braund, M. (1991). Children´s ideas in classifying animals. *Journal of Biological Education*, 25(2):103-110.

Brooks, M. (2009). Drawing, visualization and young children´s exploration of "Big Ideas" *International Journal of Science Education*, 31(3):319-341.

Carneiro, S. M. M. (2001). A dimensão ambiental da educação escolar: enfoques de uma pesquisa diagnóstica no âmbito das séries iniciais de ensino. *Teias*, 2(4):1-12. (The environmental dimension in primary education).

Carrier, S. J. (2007). Gender differences in attitudes toward environmental science. *School Science and Mathematics.* 107(7):271-279.

Carvalho, S. P., Klisys, A., and Augusto, S. [eds.] (2006). *Bem-vindo, mundo!* Criança, cultura e formação de educadores. São Paulo: Editora Peirópolis. (Welcome world! Children, culture and training educators).

Chang, N. (2012). The role of drawing in young children´s construction of science concepts. *Early Childhood Education Journal*, 40:187-193.

Chen, S-H. , Ku, C-H. (1999). Aboriginal children´s conceptions and alternative conceptions of plants. *Proc. Natl. Sci. Coun. ROD*, 9(1).10-19.

Cherubini, M., Gash, H., and McCloughlin, T. (2008). The digital seed: an interactive toy for investigating plants. *Journal of Biological Education*, 42(3):123-129.

Christidou, V., Hatzinikita, V. (2005). Preschool children´s explanations of plant growth and rain formation: a comparative analysis. *Research in Science Education,* 36(3):187-210.

Colinvaux, D. (2004). Ciências e crianças: delineando caminhos de iniciação às ciências para crianças pequenas. *Contrapontos*, 4(1):105-123. (Science and children: an outline for introducing small children to science).

Cox, M. (2005). *The pictorial world of the child*. Cambridge: Cambridge University Press.

Crepaldi, T., Filho, A. L. M., Silva, R., Silva, D., Teixeira, G., and Junior, B. L. (2011). O encontro da ciência e da tradição no Brasil: as plantas medicinais e as rezadeiras. *Captar: ciência e ambiente para todos.* 3(2):69-79. (A meeting of science and tradition in Brazil: medical plants and lady prayers).

Dougherty, J. W. D. (1979). Learning names for plants and plants for names. *Anthropological Linguistics*, 21:289-315.

Driver, R. (1989). Student´s conceptions and the learning of science. International *Journal of Science Education*, 11:481-490.

Duffey, K. J., Pereira, R. A., Popkin, B. M. (2013). Prevalence and energy intake from snaking in Brazil: analysis of the first nationwide individual survey. *European Journal of Clinical Nutrition*, 67(8): 868-874.

Eshach, H. (2006). *Science literacy in primary and pre-school*. Springer: The Netherlands.

Fischer, K. W., Rose, S. P. (1998). Grow cycles of brain and mind. *Educational Leadership*, 56(3): 56-60.

Gatt, S., Tunnicliffe, S. D., Borg, K., and Lautier, K. (2007). Young Maltese children´s ideas about plants. *Journal of Biological Education*, 41(3):117-121.

Gentner, D., Stevens, A. L. (1983). *Mental models*. Hillsdale: Lawrence Erlbaum Associates.

Gil, A., Fanizzi, S. (2011). *Porta aberta: ciências, 5º. Ano*. São Paulo: Editora FTD .(Open door: sciences, 5th grade)

Gilbert, J. K., Boulter, C. J. (1998). Learning science through models and modelling. In: B. J. Fraser and K. G. Tobin (eds.) *International Handbook of Science Education*, Dordrecht: Kluwer Academic Publishers, 53-66.

Greene, H. (2005). Organisms in nature as a central focus for biology. *Trends in Ecology and Evolution*, 20(1):23-27.

Guimarães, F., Santos, F. S. dos (2011). A Botânica escolar nos ensinos primário e básico (1º. ciclo) no último século em Portugal; análise de manuais escolares de ciências da natureza. *Revista de Educação*, 18(1):83-111(School Botany in primary school in Portugal: textbook analysis concerning natural world).

Harvey, M. (1989). Children´s experiences with vegetation. *Children´s Environmental Quarterly*, 6(1):36-43.

Hopperstad, M. H. (2010). Study meaning in children´s drawings. *Journal of Early Childhood Literacy*, 10(4):430-452.

Hatano, G. (1993). The development of biological knowledge: a multi-national study. *Cognitive Development*, 8(1): 47-62.

Inagaki, K., Hatano, G. (2006). Young children´s conception of the biological world. *Current Directions in Psychology Science*, 15(4): 177-181.

Johnson-Laird, P. N. (1993). *Mental models: toward a cognitive science of language inference and consciousness*. Cambridge: Harvard University Press.

Johnston, J. (2005). *Early explorations in science*. Maidenhead: Open University Press.

Keil, F. C. (2003). That´s life: coming to understand biology. *Human Development*, 46: 369-377.

Kinoshita, L. S., Torres, R. B., Tamashiro, J. Y., and Formi-Martins, E. R. (2006). *A Botânica no ensino básico: relatos de uma experiência transformadora*. São Carlos: Rima Editora. (Botany in primary school: report of a successful experience).

Klein, E.S., Pinheiro, M. A., and Silveira, V. (2001). Construindo o conhecimento de Botânica: uma experiência interdisciplinar em Campinas. *Ciência e*

Ensino, 10:9-13 (Building up botanical knowledge: an integrated experience).

Knight, S. (2009). *Forest schools and outdoor learning in the early years*. London: Sage Publications.

Kramer, S. (1994). *Com a pré-escola nas mãos: uma alternativa curricular para a educação infantil*. São Paulo: Ática Editora (Dealing with preschool: an alternative curriculum for the kindergarten).

Kramer, S. (2006). As crianças de 0 a 6 anos nas políticas educacionais no Brasil: educação infantil e/é fundamental. *Educação e Sociedade*, 27(96):797-818. (Children aged 0 to 6 years old and the educational policy in Brazil: kindergarten and primary school must be compulsory).

Krampen, M. (1991). *Children´s drawings: iconic coding of the environment.* New York: Plenum Press.

Kuhn, D. (1989). Children and adults as intuitive scientists. *Psychological Review,* 96:674-689.

Kuntz, M. G. F., Fiates, G. M. R., and Teixeira, E. (2012). Healthy and tasty school snacks: suggestions from Brazilian children consumers. *International Journal of Consumer Studies,* 36(1):38-43.

Libarkin, J. C., Beilfuss, M., and Kurdziel, J. P. (2003). Research methodologies in science education: mental models and cognition in education. *Journal of Geoscience Education*, 51(1):121-126.

Lindmann-Matthies, P. (2002). The influence of an educational program on children´s perception of biodiversity. *Journal of Environmental Education*, 33: 22-31.

Lindemann-Matthies, P. (2005). "Loveable" mammals and "lifeless" plants: How children´s interest in common local organisms can be enhanced through observation of nature. *International Journal of Science Education*, 37(6):655-677.

Lindemann-Matthies, P. (2006). Investigating nature on the way to school: responses to an educational program by teachers and their pupils. *International Journal of Science Education*, 28: 895-918.

Lorenzi, H., Sartori, S., Bacher, L. B., and Lacerda, M. (2006). *Frutas brasileiras e exóticas cultivadas*. São Paulo: Instituto Plantarum de Estudos da Flora. (Brazilian fruit and exotics plants).

Lorenzi, H., and Souza, H. M. (2001). *Plantas ornamentais no Brasil: arbustivas, herbáceas e trapadeiras*. Nova Odessa: Instituto Plantarum. (Ornamental plants from Brazil).

Louv, R. (2007). *Last child in the woods. Saving our children from nature –deficit disorder*. Chapel Hill: Algonquin Books.

Luquet, G-H., (1927/1979). *Le dessin enfantin*. Neuchatel: Editions Delechaux & Niestlè. Porto: Livraria Civilização Editora. (Children´s drawings, o desenho infantil).

Martínez-Lousada, C., García-Barros, S., Garrido, M. (2014). How children characterise living beings and the activities in which they engage. *Journal of Biological Education*, 48(4): 201-210.

Martinho, L. R., Talamoni, J. L. B. (2007). Representações sobre meio ambiente de alunos de quarta série do ensino fundamental. *Ciência e Educação*, 1(13): 1-13. (Environment representations by 4th grade primary school pupils).

Mauseth, J. (2009). *Botany-An introduction to plant biology*. Canada: Jones and Bartlett.

Moen,T. (2006). Reflections on the narrative research approach. International *Journal of Qualitative Methods*, 5(4): 1-11. Available: http://www.ualberta.ca/~iiqm/backissues/5_4/pdef/moen.pdf.

Moraes, R. (1995). *Ciências para as séries iniciais e alfabetização*. Porto Alegre: Sagra-DC Luzzato (Science at the first grades of primary school and literacy).

Oliveira, D. L. de (2002) [ed.] *Ciências nas salas de aula*. Porto Alegre: Ed. Mediação. (Science teaching in the classroom).

Oliveira, F. de, Akissue, G. (1989). *Fundamentos de Farmabotânica*. São Paulo: Livraria Atheneu Editora. (Principles of Pharmacobotany).

Oliveira, R. F. de, Antunes, I. T., and Alcantara, J., (1986). *Atlas Escolar de Botânica*. Rio de Janeiro: Fundação de Assistência ao Estudante (School Atlas of Botany).

Patrick, P., and Tunnicliffe, S. D. (2011) What plants and animal do early childhood and primary student´s name? Where do they see them? *Journal of Science Education and Technology,* 20:630-642.

Rapp, D. N. (2007). *Mental models: theoretical issues for visualization in science education*. In: J. K. Gilbert (Ed.), Visualization in Science Education (pp. 43-60), Dordrecht: Springer.

Richardson, K. (1998). *Models of cognitive development*. Hove: Psychology Press.

Rowlands, M. (2001). The development of children´s biological understanding. *Journal of Biological Education*, 35(2):66-68.

Rymell, R. (1999). What defines a plant? *Primary Science Review*, 57:23-25.

Schussler, E. E., Olzak, L. (2008). It´s not easy being green: students recall of plant and animals images. Journal of Biological Education, 42:112-119.

Schwarz, M. L., Sevegnani, L., André, P. (2007). Representações da mata atlântica e de sua biodiversidade por meio de desenhos infantis. *Ciência & Educação*, 13 (3): 369-388, (Representation of the Atlantic Rainforest and its biodiversity through children´s drawings).

Sipinski, E. A. B., Hoffmann, P. M. [Eds.] (2010) *Cultura e biodiversidade nos jardins de Curitiba*. Curitiba: Sociedade de Pesquisa em Vida Selvagem e Educação Ambiental. (Culture and biodiversity at the parks in Curitiba).

Solomon, J. (1987). Social influences on the construction of pupils understanding of science. *Student Science Education*, 14: 63-82.

Strgar, J. (2007). Increasing the interest of students in plants. *Journal of Biological Education,* 42(1): 19-23.

Stavy, R., Wax, N. (1989). Children´s conceptions of plants as living things. *Human Development*, 32:88-94.

Sumida, M. (2013). The Japanese view of nature and its implications for the teaching of science in the early childhood years. In: Georgeson, J., Payler, J. [Edts.] *International perspectives in early childhood education and care*. Maidenhead: Open University Press, pp. 243-256.

Symington, D., Boundy, K., Radford, T., and Walton, J. (1981). Children´s drawings of natural phenomena. *Research in Science Education*, 11:44-51.

Tamer, P., Gal-Chappin, R., and Nussnovitz, R. (1991). How do intermediate and junior high school students conceptualize living and non-living? *Journal of Research in Science Teaching*, 18(3): 241-248.

Tiberghein, A. (1994). Modeling as a basis for analyzing teaching-learning situations. *Learning and Instructions*, 4:71-87.

Toomer, S. (2013). Seeing the wood for the trees. *The Biologist*, 60(3): 12-15.

Tull, D. (1994). Elementary students´ responses to questions about plant identification: responses strategies in children. *Science Education*, 78:323-343.

Tunnicliffe, S. D. (2001) a. Out of the mouths of babes: what children say about plants as exhibits. *Public Garden*, 1-3, (Autumn).

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

Tunnicliffe, S. D. (2013). *Talking and doing science: a practical guide for ages 2-7.* London: Routledge.

Tunnicliffe, S. D., Gatt, S., Agius, C., Pizzato, S. A. (2008). Animals in the lives of young Maltese children. *Eurasia Journal of Mathematics, Science and Technology Education*, 4(3): 215-221.

Tunnicliffe, S. D., and Reiss, M. J. (1999). Building a model of the environment: how do children see animals. *Journal of Biological Education*, 33(4): 142-148.

Tunnicliffe, S. D., and Reiss, M. J. (2000). Building a model of the environment: how do children see plants? *Journal of Biological Education*, 34(4): 172-177.

Vella, Y., and Gatt, S. [Eds] (2003).*Constructivist teaching in primary school*. Luqa, Malta: Editorial Agenda.

Villarroel, J. D., Infante, G. (2013). Early understanding of the concept of living things: an examination of young children´s drawings regarding plant life. *Journal of Biological Education*, *48*(3): 119-126.

Wandersee, J. H., and Schussler, E. E. (2001). Toward a theory of plant blindness. *Plant Science Bulletin*, 47(1):2-9.

Ward, H. (2007). Using brains in science: ideas for children ages 5 to 14. London: Paul Chapman.

Wood-Robison, C. (1991). Young people´s ideas about plants. *Studies in Science Education*, 19:119-135.

Yang, H-Chin., and Noel, A. M. (2006). The developmental characteristics of four- and five-year-old preschoolers´ drawing: an analysis of scribbles, placement patterns, emergent writing, and name writing in archived spontaneous drawing samples. *Journal of Early Childhood Literacy*, 6(2): 145-162.