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Exploration and development of early childhood ecological education

Anne Marie Wells

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Dissertação apresentada à Universidade de Coimbra para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Ecologia, realizada sob a orientação científica do Professor Doutor José Paulo Sousa (Universidade de Coimbra) e da Professora Doutora Anabela Marisa Azul

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Glossary

Activity	An organized task or project
Attitude	"What a person believes, understands, and feels about something, as well as the person's behavior towards it"(Rogers, 2003 p. 177).
Collaborative action research	A process where teachers reflect on their education approach and/or collectively research the solution to an issue, and develop a plan to implement better practices (Sagor, 1992).
Culture	"An identity which everyone has based on a number of factors from memories, ethnic identity, family attitudes to child rearing, class, money, religious or other celebrations, or division of family roles according to gender or age. Culture evolves for individuals and communities" (French, 2007 p. 4)
Ecological education	A subcategory of environmental education. Teaching efforts that focus on ecological concepts such as a plant or animal species or a community of plants or animals.
Early childhood	Period of human development which extends from birth to eight years.
Emergent curriculum	"Curriculum that arises from children's interests and adults' understanding of children's needs" (French, 2007 p. 4)
Environmental education	Teaching efforts that focus on all concepts related to nature and the environment including, but not limited to, sustainability, pollution, and waste management.
Family	Any relation, biological or not, reflect the primary individuals with whom a child lives regularly.
Formative assessment	Analysis of progress taken during instruction with the goal of determining a means to better teaching and increase learning (Hunt & Pellegrino, 2002).
Parent	Any relation, biological or not, reflected the primary caregiver of a child.
Program	An organized group of activities.

Summative assessment	Analysis of whether or not the student met the learning goals of a project, lesson, or activity (Bloom et al. 1971)
Traditional education	Teacher-directed, teaching strategies that stress the acquisition of skills, short-term student performance and evaluation, comparison between children, and teacher-controlled instruction (Stipek, 1991).
Triangulation	An assessment technique that takes into account multiple points of view to better understand the results (Stake, 2000)

Abstract

Environmental education that promotes knowledge about and connection to nature and the environment is essential to fostering ecological awareness and sustainability for the future human well-being. Ecological concepts that focus on a single species or community of species are easy for children to see, understand, and interact with regularly. This thesis attempts to explore and develop ecological education efforts in early childhood (children 2- to 6-years-old) at the Jardim de Infância dos Serviços de Ação Social da Universidade de Coimbra. To achieve these goals, collaborative action research between Ecology and/or Education specialists was implemented focusing on an Ecological Education (EcoEd) approach for young children. The collaborative action research involved semi-structured interviews and frequent meetings which resulted in a conceptual framework based on four principal elements: discovery, play, expression, and connection. The conceptual framework was then explored through a constructivist project on “Why am I a bird?”, totaling seven activities at the kindergarten and three at-home activities, which focused on diversity, life cycle, and conservation of birds. Children explored the project “Why am I a bird?”, by playing a participative, image sorting game with different animals; constructing a story on birds; constructing, decorating, and creating a bird house community at the Jardim Botânico da Universidade de Coimbra; playing treasure hunting games to explore bird diversity and life cycle; experiencing chicken eggs incubating and hatching; listening to bird sounds; introducing pollution issues using an experiment with bird feathers; and an extension of the project to family. The effectiveness of the Ecological Education approach was tested with formative assessments during and after activities as well as multiple methods of summative assessment including before-and-after

questionnaires, children's drawings, and structured, group discussions. Findings indicate children's knowledge and attitudes scores regarding birds increased significantly. Children's drawings of birds revealed an increase in knowledge regarding physical attributes, habitats, diversity, names, and/or contexts of life cycle. Structured, group discussions showed a shift in topics discussed from basic physical attributes to more statements on habitat and animal behavior. Children discussed the wild birds living in their communities and their behaviors and other birds from around the globe. Educators reported the children's interests continued to introduce topics from the "Why am I a bird?" project.

This study demonstrates that ecological efforts focusing on simple ecological concepts, such as a single bird species, or community of birds, and/or other plants or animals, stimulated children to interact constructively. The conceptual framework and the ecological education approach in a perspective of knowledge construction and development of ecological awareness and attitudes from early childhood are discussed.

Keywords: Early childhood Ecological Education; collaborative action research; formative and summative assessment; ornithology.

Resumo

Uma Educação Ambiental que promove integração de conhecimento e ligação com a natureza e o meio ambiente é essencial numa perspetiva de consciencialização ecológica, sustentabilidade e bem-estar para o futuro. Os conceitos ecológicos que incidem numa única espécie, ou comunidade de espécies, facilitam a visualização, interação e o entendimento por parte das crianças. Nesta tese procura-se explorar e desenvolver uma abordagem para Educação em Ecologia na primeira infância (crianças de 2 a 6 anos de idade) ao Jardim de Infância dos Serviços de Ação Social da Universidade de Coimbra. Para tal, foram desenvolvidas metodologias colaborativas de investigação-ação nos domínios da Ecologia e/ou Educação, que envolveram entrevistas semi-estruturadas e construtivismo em grupos de discussão; dela resultou uma estrutura-conceito tendo por base quatro elementos principais: a descoberta, o jogo, a expressão e a ligação. A estrutura-conceito foi então explorada através de um projeto construtivista: "Porque sou uma ave?" totalizando sete atividades no jardim de infância e três atividades realizadas em casa, com o foco na diversidade, o ciclo de vida e a conservação das aves.

As crianças exploraram o projeto "Porque sou uma ave?" através de um jogo participativo com imagens de animais diferentes; a construção de uma história sobre as aves; a construção, decoração e criação de um bairro para pássaros no Jardim Botânico da Universidade de Coimbra; acompanhamento de período de incubação e eclosão de ovos de galinha; sons de pássaros; introdução de contextos sobre poluição através de experiência com penas de aves; extensão do projeto à família. A eficácia da abordagem Educação em Ecologia na primeira infância envolveu métodos de avaliação formativa durante e após as atividades, e métodos de avaliação sumativa, antes e depois de questionários,

desenhos das crianças e discussões estruturadas em grupo. Os resultados dos inquéritos e desenhos revelaram um aumento significativo no conhecimento das crianças sobre as “aves”, bem como mudanças nas suas atitudes. Concretamente os desenhos das crianças permitiram evidenciar o conhecimento sobre os atributos físicos e suas diversidades, habitats, nomes específicos e/ou outros contextos do ciclo de vida e conservação. As discussões estruturadas em grupo revelaram uma mudança no tópicos discutidos, de atributos físicos para habitat e comportamento animal. Também das discussões estruturadas, as crianças construíram um relatório sobre as aves que vivem em suas comunidades e os seus comportamentos, bem como outras aves de todo o mundo. Os educadores de infância documentaram a continuação do projeto por iniciativa das crianças. Este estudo permitiu demonstrar que a abordagem Educação em Ecologia na primeira infância, a partir do projeto "Porque sou uma ave?", e o foco em conceitos simples de Ecologia,como uma espécie de uma ave ou comunidades de aves e/ou outras plantas e animais, contribui para estimular a descoberta, o jogo, a expressão e a ligação entre crianças, comunidade educativa e famílias. Este estudo permitiu concluir, também, sobre a importância de integrar métodos de avaliação formativa e sumativa quando se pretende determinar e eficácia de uma abordagem de Educação em Ecologia na primeira infância.

Palavras-chave: Educação em Ecologia na primeira infância; metodologias colaborativas de investigação-ação; avaliação formativa e sumativa; ornitologia.

Chapter 1: Introduction

Introduction

Ecological awareness may depend on the socio-cultural experiences and education of any individual person (Schleicher, 1989; Orr, 1990), which is why ecological issues can stem from social systems that do not value nature and the environment (Orr, 2004). Ameliorating these ecological issues may be reliant on the interdisciplinary aspect of combining empirical sciences with social sciences (Schleicher, 1989; Orr, 2004). Educational efforts in this field can be a method of raising ecological awareness and concern within society and the culture, and may be the essential component to solving complex environmental issues (Schleicher, 1989; Jacobson et al., 2006; Marale, 2012).

Research suggests that despite the need for higher levels of ecological awareness and stewardship, overall environmental education efforts have declined (Evans et al., 2006) and pre-service teachers are not prepared sufficiently to provide effective education related to nature and the environment (Miles & Harrison, 2006).

This research involves: i) determining the important elements to promote education regarding nature and the environment in early childhood; ii) Exploring, developing and assessing the strategy developed from the determined elements with children, educators, and researchers, and iii) Developing a framework based on a collaborative action research (Sagor, 1992) effort to promote ecological awareness in early childhood. The study will test, therefore the following hypotheses:

1. Participating in ecologically-focused, hands-on, educational activities will improve children's ecological understanding; and
2. Participating in ecologically-focused, hands-on educational activities will improve children's ecological attitudes.

1.1 Ecological education: Why is this of current interest?

> *"(...) [E]ducation should be the most significant priority in future conservation strategies and action plans*"
>
> (Marale, 2012 p. 878)

> *"(…)[O]ur societies urgently require new kinds of education that can help prevent further degradation of our planet, and that foster caring and responsible citizens genuinely concerned with and capable of contributing to a just and peaceful world."*
>
> (Samuelsson & Kaga, 2008 p. 9)

Schleicher (1989) argued the need of thoughtful changes in attitudes about environmental issues to reflect deep values for nature conservation and sustainability and which revolve around ecological ethics. Two decades later, The Green Wave Programme (GWP) (2009) revealed that children's ecological knowledge and attitudes and reverence are declining (GWP, 2009).

Effective education is a critical component of conservation as well as any environmental effort (Jacobson et al., 2006; Wells & Lekies, 2006; Marale 2012). In fact, Jacobson et al. (2006) stated that eco-focused education efforts toward children are an essential strategy to ensuring the healthy future of the planet. Hacking & Barratt (2007) identified eco-focused engagement and education in early childhood as critical for developing pro-environmental attitudes and behaviors, but also are important for fostering psychosocial qualities to strengthen environmental and nature stewardship (Orr, 2004).

Marale (2012) wrote of education as "the most significant priority in future conservation strategies and action plans" (p. 878). Jenkins (2003) underlined the need of interdisciplinary approaches combining science and culture to achieve successful education efforts regarding the environment. Katz (1997) argued though that the responsibility is on educators to effectively reach and

engage with each student, which may require novel strategies to evaluating the education approaches that focus on environmental issues.

Yet, the effectiveness of ecological engagement and education efforts is not linearly correlated with children's exposure to eco-focused education programs or knowledge regarding environmental and ecological concepts and processes (Hungerford & Volk, 1990, Müller et al., 2009, Wells & Lekies, 2006). Wells & Lekies (2006) suggested that the lack of efficacy might be due to traditional teaching strategies.

"Formal" or "traditional" (Orr, 1990; Gadotti 1994), subject-centered school systems and teaching strategies (Annex I.VI), were described by Orr (1990) as a "monologue" on the part of the educator where the pupils and their interests are not taken into consideration (p.50). According to the pedagogical philosophies of Brazilian educator, Paulo Freire (Chapter 1.2.2), "traditional" or "formal" education is based on the educator's authority and the pupils' ability to listen and regurgitate information (Gadotti 1994). Children do not discover knowledge, but rather are only given information by the teacher. He referred to this teaching method as the "Banking Model," where children are empty minds being filled with information that they are expected to be able to regurgitate (Chapter 1.2.2). Freire's "Banking Model" could be compared to Harvey & Daniels' (2009) description of the "coverage approach;" teachers are seen as the expert and presenter, students rely solely on the verbal source of the teacher and possibly a textbook, topics are assigned to memorize isolated facts, while students work solitarily through memorization and receive information by quietly listening, being motivated by extrinsic motivation (such as grades or

punitive measures), forgetting everything after assessment and moving onto the next subject.

Stipek (1991) described traditional education as teacher-directed approaches that stress the acquisition of skills, short-term student performance and evaluation, comparison between children, and teacher-controlled instruction. Stipek also insists that these techniques that are claimed to spark initiative or motivation in struggling children actually result in low self-confidence, an unwillingness to participate, and lower motivation to accept more challenging tasks or to advance their skills (Stipek, 1991).

Samuelsson & Kaga (2008) encouraged stepping away from traditional teaching styles because they do not provide the best results in learning about themes that are interdisciplinary. Eco-focused education programs that reflect traditional styles of teaching tend to concentrate on facts more than the development of positive attitudes toward and experiences in nature (Schleicher, 1989) via more interactive, non-formal methods of teaching, and are less likely to have an influence that endures long-term (Wells & Lekies, 2006). Indeed, many education specialists agree that the educational techniques to which teachers and children are accustomed are outdated and no longer effective, and there needs to be a shift in the educational paradigm (Hattie, 2009; Mitra, 2013; Annex I.VI).

Grün (2005) stated that the most prominent reason for not developing an eco-based education program that is actually effective is the characteristics of traditional education that create a separation, a “chasm,” between nature and society. Orr (2004) argues that all forms of education teach about the environment, but that children are either taught they are “part or apart” from

nature. Contrastingly, Kim & Lim (2007) recommended that nature programs in preschool emphasize balance and harmony between humans and their environment.

Despite the growing opposition to traditional teaching techniques, however, studies have shown that some educational approaches for children are becoming stricter, where teachers are spending more time directing lessons and tests, and children are spending less time exploring and investigating or learning through hands-on activities (Marcon, 1999; Hyson, 2003; McMurrer, 2007).

Many studies exist on what particular experiences or educational elements are effective and will best predict pro-environmental attitudes and behaviors during life (Tilbury, 1994; Wilson 1994; Ewert et al., 2005, Wells & Lekies, 2006; Hacking & Barratt, 2007; Müller et al., 2009; Chen-Hsuan & Monroe, 2012), but the results vary. Direct outdoor experiences, wild natural experiences, generally positive experiences outdoors, engagement in environmental learning, deep emotional connections to nature, hands-on experiences in nature, and environmentalist role models, are among the elements listed as either influential for developing a connection to nature, developing pro-environmental behaviors, or both (Ewert et al., 2005; Wells & Lekies, 2006; Hacking & Barratt, 2007; Müller et al., 2009; Randler, 2009; Marcum-Dietrich et al., 2011; Nature Conservancy, 2011; Chen-Hsuan & Monroe, 2012). The common denominator, however, is shaping attitudes, behaviors and actions from an early age (Tilbury, 1994; Wilson, 1994; Ewert et al., 2005; Wells & Lekies, 2006; Hacking & Barratt, 2007; Samuelsson & Kaga, 2010; Nature Conservancy, 2011; Awasthy et al., 2012; Chen-Hsuan & Monroe,

2012), highlighting the need to start increasing children's knowledge and attitudes toward nature and the environment in preschool.

1.2 Early childhood and ecological education

> *"(…)[New kinds of education] must begin in early childhood, as the values, attitudes, behaviours and skills acquired in this period may have a long-lasting impact in later life."*
>
> (Samuelsson & Kaga, 2008 p. 9)

Duhn (2012) argued that there is a need for eco-focused education efforts to focus even more on children. The early childhood years are an important time for adults to help foster curiosity and wonder in children regarding the outdoors (Wells & Lekies, 2006; Hacking & Barratt, 2007; Samuelsson & Kaga, 2010). Indeed, events experienced at young ages play a key role in development into adulthood (Convention of Scottish Local Authorities [CSLA], 2008). Early childhood has been called the "window of opportunity" to engage with nature and learn eco-friendly lifestyle habits (Samuelsson & Kaga, 2010). Moreover, Robertson (2008) showed the importance of a nature-based preschool program during the early childhood years to develop further critical attitudes and environmental behaviors.

Patrick & Tunnicliffe (2011) described that in early childhood, "rich" experiences in nature influence children's understanding more than schools, so schools and teachers should be focusing on more opportunities for children to develop deeper, more meaningful connections outdoors rather than focusing, again, on the transference of environmental facts and figures (Chen-Hsuan & Monroe, 2012).

Scientific concepts, in general, tend to estrange children because they do not take place in their lives regularly (Avraamidou & Osborne, 2009). Science

education expert, David Wilgenbus, stated in an interview that it is important to remember to focus on themes that young children can experience and observe regularly so that the lesson becomes relevant to their daily lives (Annex I.VII). Indeed, Duhn (2012) would agree, stating that children need to engage in themes that affect their lives at their current age as well as into adulthood to develop their pro-environmental attitudes and sense of stewardship.

Hinds & Sparks (2008) suggest beneficial educational experiences regarding the environment are created through "repeated exposure to nature" and recommends that educators reflect on how to create positive learning experiences for children outside of the classroom, in natural environments. In addition, direct experiences in nature was the most important variable in regards to outdoor experiences at a young age and the effects it has on environmental beliefs later on in life (Ewert et al., 2005; Monke, 2007).

Detailed information about species is listed as ineffective and not recommended for preschoolers as it is not as meaningful or memorable as experiential learning (Robertson, 2008). Some research suggests that specifically in early childhood, education should be based on experiences rather than on random bits of "measurable knowledge" (Hägglund & Pramling, 2009) or "skills" (Russo et al., 2008). A report on early childhood pedagogy generated by the Members of the British Research Association (MBRA) (2003) recommends that preschool-age children in particular be taught in "informal" ways that focus on their interests.

Approaches that focus on simple subjects revealed to be more appropriate for preschoolers (MBRA, 2003; Nikolaeva, 2008; Russo et al., 2008). For example, a single plant or animal, or a community of plants or

animals can easily be the starting point (Nikolaeva, 2008; Randler, 2009). Therefore, from the umbrella-subject of environmental education, focusing on Ecological Education (EcoEd), in early childhood may be the best route.

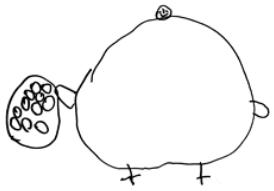
Focusing on a single species may help to gain more attention to an environmental issue as well because it is easy to communicate the needs of an animal and its protection compared to attempting to convey the need for protecting a particular ecosystem that is out of the realm of the daily consciousness of the average person (Randler, 2009), or in this case, child. Plus, conservation efforts that focus on preserving a particular species oftentimes aid the other species and ecosystem as a whole as a result (Randler, 2009). However, EcoEd activities with children from urban areas that focus on species tend to be restricted to classroom learning (Fisman, 2005) such as listening to recorded sounds, watching videos, or lecture-style lessons, which oftentimes fail to make a substantial connection with children (Nobel, 1996). Indeed, EcoEd needs to provide both knowledge as well as a connection to the outdoors that will foster an intrinsic motivation to protect nature and the environment into adulthood (Nikolaeva, 2008; Chen-Hsuan & Monroe, 2012; Annex I.VI).

Especially in early childhood, it is important to follow a more constructivist approach – allowing children to discover knowledge through stages and collaboration with peers and educators (French, 2007). Constructivism, often linked to the works of Piaget and Vygotsky (French, 2007; Sylla et al., 2011) and Inquiry-based Learning and John Dewey (Harvey & Daniels, 2009), and whose main characteristics are shared with the educational philosophies of Paulo Freire and Reggio Emilia (Chapters 1.2.1, 1.2.2), focuses on maintaining

equality between teacher and student. That is to say that both teacher and student are equally involved in the learning and teaching processes, and children are encouraged to actively think for themselves rather than absorb information lectured to them (Trevors, 2006; Hägglund & Pramling, 2008).

Taking into account the recommendations from a variety of research, what educational approach can be implemented that will result in improved knowledge and attitudes in young children?

Chapter 2: Developing an early childhood ecological education approach



Developing an early childhood ecological education approach

For the purpose of being effective in exploring and designing activities, several educational approaches were studied and analyzed for selecting key components and constructing the educational approach used in this study. Two approaches currently being implemented in Portuguese schools, that of Reggio Emilia at the Jardim de Infância dos Serviços de Ação Social da Universidade de Coimbra (JISASUC) and that of Paulo Freire at Escola de Ponte, Porto are explored further.

2.1 Reggio Emilia: Emergent curriculum and the triadic relationship

Reggio Emilia refers to a pedagogical approach developed by Loris Malaguzzi (1920 – 1994) in Reggio Emilia, a province in Italy, in the aftermath of World War II. Much of the educational philosophy developed by Malaguzzi is similar to that of Paulo Freire; it is easy to draw comparisons between the two approaches.

A unique aspect about the Reggio Emilia curriculum, though, is that there is not one (Smidt, 2013). There is neither a prepared curriculum for teachers to follow nor tests. The curriculum is built by the children through series of long- and short-term projects based on the children's interests (Smidt, 2013). This approach is often referred to as "emergent curriculum" (French, 2007 p. 4). Malaguzzi believed children should seek their own answers to their own questions, but at the same time have the guided support of educators (Smidt, 2013), which is a similar philosophy to "Inquiry-based Learning," an approach popularized by philosopher and education reformer, John Dewey (1859-1952) (Harvey & Daniels, 2009).

In this way there is no step-by-step model or training program in order for other schools to replicate, but as Papatheodorou (2006) argued, “we can take aspects from the Reggio Emilia practice and incorporate them into existing practice, but we cannot ‘do’ Reggio Emilia” (Papatheodorou, 2006 p. 6). Education, instead, should be developed locally or at least regionally to account for the difference in realities between cultures and countries (Gadotti, 1994). Indeed, Papatheodorou (2006) further argued that Reggio Emilia incorporates their own society and cultural values into the projects that they create and that different countries are going to operate differently both culturally and educationally, so Reggio Emilia methodologies should be used as guideline principles instead of an “imposed framework” (Papatheodorou, 2006 p. 6). Educators should teach comfortably in their own cultural identity instead of in the “borrowed identities” of others (Papatheodorou, 2006 p. 6).

The Reggio Emilia schools do not create a specific curriculum purposely for this reason, and in order to prevent teaching without learning (Smidt, 2013). Instead they learn through hands-on activities and teachers must continuously assess formatively by taking notes on the observed behaviors, statements, and interpretations the children make in order to develop a continuum of a child’s progress instead of simply evaluating results of a standardized test (Smidt, 2013). Children then become active seekers of knowledge instead of the empty vessels where knowledge is dumped, as criticized by Paulo Freire in his “Banking Model” philosophy (Gadotti, 1994 p. 52).

Another aspect that Malaguzzi recognized as considerably important is the link between school, child, and family. Family and community members are encouraged to be strong presences in the children’s educational lives,

connecting school life with home life regularly (Smidt, 2013). Smidt (2013) described parents as being allowed to participate when and as much as they like in their children's learning experiences at school. Involving family not only allows parents and family members to become more engaged with their child's development, but also shapes the educational experience in a more culturally relevant way for the children (Smidt, 2013). Again, in this way, a specific curriculum would be inappropriate due to the vast differences culture to culture. Therefore, only a philosophical guide of incorporating cultural and familial experiences can be implemented.

2.2 Paulo Freire: Moving past "traditional" education

Paulo Freire (1921-1997) was a Brazilian educator and philosopher most famous for his work, Pedagogy of the Oppressed (1968), where he linked authoritarian-style teaching in schools to the authoritarian political regime in Brazil in the mid-20th century. He suggested a new model based upon equality between learner and teacher as co-creators and re-creators of knowledge and ideas that is more efficient than the traditional school concept. He is responsible for the literacy of millions of people around the world, changing the way in which literacy was taught to the masses in order to make it more relevant to the people's life experiences (Haddad, 2008). Moacir Gadotti, author of the book Reading Paulo Freire: His Life and Work (1994), says there is no "Paulo Freire Method," but rather it is an educational philosophy. Gadotti described the three stages of the philosophy:

1. "The Investigation Stage" where themes that will formulate learning are discovered;
2. "The Thematization Stage" where the themes found in the "Investigation Stage" are organized and put into context and where new themes are subsequently generated; and

3. “The Problematization Stage” where the limits due to “existential situations” are discovered and analyzed (Gadotti, 1994 p. 22-23).

As seen in Stages 2 and 3, Freire emphasized the importance of perpetual formative assessment – observing and analyzing what is being done and what was done, and determining how to continue in a better, more effective way, constantly recreating one’s teaching strategy (Gadotti, 1994). Freire believed to be a great educator, the educator must constantly be thinking of how they can make their teaching better, how to reorient their teaching to fit the current children, the current culture, and the current context (Gadotti, p. 133).

Similar to constructivism mentioned previously, Freire also emphasized a dialogue between student and teacher, much like the methodology of Loris Malaguzzi and the Reggio Emilia schools (Chapter 1.2.1). Dialogue, for Freire, first meant that teachers respect their children, their ideas, and their questions (Gadotti, 1994). To hand control over to children, particularly if they are young children, a teacher must view the children as being competent partners whose ideas and thoughts are worth respecting (Smidt, 2013).

The opposite of a dialogic relationship, is what Paulo Freire referred to as the “Banking Model” of “traditional” school. Teachers speak, choose, and authorize and children listen, follow the choices of the teacher, and whose ideas are never heard (Gadotti, 1994 p. 52). Following the “Banking model,” teachers end up disregarding the questions and concerns of the children, and they, therefore, lose the pleasure of exploring and discovering (Gadotti, 1994; Haddad, 2008). While some may argue children are learning discipline, others still would say children are learning submission and blind obedience (Gadotti, 1994; Haddad, 2008). Haddad (2008) asserted that this form of teaching

"contaminates" the education system, particularly in the early childhood years (Haddad, 2008).

Gadotti further explains that Paulo Freire suggested that teachers fall out of this practice of the monologue, "Banking model" by first realizing and expressing that they are not the sole possessors of knowledge, and that they do not know all the answers (Gadotti, 1994). However, Paulo Freire also stressed the fact that the alternative to the "Banking model" of teaching is not the "Laissez-faire model" – simply leaving children to study alone and the teacher refusing any responsibility toward the education of the children (Gadotti, 1994 p. 57).

Instead, Freire encourages educators to direct and guide tasks, which is different from ordering someone to do something (Gadotti, 1994). Again, this approach is modernly referred to as "Inquiry-based Learning," where students are seen as knowledge creators, interact and engage with the educators, and practice collaborative work with multiple resources (Harvey & Daniels, 2009).

Combining all of the aspects of Freire's pedagogical philosophies, Gadotti listed them in four principles (Table I).

Table I. Adapted from: Gadotti, M. (1994). Reading Paulo Freire: His Life and Work. (J. Milton, Trans.). Albany, NY: State University of New York Press. P. 101.

Principles
1. The educator is the subject of his/her practice; the creation and recreation of an educational action through a reflection upon his/her everyday practice is his/her responsibility.
2. The training of the educator should be permanent and systematized, because the practice is formulated and reformulated.
3. Pedagogical practice requires the comprehension of the very genesis of knowledge, in other words, how the process of knowing takes place.
4. The program of training educators is a precondition for the process of reorientation of the curriculum in schools

2.3 Exploring current ecological education strategies

To add to scientific literature resources, semi-structured interviews were conducted with specialists in education, science education, environmental education, early childhood outdoor education, and ecology to aid in developing an effective approach to teaching ecological education in early childhood (Annex I).

How would you define *Environmental Education*?

> "*(…) It starts with this: however you want to define the environmental component of work, it seems to me, as the lead learner of the school, that there's very little point in presenting educational sustainability in any form to the children if the education itself is not sustainable: the entire package of education. The way that education is presented, and it's more or less the same internationally, is in my view not sustainable (…)*"
>
> Alan Wagstaff
> Learning Manager and Curriculum Coordinator for the Green School
> Bali, Indonesia

How important is *Ecology Education* for society's path to a sustainable future?

> "*(…) ecology establishes the scenarios of an ecosystems' balance for human well-being*, *and brings up the importance of the relationship with nature. The more we know about the planet's ecology, the more we will enjoy it and the more we assume its protection.*"
>
> Helena Freitas
> Coordinator of the Centre for Functional Ecology
> University of Coimbra, Portugal

> "*(…) I recall when Piaget first came to the US he was consistently asked what he termed the American Question – how can we speed up the transition of young children through the early stages. His answer was always – and why would you want to. There are so many critical learning skills that can be taught in this early childhood phase and we need a healthy debate on what these are (…)*"
>
> John Hattie
> Director of Melbourne Educational Research Institute
> Melbourne, Australia

How important is *Early Childhood Education* for society's path to a sustainable future?

"*Vital, but not lecturing at them*."

Sue Dale Tunnicliffe
Institute of Education in London
United Kingdom

"Education starts and environmental education starts pre-birth. Children before they're born are learning things about their environment in which they are living in the womb. From the moment they are born, they continue to develop and learn about the world in which they live. If we don't capitalize on that, it brings enormous issues for society later on in life. "

Jane Susan Johnston
Associate Professor at Bishop Grosseteste University in Lincoln
United Kingdom

"*(…) Our Pre-Kindergarten follows the Reggio Emilia approach (…) I believe that ecological education refers to how living things are connected within the environment. We are a part of the environment because we live in a certain area. The most important part of my job is helping children to establish their Sense of Place. This connection to different aspects of their communities will hopefully contribute to their sense of responsibility to the environment and the goals of environmental education.*"

Charlotte Souter
Outdoor Exploration Pre-Kindergarten Faculty
For the Journeys School of the Teton Science Schools
Wyoming, United States

What specific aspects are necessary to have a successful scientific experiment or project?

"(...) *So, with children so young, I think the most important aspect is the sensory aspect (…)*"(Translated from original French).

David Wilgenbus
Education Coordinator for the *Fondation de La main à la pâte*
Montrouge, France

Children's understanding particularly related to science concepts is shaped by the way teachers develop and organize the activities (Chen & Cowie, 2013). The more diverse the activities and lessons are, the more likely the educator is to engage with each child's learning style, and the less likely a child will fail to connect with the theme (Chen & McNamee, 2007). Hattie (2009)

argued that teachers need to have knowledge about the content being taught, but also the ability and knowledge of how to teach and to be effective educators. Children in a classroom are each unique, and a teacher needs to be able to set goals that are appropriate for the diversity of children in the class (Hattie, 2009). Hattie (2009) further argued that the educators who spend the time evaluating what is appropriately challenging are more effective than those who perceive their role as providing lessons/activities and expecting children to do their best..

In addition to literature review, semi-structured interviews were conducted with the faculty of two environmentally-focused schools to explore the educational approaches undertaken actually in order to further construct a methodology for "Exploration and Development of Early Childhood Ecological Education."

2.3.1 Journeys School of the Teton Science Schools

Located in Wyoming, United States, The Journeys School is an independent school whose core learning approach is "teaching children outside of the classroom" (Journeys/Outdoor Education, 2008). In an interview conducted with Charlotte Souter, Outdoor Exploration Pre-Kindergarten curriculum coordinator/teacher (Annex I.IV), she confirmed that The Journeys School follows the Reggio Emilia approach for early childhood and expressed how this approach's emphasis on projects and place-based learning allows children to better appreciate their environment (Annex I.IV). The Journeys School Pre-Kindergarten Program Book, describes the concept of "Emergent Curriculum" that evolves from the observations of teachers who then use their observations to "facilitate opportunities and activities" that align with what

interests the children most (Journeys, 2013). This approach is defended with the belief that the children-centered methodology, verses traditional teacher-directed methods, makes learning meaningful, which motivates children to learn and solve issues (Journeys, 2013).

Souter described implementing the Reggio Emilia approach by spending the autumn season introducing her students to different outdoor areas around the school and carefully noting conversations and interactions she observes with the children in order to gauge their interests and determine how to develop projects to facilitate those interests; again reflecting a constructivist approach.

The Outdoor Exploration Pre-Kindergarten's approach also follows that of Reggio Emilia through interacting and collaborating with the community and cultural aspects, by using "local experts" to help children learn and explore the topics that intrigue them the most, and by discussing observations with colleagues in order to guide children's learning in a meaningful way. The school also regularly interacts with parents, encouraging them to volunteer and participate in outings. Parents are also asked to participate directly in a hands-on way with projects that their children will eventually continue and finish. The finished project will then reflect contributions from the entire school community including children's families. This approach shortens the gap between child, teacher, and family, building a strong educational community that will be the foundation for children's long-term learning experience, as well as strengthening connections between the children, children's families, and their environment.

2.3.2 The Green School

Alan Wagstaff, curriculum coordinator for The Green School in Bali, Indonesia, has many criticisms of the traditional education system of subject-

centric, exam-centric methods. Wagstaff argued that traditional schooling concepts focus only on the intellectual side of a subject, neglecting almost entirely "intrapersonal" aspects (Annex I.VI). When developing the curriculum for the Green School, he described incorporating "intrapersonal" aspects into every lesson of every subject whilst discussing his concept of "The Big Four" (Figure 1):

> *"(…) Then there is the secular-spiritual or intrapersonal. We don't want to employ any religious content in that quadrant. This is a way of describing [the quadrant] completely secularly where it won't upset anyone's belief. It's simply an interior singular. 'I intuit that...' 'I symbolize….' Not 'I believe....' In the intrapersonal quadrant all you have to say to children, even adolescents, is that it is simply their imagination. It's nothing to do with God or angels, it's just imagination. Let's just imagine that [the subject] is talking to us. Let's try and ask, 'What is its significance?'… It is just as important to engage the subject matter subjectively through art as it is intellectually as it is physically as it is spiritually. They're all equal. They only seem unequal when the enterprise of education focuses only on the intellect. It's not that the intellect is somehow wrong. It is only difficult or problematic when it is all that is applied (…)"* (Annex I.VI).

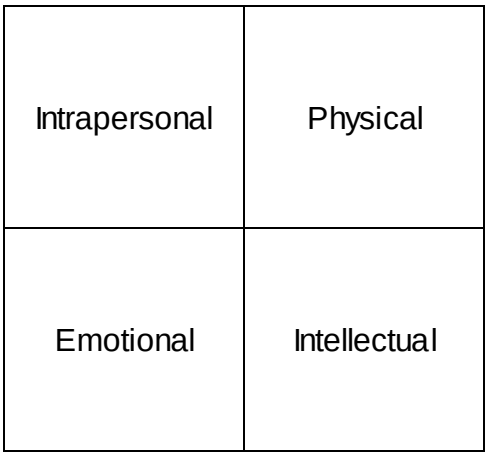


Figure 1. Pedagogical concept adapted from Wagstaff, A. (n.d.) *Thematic Lessons: The Big Four* (slide presentation).

In other words, education must take on more than just intellectual components, (Marale, 2012), particularly when studies show that connection to nature is such an important driver for environmental stewardship (Chen-Hsuan & Monroe, 2012).

Like the pedagogical approach of Reggio Emilia, classes take on short- and long-term projects that are interdisciplinary in nature. Explaining this approach using "The Big Four," Wagstaff described a project on coconuts:

> *"(…) A great project that one of our environmental teachers brought in, was a 4-week project on the coconut economy. He knew about the 'big four', so the next minute, we had safety mats under some coconut trees, he brought one of these guys out, who showed them how to go up a tree with a rope around their waist, they climbed the tree, they grabbed a coconut, they brought it down, they did this every day. Then they did all the intellectual things that you would expect. Then they had a song, they created an artwork, and they sat beneath their own coconut tree and said "what are you telling me?"… Let's just imagine that it's talking to us. Let's try and ask, "What is its significance?"* (Annex I.VI)

Following this approach, Wagstaff argues that students are more engaged; they are not memorizing facts, figures, and dates, but rather learning problem-solving, philosophy, collaboration, and critical thinking.

2.4 Conceptual framework

A guideline was created to design the activities reflecting hands-on, constructivist methods that would be appropriate for all of the children of JISASUC regardless of their developmental stage and age (varying between two- and six-years-old) using the semi-structured interviews and literature review, along with the collaborative action research between the author, Faculty of Sciences and Technology, researchers from the Centre for Functional Ecology, the Institute of Marine Research, and the Center of Interdisciplinary Studies of the 20th Century, and the faculty of JISASUC. The purpose of collaborative action research is to gain multiple perspectives on a complex issue (Sagor, 1992); in this case, developing ecological education for early childhood.

These guidelines evolved into a proposed framework reflecting the key elements that frequently emerged – discovery, play, expression, and connection.

2.4.1 Discovery

Discovery encompasses a wide variety of actions that pertain to the exploration of objects or phenomenon. Examining, searching, handling, questioning, discussing, and observing are all part of a child's discovery. Teachers have the opportunity to foster children's pleasure of answering questions through "research" without having to provide a "right answer" to every question (Rinaldi, 2006). As mentioned in above and in Chapter 1.2.1, Paulo Freire discussed intensively the importance of active discovering processes to knowledge construction instead of a passive "knowledge transference" process (Gadotti, 1994). Gadotti (1994) continued to write of Paulo Freire's teaching philosophy this way:

> *"It is basically about a different vision of educational practice. In the education of children, what is important is not to open their heads to give them the names of islands or historical characters but to allow them to create by getting to know the world and to get to know the world by creating, expressing themselves and expressing reality, in an increasing lucid understanding of their reality"* (Gadotti, 1994 p. 23-24).

Reflective of constructivist theory, in other words, it is more effective to allow children to discover for themselves, with the guidance of their teacher, how their environment is connected and functions, and not by means of traditional education styles.

David Wilgenbus also conveyed this message saying that preschool-age children will be on a discovery rather than explanatory level where they can experiment with objects and/or phenomenon without having to explain the

scientific reasoning behind the phenomenon (Annex I.VII). Discovery can take on several characteristics and strategies, but the most important element is that they are able to directly handle objects or experience natural phenomenon firsthand (Müller et al., 2009; Annex I.III; Annex I.IV; Annex I.VII). The common theme amongst interviewees and scientific literature is discovery activities that are "hands-on." Informal lessons with hands-on activities are essential when teaching children about plants and animals (Randler, 2009; Patrick & Tunnicliffe, 2011).

One case study documented that kindergarteners who participated in hands-on, EcoEd activities were able to communicate what they learned, developed self-confidence, as well as reading, science, and math skills, which will prepare them for entering the educational system (Miller, 2007). Another study suggests a hands-on educational approach to teaching children about the environment may increase children's environmental attitudes and stewardship (Chen-Hsuan & Monroe, 2012). Laubenthal (1999) described how firsthand experiences allowed children to better understand food chains and life cycles and demonstrate their understanding through creative outlets such as writing and illustration more easily. Yet another study showed that children, who learned using computer-based educational materials only, did not have significant changes in attitudes toward the theme compared to children who learned using the computer-based educational materials plus handling objects and taking part in various hands-on activities and experiences (Sylla et al., 2011). Those who learned with additional hands-on activities showed significantly better attitudes as well as more contextual (verses static) drawings and/or they drew themselves interacting with the subject. The change in

drawing richness may indicate a higher level of engagement with the subject (Sylla et al., 2011).

Hands-on experiences seem to show better results in regards to children's educational progress, but another report suggests children also need "rich environments" in order to develop their cognitive abilities through exploring through touch and manipulation and experimenting with various materials (French, 2007). Indeed, this type of "rich environment" that is "hands-on" and permitting of exploration and open to questions is a fundamental element of the Reggio Emilia approach (Smidt, 2013).

As mentioned before, the Reggio Emilia approach shares characteristics to the educational philosophy of Paulo Freire in that both Freire and Malaguzzi believed that children' minds were not "empty vessels" needing to be filled by teachers (Gadotti, 1994; Smidt, 2013), but rather children should ask and actively seek to answer their own questions with the hands-on support of the teacher (Gadotti, 1994; Annex I.III; Smidt 2013). Malaguzzi encouraged teachers to allow children to "mess about," to discover, and to investigate in order to allow the learning to happen with their own discoveries (Smidt, 2013).

2.4.2 Play

It has been recommended that adults plan playtime for children (French, 2007; Brooker& Edwards, 2010) for the healthy development of children (MBRA, 2003) as well as pedagogical purposes (Edwards, et al., 2010). Jane Johnston, Associate Professor at Bishop Grosseteste University in Lincoln, United Kingdom and Co-editor of the Journal of Emergent Science, also believes that teachers should play side-by-side with the children (Annex I.III). She stated that science education in the early childhood years is all about play,

and that teachers should play along with them as a role model, asking them questions to stimulate their curiosity and excitement in the natural world (Annex I.III). Playing and physical movement can capture children's interest and willingness to learn about ecological concepts, setting them up for positive learning experiences and building emotional connections with nature (Nobel, 1996' Edwards et al., 2010; Smidt, 2013; Annex I.III; Annex I.IV; Annex I.VI; Annex I.VII). Allowing children to play and explore places outside of the classroom or to handle and play with natural objects inside the classroom, for example, aligns with discovery, but at the same time has very physically active and playful components.

Bixler et al. (2002), discovered that indeed children who played in natural environments valued natural places more highly. Though spending quality play time in natural spaces increases the likelihood that adults will value natural places for recreational reasons, time spent independently playing does not correlate directly with pro-environmental behaviors and stewardship later on (Bixler et. al., 2002). This suggests that play is an important element for capturing the interest of children, but further educational efforts need to be made in order to develop the desirable pro-environmental behaviors. However, that might be because the time spent playing was not organized and facilitated by teachers for the purposes of teaching environmental concepts.

Edwards et al. (2010) contrarily believe that specific play-based teaching techniques can be effectively utilized to teach ecological concepts. Teachers should be, however, well-informed in the theme surrounding play in order to facilitate active involvement, use various materials and environments (outdoor

and indoor), and finally observe and assess the children during play activities for efficacy (Brooker& Edwards, 2010).

Three types of play – open-ended, modeled, and purposefully-framed (Edwards, et al., 2010) can be utilized by teachers for the purposes of teaching about the environment. As described by Edwards & Cutter-Mackenzie (2011), relative to environmental education, during open-ended play, children receive play materials from the teacher that are related to the theme and are allowed to play with the materials and develop their own understanding and knowledge. During modeled play, on the other hand, the teacher demonstrates how to use the materials before the children handle them (Edwards & Cutter-Mackenzie, 2011). Finally, purposefully framed play is a combination of the two prior types – allowing children to manipulate the materials on their own first, and modeling how to use them afterward (Edwards & Cutter-Mackenzie, 2011). Cutter-Mackenzie & Edwards (2013) found that purposefully-framed play allows for a connection between knowledge and experience, successfully teaching children environmental concepts through playing.

2.4.3 Expression

Expression can take on multiple meanings. In the "traditional" concept of education, as previously mentioned, Paulo Freire's "Banking Model" in which teachers speak and children listen comes to mind (Gadotti, 1994 p. 52). Instead, children should be encouraged to express themselves, discuss, ask questions, interact as partners with the teacher (Hägglund & Pramling, 2009; Annex I.III; Smidt, 2013) in a dialogue rather than a teacher's monologue (Orr, 1990). Allowing children to tell anecdotes of their lives related to the theme incorporates their knowledge of the subject, and the children will learn not only

from the guidance of the teacher, but also through the inputs of each other (Smidt, 2013).

"Expression" does not only refer to verbal expression of thoughts in a dialogic way. Children can also express themselves artistically through drawing, painting, dance, pretend, and more. Artistic expression is important to children's learning processes and development (French, 2007; Brooks, 2009), and fosters children's interest in the educational theme (Nobel, 1996). While helping children formulate or reinforce ideas, artistic expression also can be the product of what the children have learned (Brooks, 2009). Learning in and about the natural environment can open the possibility of exploring nature-inspired music, art, and literature and different aspects of the culture which will foster their self-expression as well as building the connection between the intellectual, psychosocial elements of EcoEd (Edwards, Gandini, & Forman, 1998).

Drawing can help children put into visualization their concept of what they are learning; reinforcing the knowledge they gained from their discoveries in a way in which they are capable, unlike with writing (Chang, 2012). Since young children are only just learning how to read and write at this age, it is important to allow them to express themselves in other means that are appropriate for their stage of development (French, 2007). Artistic expression can also be a means of allowing a child to incorporate the theme into how they envision their lives (Nobel 1996) - an "oscillation" between what is real and their imagination (Hägglund & Pramling, 2009). Referring to traditional schooling systems, Nobel (1996) wrote, artistic expression can allow people to "grasp this unity between the outer world and [their] own inner world, something which

traditional teaching and the whole system of education works against rather than facilitates" (Nobel, 1996 p. 105).

2.4.4 Connection

2.4.4.1 Personal connection

Paulo Freire believed that in order for someone to learn, there must be an interest to learn, and that if a student does not establish a connection to the subject in question, no substantial amount of learning will take place (Gadotti, 1994). Scientist Elias Fries is noted as saying, "If organic nature is ever to be studied with success, love for it must be aroused and upheld in youth."(Nobel, 1996). Samuelsson & Kaga (2010) would agree, recommending that education providers need to rethink their place in establishing a connection to the environment through developing pro-environmental values, attitudes, and behaviors in children.

Trevors (2006) ascertained that environmentally-focused educational approaches are too factual and full with details that do not connect with children. Alan Wagstaff also emphasized the need to let go of subject labels such as "environmental studies" or "ecological education" when trying to develop a program in the realm of a traditionally subject-based education system, saying that these titles have no meaning if the educational approaches fail to engage with students (Annex I.VI). To fix the "chasm" that separates nature from culture that is preventing eco-based education from really providing positive results (Grün, 2005), Wagstaff said the first step is to create an education system that is sustainable, and then allowing the "green info" to truly make its way into every aspect of the lessons, education, and curriculum. Once pro-environmental attitudes and behaviors are at the core of the curriculum and educational strategies, then "sustainability" or "environment" or "ecology" is no

longer just simply a subject that is tackled with intellect only, but with all aspects that are intellectual, physical, emotional, and intrapersonal, allowing children to engage fully in their educational experience (Annex I.VI).

David Wilgenbus would agree saying that when developing an eco-focused education program particularly for preschoolers, the acquisition of facts and information, the intellectual aspect, is less important than creating and fostering positive, environmental attitudes (Annex I.VII). Besides intellectual aspects, a well-rounded approach also incorporates physical, emotional, and intrapersonal aspects (Annex I.VI; Figure 1).

Nikolaeva (2008) similarly stated that indeed positive attitudes and feelings toward nature and the environment do not develop from knowledge alone, but from "personal meaning and purpose" (p. 68). Educators need to tap into the children's interests and build a connection with a particular plant or animal, a location, or a feeling that is elicited by spending time in nature, or other emotional development in order to create lasting impacts (Müller et al., 2009; Chen-Hsuan & Monroe, 2012) since level of emotional connection to nature is the best predictor of pro-environmental habits and behaviors (Müller et al., 2009).

Personal connections, however, have been shown to also be related to familial and cultural contexts (Chen-Hsuan & Monroe, 2012), so it is important to explore those aspects of connection more deeply.

2.4.4.2 Familial / cultural connection

Parents' participation in their children's education, in particular, has been shown to provide positive results in children's attitude towards learning (French, 2007). In regards to EcoEd specifically, it has been shown that children learn most about different plant and animal species through home learning (Patrick &

Tunnicliffe, 2011) rather than at school. In fact, research from the United Kingdom suggested that student achievement is influenced more greatly by children's learning environment at home during early childhood than whether or not the child attended preschool (CSLA, 2008). Parental involvement, therefore, is essential at this stage of life, and it has been recommended that this stage be seen as the "first phase of education" (MBRA, 2003 p. 9).

Aside from the intellectual aspect of EcoEd, considering that parents and children show similar levels of connectedness to nature, it has been suggested that children's environmental attitudes and interests are indeed also influenced by their parents who naturally pass down their values to their children (Robertson, 2008; Chen-Hsuan & Monroe, 2012). Even the simple recounting of personal stories of having positive experiences in nature have shown to increase a child's likelihood to want to have experiences in nature (Fraser et al., 2010).

Malaguzzi recognized this importance between family and child, focusing the Reggio Emilia early childhood pedagogical philosophy, in a socio-historical and socio-cultural way, around the triadic relationship of child, family, and teacher (Chapter 1.2.2; Smidt, 2013). Smidt (2013) describes parents as being allowed to participate when and as much as they like in their children's learning experiences at school. Kroeger & Lash (2011) stated that including parents helps to support the teacher as well, and changes the authoritative dynamic from absolute authority of the teacher to a more inclusive dynamic between teacher, child, and parent.

Indeed, education in early childhood is influential at developing pro-environmental behaviors and attitudes particularly if the activities include

families and the community in the educational process (Samuelsson & Kaga, 2010). Moreover, Robertson (2008) found that the pro-environmental attitudes that are formed by an eco-focused education program are more likely to continue if they are fostered by family or society.

When developing educational activities for early childhood, Samuelsson (2011) recommended that educators be mindful of the cultural and experiential background of each child since this strong influence will alter the stage of development at which each child is, regardless of current age. Paulo Freire would agree with this statement believing that educational material should reflect the differences in cultures and realities that can exist within individuals of an entire country (Chapter 1.2.1, Gadotti, 1994). Furthermore, a cross-national analysis conducted by Lévy-Leboyer et al. (1996) revealed that when attempting to pinpoint what would develop pro-environmental attitudes and behaviors, there was no “general rule” that could be determined between the five countries included in the study – France, Germany, Italy, Portugal, and the United Kingdom. This result could be used as an argument for developing regional or local curricula that best suits the culture (Gadotti, 1994) when developing EcoEd activities, rather than attempting to create a strict syllabus to be used generically.

2.4.5 Diagram

Through the collaborative action research, the four elements recurring frequently were the basis of the framework. The four elements, though able to be separated and discussed individually, take on an overlapping effect when discussed in regards to EcoEd activities. So instead of creating and implementing activities that focus on one element at a time (Figure 1), the

elements will appear as a Venn diagram (Figure 2) where activities might share characteristics of more than one element.

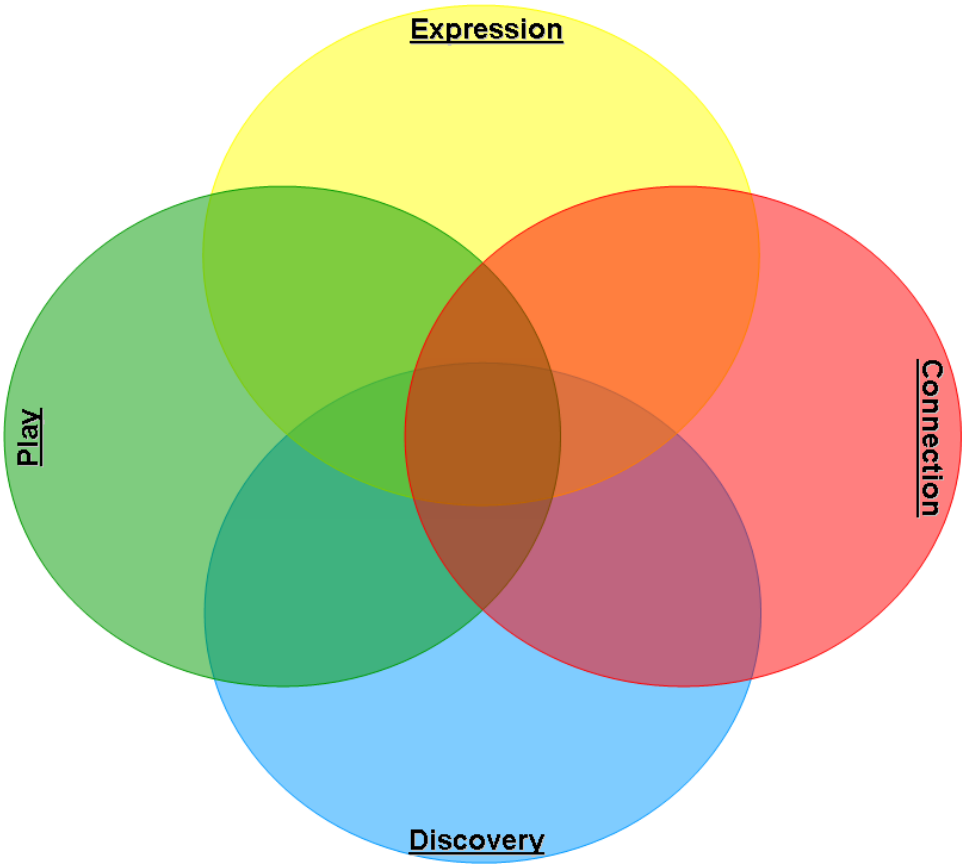


Figure 2. Framework proposed for *Early Childhood Ecological Education*. The interconnectedness is due to the overlapping of characteristics from each element that will exist while designing activities.

Chapter 3: Exploring an early childhood ecological education approach

Exploring an Early Childhood Ecological Education Methodology

The JISASUC is inspired by a combination of different educational strategies; the most influential though, is the Reggio Emilia pedagogical approach (Chapter 1.2.2). Teachers with their students regularly develop short- and long-term projects that emerge from the children's interests (emergent curriculum), or that follow a particular theme. Therefore, before developing the EcoEd activities, the theme as well as the direct outcomes of the activities and long-term goals of the entire program were defined.

Birds were chosen as this study's theme for multiple reasons. In Portugal, seventeen of the nineteen vertebrates classified as "regionally extinct" by the Portuguese Environmental Agency (Agência Portuguesa do Ambient [APA]) were species of birds (APA, 2008 p. 150). It may be beneficial to raise ecological awareness, starting at an early age, as an attempt to prevent further extirpations of bird species. Also, children can easily see and connect with birds regularly in and outside of school regularly. Even in an urban setting, birds can easily be seen in parks, perched on the school building, or flying overhead. In this way, the subject is not isolated to the school environment but can be transferred into different aspects and areas of the children's lives.

The theme did not aim to teach preschool children everything there is to know about birds, but rather aimed to create an interest in birds and attempt to build a connection with children and these neighborhood creatures, so that they might act in a protective manner towards them in the future (Chen & Cowie, 2013; Annex I.IV). As a direct result of the activities, children should demonstrate increased knowledge about what birds are, what they look like, where they live, and how they live. More importantly, though, children should

demonstrate an increased affinity toward birds (Bogner, 2002; Randler & Bogner, 2002).

As a long-term goal, the affinity to birds that children develop will hopefully lead to a life-long connection and sense of stewardship toward these important creatures (Monke, 2007).

The unit focused on the foundation of ideas needed to be understood before they could go further and build their knowledge of the subject later on in school (Chen & Cowie, 2013). In this case, the foundation concepts were identified as bird physiology, bird behavior, and the bird life cycle. The basis of these activities is not to create a "one-size-fits-all" program that can have the same positive effects with any set of children in any location. These are examples of activities that incorporate the different elements of discovery, play, expression and connection. A teacher's EcoEd approach should be based on the culture in which the children live, and be adapted constantly (Gadotti, 1994) to further the children's learning at the level at which they currently stand (Chen & McNamee, 2007)

After each activity, formative assessments were made using the children's statements and sentiments that were documented during the activity in order to analyze their level of understanding and to ensure children were ready to tackle a novel concept before moving on to another activity instead of keeping to a strict syllabus of activities (Smidt, 2013). Keeping constructivist ideals in mind, flexibility and spontaneity were exercised. Indeed, the original activities designed were not the activities actually implemented. The initial strategy was showing an inability to transform the children into actors; it was more unidirectional than dialogic. Formative assessments and continuous

feedback and collaborative action research throughout the project led to the following activities being implemented.

3.1 At-school activities

3.1.1 Activity 1: Which is a bird?

Activity 1 was designed in order to explore the concept of “birds” and help the researcher/educator to better contextualize the “starting point” of the study. Simple introduction of a topic by explaining the difference between birds and other animals would not engage with children of younger ages, one cannot merely pass on knowledge to a young child, and expect them to remember it (Nobel 1996). One strategy to explore new topics may be by using images as visual aids (Nobel, 1996 p. 247; Danisa et al., 2006).

Firstly, images were brought into the classroom and each child was encouraged to describe the animals in the images and to introduce new facts or personal stories or events associated with the image and animal. After describing the animal and discussing which was a bird or not, the children decided to organize the pictures in two areas of the room designated by “birds” and “other animals” so that each child could see all of the images easily and continue playing and discussing (Figure 2).

Later, children were encouraged to express which birds (or other animals) they liked in particular or found interesting based on the pictures. During the discovery process, books, magazines, and journals were also available in the classroom, for children to look through to find pictures of birds and inspire creative art. Drawing materials were available for children to use to draw pictures of birds or other animals inspired by the images they were playing with. As mentioned, allowing the children to express their thoughts artistically helps to develop their interest in the subject (Nobel, 1996 p. 250), but also the

drawings can be used by the instructor as a means of assessment, as evidence of the evolution in the child's understanding of the subject (Dove et al. 1999; Prokop et al., 2008; Russo et al., 2007; Smidt, 2010; Chang, 2012) (Chapter 3.3).

Figure 2. A child stands to hold her animal picture in front of the class. The class decides together in which category this picture should be placed for this sorting game activity.

The main goal of this activity was to evaluate the strategy of using pictures and sorting games to explore and promote active discussion about biological characteristics, but also environmental and cultural aspects associated to certain animals. From the sorting activity, it is expected to assess the i) effectiveness of using pictures and sorting games to introduce and explore novel topics in class; ii) overall information about birds among the children; iii) curiosity and engagement of the children regarding birds; iv) particular information or events about birds that children already know; v) particular information or events about birds that children intend to know or experience.

3.1.1.1 Formative assessment

With this activity, two animals in particular seemed to be debated about whether or not they were birds – the butterfly, and the bat. Because these two creatures fly, the children were unsure about whether or not they were birds. Though the majority of the children were aware that some birds do not fly, like

the penguin and the ostrich, there still was some uncertainty about whether or not butterflies and bats were birds based upon the fact that both fly. Instead of giving the correct answer, children were encouraged to discuss the question with their families and told that we would discover the answer together later on in other activities.

3.1.2 Activity 2: Mommy, why am I a bird? Story

In Activity 1, children explored together physical characteristics, behaviors, and habitats of different animals, focusing primarily on birds, and discussed also together which animals were birds or not. Activity 2 was a reinforcement activity using a story (Annex II).

In Agnes Nobel's book, Education through Art: the Steiner School Approach, using storytelling is described as "the most effective method" to teaching young children (Nobel, 1996 p. 25). Like previously written, Nobel also discouraged attempting to transfer factual information onto young children, and instead suggests presenting information to children artistically through various forms of expression in order to develop the children's interest in the subject so that they can learn more factual and specialized knowledge as they continue through the education system (Nobel, 1996).

The strategy used was to construct a fun story reiterating the information and messages from the children in Activity 1. During the story a projector displaying images was used while the story was read aloud (see link provided in Annex II). At the end, children were encouraged to discuss the story and aspects that they did or did not like.

The story was assessed based on children's verbal feedback immediately after the story, as well as later in their classrooms when they discussed the story together.

2.1.2.1 Formative Assessment

At the end of the story, the children demanded an encore, at which time; the teachers complied with the request. This demonstrates that the story was entertaining for the children, and a successful means to captivate their attention to reinforce the information they learned from the first activity. Being entertained by ecological themes helps to build the connection and interest in the children to go further and learn more about the subject.

Teachers also reported that the children stated enjoying the story with the projected images. The most common feedback was that the children remembered and discussed most easily birds singing, being born from eggs, and having feathers.

3.1.3 Activity 3: Bird picture treasure hunt

In Activity 3, children enjoyed a mysterious “bird treasure hunt.” The first clues – two photos and a message – were left on a wall commonly used by the children. The message was read by the educator when the children arrived to their classroom after being away. The message instructed to choose which one of the two animals was a bird in order to receive directions to a “surprise.” In order to receive the directions to the next set of pictures, they had to correctly choose the bird. At the next point, children had to choose, between three photos, which one was of a bird (Figure 3).

This form of purposefully-framed play (Edwards & Cutter-Mackenzie, 2011) allowed children to first interact with the images they discovered in the classroom, and then follow the “model” of the instructor of choosing the correct image before moving forward to the next step of the hunt.

Figure 3. Three photos are given where the children have to choose which animal is a bird out of a butterfly, a monkey in a tree, and an owl.

This continued until the children had to choose the bird out of six photos of animals. In this way, children are actively moving and playing with the theme of birds (Figure 4), and fulfilling the educational strategy of including play activity and games surrounding the theme (Chapter 1.3.2), while at the same time the children's ability to choose the bird image correctly was observed and noted (Brooker & Edwards, 2010) to determine if the children are ready to move forward based upon the answers they give.

At the end of the treasure hunt, the children arrived to an egg incubator that was used later for another activity. Children were asked to discuss what they thought the incubator was and how it could be used. They were encouraged to touch it, open it, look inside it, and imagine what its use was. On the incubator was a "mysterious" note that explained to the children that the machine was empty, but at some point it would be filled with "something," at

which time they could come back to visit the machine and maybe some of their questions would be answered.

Afterward, children were provided art materials if they wanted to draw out how they imagine and predict the machine worked.

Figure 4. Children run and search for the next cluster of photos.

3.1.3.1 Formative assessment

At each step of the “treasure hunt” the children would have to all be in agreement of the bird before the picture was turned over to reveal if they were correct or not. Using this sort of team strategy with answering the questions, there were no errors in the choices. Every class at every step successfully chose the bird out of the group of animals presented. With the clusters of pictures that contained a butterfly, which was previously incorrectly considered a bird, every classroom of children chose the owl as the bird of the cluster (Figure 3). When presented with an animal in a tree or with eggs – commonly known characteristics of birds – they still chose the bird correctly (Figure 5)

When the children reached the incubator, they seemed very puzzled. The most common idea was that the machine was used to cook or to wash something. Their guesses most likely reflected the machines that they observed

in use in their daily lives and suggest that none of the children have seen or used an incubator before.

Figure 5. Though children were presented a mammal on a tree and a snake with eggs, they still consistently chose the bird image.

3.1.4 Activity 4: Bird sounds

During this passive, observational activity, bird sounds were simply played on a stereo during the day to spark children's curiosity and also to continue the theme of learning about birds even when no constructive activity is organized.

During children's playtime or other unrelated activity, bird sounds were played at a very low volume. The volume was raised at equal intervals every few minutes until full volume was reached to create a subtle immersion into the bird sounds. For about 30 minutes at full volume, the children's reactions, comments, questions, and/or interactions with the sounds were recorded for later analysis. Then, the volume was lowered again at equal intervals every few minutes until the sound was muted. The entire activity took about 45 minutes. The children were asked afterward if they would like to try to listen for real birds outdoors. Those who were interested went outdoors to listen for birds and used their imaginations to imagine what the birds were saying. Children were also

encouraged to imitate the bird sounds and asked what they would sing about if they were a bird.

3.1.4.1 Formative assessment

In one classroom, the bird sounds went noticed, but not discussed and did not spark nearly any interaction between the sounds and the children. Two classrooms became particularly involved in discussing the bird sounds, and in one classroom, half of the children became engaged with the sounds, while the other half did not (Annex III).

A common event was that the children imitated the sounds that they heard, chirping as if they were birds. The sounds sparked in one child the inspiration to run back and forth the classroom and dancing saying she was pretending to be a chicken [see link provided in Annex III]. Interestingly, in one classroom, a short discussion was started between the children about where bird sounds are coming from and where birds live.

“I don’t think they can be indoors”
“Some birds are indoors”
“The birds are singing”
“Some live here in Coimbra”
[Children imitated songs and bird noises]
“I went to the woods. There are birds there” (Annex III).

When asked to use their imaginations to translate what the birds were “saying” when they sang songs, some children responded this way:

“We’re eating.”
“We’re playing.”
“Bye.”
“They are afraid of witches.”
“Hello.”
“They are just living.” (Annex III).

None of the statements recorded (Smidt, 2013; Annex I.IV) reflected that the birds were communicating with each other specifically, for example about territory or mates. This might be an interesting theme to explore with the

children, and a way to branch into a new segment about listening to bird calls, using the children's misconceptions about bird songs as a means of developing the program in a corrective manner (Harlen, 2001a).

3.1.5 Activity 5: The "Cantinhos dos Ninhos" project

To include not only family members, but also community members in a conjoint effort in an activity focused on bird ecology; an event was organized at the preschool, using upcycled wood materials collected from throughout the city to build bird houses. Parent and community volunteers were recruited to help make usable wood pieces from the upcycled materials to be used for building. With the guidance of parents and/or community members, the children learned to use hammers and nails, or screws and screwdrivers, and sandpaper (Figure 6). In addition, each child was able to express their creativity through painting, decorating, and drawing on the bird houses (Figure 7, see link in References).

Figure 6. A 4 year-old child using a hammer for the first time with the guidance of a parent volunteer.

Before construction began, parents and volunteers were instructed on how to include the children in the building process, and guided with some ideas for discussion while building. For example, parents were encouraged to ask the children questions like “Which birds might live in these houses,” “Why is the roof slanted,” “Why will the houses be put high in the trees” and/or “From which predators might birds need to protect themselves?” Encouraging open discussion between the children and volunteers aims to further emphasize the educational triad of school, child, and family/culture (Smidt, 2013) and dialogic relationship (Gadotti, 1994; Smidt, 2013).

Figure 7. Children paint bird houses they just helped to build.

According to Fraser et al. (2010) one of the apparent obstacles of parents spending time with their children in a natural setting is the idea that nature is too far away or difficult to reach. However, green spaces found in urban centers, can indeed still be places of EcoEd experiences, and cultivate pro-environmental attitudes and stewardship due to the likelihood of maintained, direct contact with the natural place (Sobel, 1998). So, not only was this event an opportunity for parents to be involved in their children’s learning, it was also

a means of introducing children and their families to a natural space in their community, hopefully fostering an interest in nature and in particular the local bird species (Wells & Lekies, 2006). The experience also combines in- and out-of- school experiences which allow children, families, and community members to see firsthand the ecological importance of their work (Schleicher, 1989), and educate them about bird species and local environmental issues that may put wildlife at risk.

After the bird house construction was completed, the thirty houses were hung by the children and volunteers in the city's botanical garden (Figure 8). For some children, family members, and volunteers, it was their first experience or their first experience in a long time, visiting the garden (Figure 9).

Figure 8. Child choosing a bird house to hang in the Botanical Garden.

Children and volunteers were able to see their finished products put to use in a local area, creating an incentive to revisit the locale, therefore increasing the likelihood of visitation for the botanical garden, and creating an intrinsic connection within the children to a natural area (Ewert et al., 2005; Wells & Lekies, 2006; Chen-Hsuan & Monroe, 2012) close to their homes.

Materials collected, houses constructed, and the amount of participation from parents and volunteers were all recorded and used for analyzing the success of this study.

Figure 9. Some children exploring the Botanical Garden.

3.1.5.1 Formative assessment

Thirty bird houses were built with the help of over seventy people from seven different community groups. Twenty-two of the bird houses are hung currently in the city's botanical garden where they can be easily accessed by the children and their families. Volunteers and children alike expressed that they enjoyed the activity, and particularly enjoyed the visit to the Botanical Garden. Further study is needed on how many parents, children, and volunteers were first-time visitors, and how many subsequently revisited the Botanical Garden. In addition, a study on how many families/community members became more interested in birds and bird protection is necessary to analyze the longer-term impacts of the activity.

3.1.6 Activity 6: Incubator treasure hunt and incubation activity

Based upon the success of the initial "treasure hunt" (Chapter 2.1.3), a second hunt was designed to correlate with the first, which led to the egg incubator once more. The second hunt started spontaneously with a knock on

the classroom door. When a child opened the door, they discovered pictures of birds and a question. The teacher read aloud each question about each cluster of bird images, such as “which of these birds has talons for catching prey?” Upon answering unanimously, the picture was turned around to reveal if it was correct or not. Correct answers led to directions for the next set of pictures.

When the children arrived at the last step, there was the incubator, plugged in with eggs inside, and a “letter from a mother hen.” A few children at a time were allowed to gently touch the eggs and explore the incubator closely while a webcam and projector displayed the eggs and the inside of the incubator onto a wall, so that the entire class could see easily. After each child was able to look at the eggs and the machine more closely, they discussed, with the guidance of the teacher, what the machine was. The teacher then read aloud the letter, in which a mother hen named “Gina”, explained what the machine was. Again, this is a blurring of the lines between reality and pretend, taking advantage of fairy tales and storytelling in an imaginative way to captivate the children’s interests (Nobel, 1996; Hägglund & Pramling, 2009). Children then discussed how to keep the eggs safe while they grew, and what the chicks would need once they were born. Interactions with animals, particularly where children play guardian-like roles, promote empathy, responsibility, and ethics because children must infer what the animals need, in this case, imagining themselves as the chicks (Maruyama, 2010).

Again the children’s ability to correctly answer the questions, as well as statements made regarding the incubator was used to analyze this activity.

3.1.6.1 Formative assessment

One common misconception was that the eggs were being cooked inside the machine. This could be a reflection of the children’s own life experiences,

only seeing eggs being cooked, and not associating them with a means of offspring development. The lack of experience and/or knowledge in this regard is reflected in the initial questionnaire responses (Chapter 3.2.3). When asked "how are birds born" and given a choice between "through eggs," "directly from the mother's body," "from the ground," or "in colonies," nearly 40% of the children responded with "in colonies," and less than 30% chose "through eggs."

During the activity, when asked how we can take care of the eggs, a recurrent response was to keep them safe and warm, to not keep the eggs where the children play regularly, and to keep the machine plugged in.

Once the chicks are born every classroom came to the conclusions that the chicks will need food and water, suggesting that preschool-aged children have some conception of the needs of animals for survival, even when living in an urban setting and never having interacted with chicks before.

They seemed to understand at the end of the first encounter with the incubator that the eggs inside were different from eggs that can be bought in a store, though, in general, they were unsure of what made them different, and why some eggs had developing chicks inside and why some did not.

Children were unsure what the chick might look like inside the egg. Some children suggested the chick was sleeping inside the shell, while others imagined the chick looking like they do when they are born, but only much smaller. No child suggested that the chick could move, eat, or drink while inside the egg, however, which is contrary to the findings of Harlen (2001b) who found that children in a classroom with incubating eggs believed a miniature-sized chick was inside feeding on food and breathing air.

Nearly every day the children asked if the chicks were going to hatch that day, showing high interest in the incubator at every age level. Unfortunately the chicks were born at night, so the children were unable to see the full hatch, though they saw the beginning of some eggs cracking and could hear one chick chirping inside its egg. Because the incubator is not supposed to be open when the eggs are soon to be hatched, when the eggs were close to hatching, a webcam and projector was set up so that children could see inside the incubator more easily. Children also looked up close through the clear plastic lid to see the cracked eggs - one with a beak peeking through.

The next day the children were able to watch a video of the chicks hatching and they were introduced to the chicks that did hatch. The chicks went to live with a teacher, and were brought back a few weeks later for the children to interact with (Figure 10).

Some children were interested in touching and holding them, but some were very afraid and startled easily by any sudden movement the chick made (see link in References). This anxiety might be due to the fact that children living in urban areas might be separated and lack connection with nature (Louv, 2005; Miller, 2005) particularly with animals that are not dogs or house cats. Further study would need to be conducted to confirm this suspicion. Nevertheless, the hesitation among the children to interact with the chicks may indicate a need for more animal exposure activities such as this, to bring more comfort with the children in order to foster a sense of curiosity, care and protection rather than fear and aversion.

Figure 10. Children gather to take turns holding and interacting with a chick.

3.1.7 Activity 7: Feather and oil experiment

Mimicking the experiment outlined by Azul et al. (2009 p. 58-59), groups of three to four children at a time were presented with chicken feathers to look at, handle, and play with. They were then asked to describe what the feathers looked and felt like. After, a cup of water was placed on the table in front of them, and they were asked what they thought would happen if they put the feathers in the water, and if they wanted, they could also draw what they thought would happen. Then, they were encouraged to take their feathers and see what happens if they put them in the water. They observed that the feather could get wet but that the feather stayed more or less the same. Next, they were presented with a cup of polluted water – water with oil, and asked again, what would happen to their feather. Again, they were encouraged to dip their feathers in the polluted water to see what would happen, to observe, and describe their feathers before and after and make drawings.

3.1.7.1 Formative assessment

Participation in this activity was lowest out of all the activities due to the large amount of children absent around the time of spring vacation session

(when the activity took place), and the inability to schedule a time to implement the activity later in the school year.

When asked what would happen if the feathers were put in either water or the oil and water mixture, responses were coded into categories: "realistic" (i.e. “it will get wet”), "unrealistic" (i.e. “parts will fall into the water”), "fantastical" (i.e. “it will turn into a witch.”), and "neither" (i.e. “I don’t know” or no answer) (Figure 11).

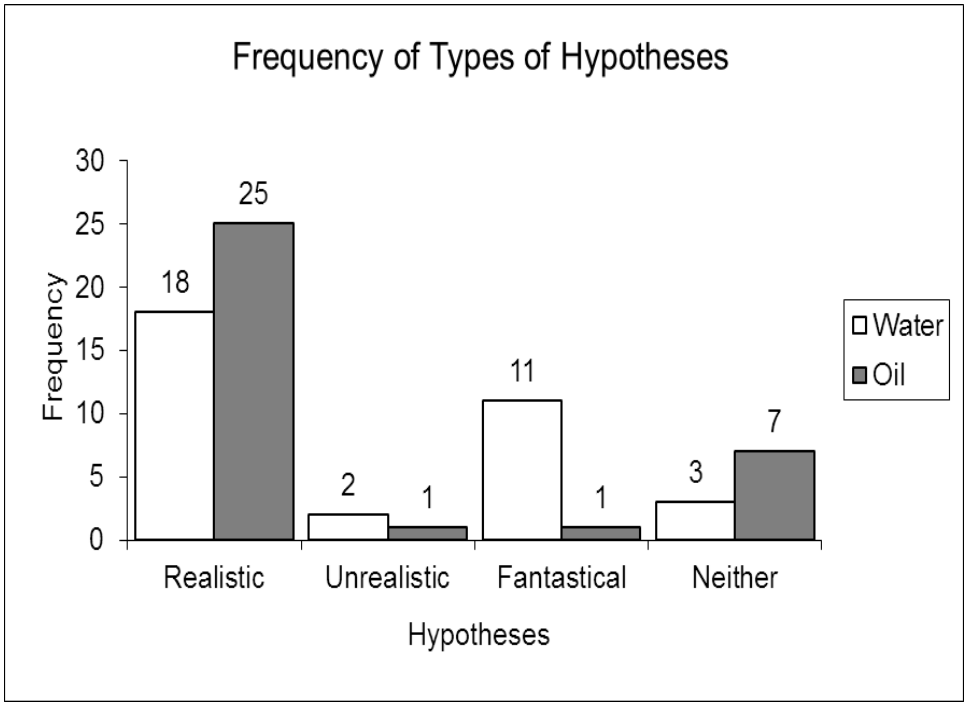


Figure 11. Graph showing types of responses made during water and oil experiment with feathers.

Since children were encouraged to place the feather in water first, and oil second, there is a visible difference in the amount of fantastical responses. This might be due to the children performing the activity and observing the lack of fantastical effect, and transferring their observations to the second trial with the oil/water mixture. The most common response to the oil/water mixture trial was simply that the feather would get dirty (N=17).

Less concerned with the state of the feather, many children used the dirty feather to draw on the paper towels on the table, creating designs using the feather like a paint brush.

One child was particularly interested in the experiment, and acted as a group leader. He suggested trying to clean the polluted water, by adding more water. After adding more clean water and seeing that the feather did not change states, he wanted to put soap in the water and try cleaning it. The group went to the bathroom and the children put liquid soap in the cup and tried to put the feather in it, without any difference. The instructor then suggested they agitate the water with their fingers to mix the soap and water together. The children did and put the feather back in, but noticed that instead of only oil, there was still oil and now soap bubbles. At this time, they had to leave for another scheduled event, but the interest and autonomy the children showed was unique to this particular group.

3.2 At-home activities

Because parents' participation in their children's education increases children's motivation to learn (French, 2007) and because early childhood education has been shown to be influential at developing pro-environmental behaviors and attitudes especially if families are hands-on in the process (Robertson, 2008; Samuelsson & Kaga, 2010; Chapter 1.3.4.2), simple at-home activities were designed to allow children and their family members to connect through discussing ecological themes. Each at-home activity emphasized that the activity was optional so that it was not seen as "homework," but simply an entertaining exercise.

3.2.1 At-home activity 1

Children were sent home with a quarter-sheet flyer which asked family members to discuss with their child the animals that their child knew that lived in their neighborhood, their country, and the world and then to discuss whether the animal was a bird or not. No documentation of the answers was asked for. The directions encouraged using other sources of knowledge such as the internet, other people, or books to broaden and/or confirm their answers. The parent/family member was then asked to send back a slip of paper with the child if they participated in the activity for record-keeping purposes.

3.2.1.1 Formative assessment

Eleven of the 62 children returned slips confirming that they participated in the at-home activity. No notes or questions were left by parents. Teachers did not report any feedback from parents.

3.2.2 At-home activity 2

Spending time observing nature with a respected adult increases the likelihood of children developing pro-environmental attitudes (Wells & Lekies, 2006). Again, children were sent home with a quarter-sheet flyer which asked family members to go outside with their child and try to take a picture of a bird or a sign of a bird. Signs of birds may include feathers, bird droppings, a nest, or something a bird would eat. The photos could be then e-mailed to teachers, where the photos would be printed and turned into a collage, posted in the entryway for the children and family members to see easily.

3.2.2.1 Formative assessment

Only one family member reported performing the activity with their child, though they did not share their photo. The lack of participation in this activity may have been due to parents' perception of nature being far away from home

or difficult to access (Fraser et al., 2010). Without further inquiry any conclusions would be speculative.

3.2.3 *At-home activity 3*

Children were sent home with a quarter-sheet flyer which asked family members to make note of any time their child discussed, pointed out, or observed birds. Poole (2001) wrote how it is imperative to include parents in the observational assessment of children. Asking parents to share stories of new behaviors is recommended (Poole, 2001). Indeed, the way that children explore and discover for themselves should be observed, noted, and interpreted with family participation (Smidt, 2013).

3.2.3.1 Formative assessment

Only one family filled in the note sheet and submitted it, but parents' comments during the bird house activity, or casual interactions at the school were noted. The most common response was recounting of activities done at school (i.e. Treasure hunt, interactions with the incubator/chicks, and the bird house construction). Other observations noted were children pointing out birds (while riding in the car for example), birds appearing independently in drawings more frequently, and an increase in questions or comments about birds.

Feedback like this is indicative of children's interest in the activities, and the influence these activities have on their life outside of school.

3.3 Activity framework in use

As discussed in Chapter 1.3, the effectiveness in constructing knowledge, critical attitudes and actions may be closely related with four frequently reemerging components – Discovery, Play, Expression and Connection (Figure 12) in an education program. There is often an overlap between the activities and the elements in which they utilize.

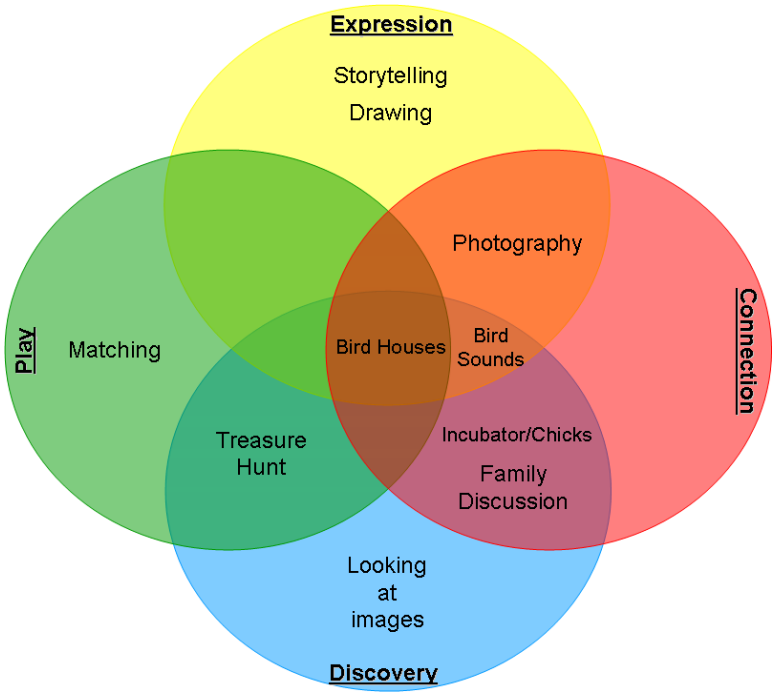


Figure 12. Using the framework developed in Chapter 1.3, activities can be categorized based on the elements they possess. This can be used to assess the variety of the activities.

While using the framework as a guide and fitting the activities to it, six activities had Discovery components, five had Expression components, five had Connection components, and three had Play components. This type of preliminary, formative assessment can be used as a guide to adjusting and planning future activities. Based on these results, the activities should be altered to include more games/play activities using the theme in order to create more balance amongst the teaching approaches.

Results and Discussion

4.1 Assessment

Assessment should be seen as a way to: i) analyze if learning goals have been met, ii) to determine the progress made by the children, as well as iii) to determine the strengths and weaknesses of the teaching methods and curriculum (NRC, 2008). Awasthy et al. (2012) reports the need for educators to assess their teaching strategies in a pragmatic way.

Before, however, one first needs to define the purpose of the assessment – What do I want to understand from the results of the assessment (Katz, 1997)? The assessment was conducted in three stages mimicking that of the three stages of Paulo Freire's pedagogical philosophy (Chapter 2.2):

i) The initial assessment intended to gain a general understanding about what the children already new about the subject (NRC, 2001). The results from the initial assessment were also helpful for selecting the criteria and the activities better suited to their level, particularly concerning their misconceptions or curiosity for scientific concepts (Harlen, 2001b). Moreover, the initial assessment allowed a valuable baseline on which to compare the activities' effectiveness (Hattie, 2009).

ii) Formative assessments, which take place constantly during the course of the activities, are where feedback from the teachers, children's statements, behaviors, misconceptions, enjoyment, etc. are noted and analyzed to determine the path of continuation from activity to activity (Chapter 3).

iii) Summative or final assessment at the end of the activities took place to analyze the effectiveness of teaching based on children's progress in knowledge and attitudes, and to determine which children were taught most

effectively in which subject areas. This information can also be used for the next developing theme in order to make teaching more effective to all students.

Like Freire (Chapter 2.2), Hattie (2009) argued that teachers should then use the information obtained from assessment to re-evaluate their teaching strategy and approaches, to see the results of assessment not as a marker of how clever the students are, but how effective the teacher is (Hattie, 2009). Hattie called upon educational systems to rethink their standard of measuring effectiveness of teaching (Hattie, 1999). Years of experience are not sufficient enough to prove efficacy; especially educators who believe they teach well because of "it works for me" models need to compare their teaching methods to other teaching methods (Hattie, 1999 p. 2). There are not many teaching methods that make children fail, and because of this, teachers believe that their style is effective, but Hattie argues that almost any teaching method can be considered effective if it is compared to zero rather than the average effectiveness (Hattie, 2003 p.4; Hattie, 2009). So, teachers need not ask if children improved, but how did they improve when comparing to the average possible improvement.

The typical effect of any educational approach implemented is an Effect Size (ES) of 0.40 (or 0.40 Standard Deviation) (Hattie, 2009). Hattie (2009) argued that an ES of 0.30 is like comparing the height of a 1.8m tall person and a 1.82m tall person. Reflective of Paulo Freire's philosophy, Hattie (2009) identified the teaching strategies that actually make remarkable differences in student achievement and learning and revealed that one of the top strategies is educators' desire to constantly improve the quality of their teaching and to verify their methods and the effect on student learning (Hattie, 2009).

So, to conduct the initial and final assessments, triangulation was used to gain multiple perspectives in understanding the data acquired (Stake, 2000), and the results of the data-collection methods (quantitative and qualitative) and sources (questionnaires, drawings, and structured, group discussion) were compared statistically as well as using the Effect Size standard.

The National Research Council (NRC) (2001) states that any kind of assessment constrains the kind of information that can be obtained, and the more kinds of information attempted to be obtained by one assessment, the less accurately the assessment will provide information about the children (NRC, 2001). In order to gain a more well-rounded view of the children's initial and final levels of understanding and attitudes, three methods of assessment were used: a questionnaire, a drawing, and a structured, group discussion. These assessment methods were also chosen to best judge the progress made by children reliably and in a scientifically valid way (Schweinhart, 1993) Observation and anecdotal notes common in the Reggio Emilia approach (Chapter 2.1; Smidt, 2013) were used as formative assessment to add detail to and support the other methods of assessment (Schweinhart,1993), as well as to analyze the most effective way to continue the activities to best suit the children at their current level (NRC, 2001, Shermis & Divesta, 2011). Indeed, the current knowledge level and level of ability needs to be clearly comprehended by the educator in order to judge the best educational route that will further their knowledge, filling in the cracks observed in the results of the assessment (NRC, 2001; Shermis & Divesta, 2011). In this way, educators use assessment as a means of analyzing the quality of the teaching methods, rather than solely ability of the children (Hattie, 2003).

Black & William (1998) reported a lack of educators critically discussing the assessment methodologies. In this study, the assessment methodology confers by itself an outcome as result of close collaboration between the researchers directly involved in the supervision, the specialists in pedagogy and ecology interviewed (Annex I), and the educators of JISASUC. During the research project, regular meetings were conducted among researchers and educators to discuss the results and the assessment strategies and methodologies and to progressively construct the follow-up actions. Discussion about the results of assessment and how to change and improve teaching with qualified colleagues and supervisors is highly suggested in order to make the education efforts the most effective (Hattie, 2003).

4.2 Questionnaire

Since they are easily replicated and administered to multiple people at the same time, questionnaires are often used to collect information on people's attitudes and knowledge, or to help define a target audience for an eco-focused program (Jacobson et al., 2006). This study's questionnaire was structured in a mostly multiple-choice style with one free-answer question. The answers reflect the children's identification and classroom demographic information, environmental attitudes, and general knowledge about birds (Annex IV).

4.2.1 Procedure

To avoid confusion due to a non-native Portuguese accent, native Portuguese-speaking school teachers or teacher assistants administered the questionnaires by reading each question aloud to a child along with the possible answers. Administrators were instructed to not help the children answer the questions or to explain any vocabulary to the child, and to not perceive the questionnaire as a test or a reflection as them as teachers. Children were then

selected one-by-one to participate in the questionnaire. Before the questionnaire was conducted, the child was told that we wanted to know what they thought about some questions. The administrator (either a classroom teacher or teaching assistant) then asked each question followed by the answer choices. If a student did not respond, responded that they did not know, or gave a different response than any of the choices, their response was noted and counted as a "0" response in the analysis.

In regards to the free-answer question, children were asked to name their favorite bird which may indicate their understanding of the word "bird" and if they know at least one bird by common name. Their responses are also indicative of particular linguistic characteristics of the Portuguese language. In Portuguese, two different common words for the English word "bird" exist. The first and most commonly known is "pássaro" which technically means any bird from the Passerine order such as finches, sparrows, and swallows. This word and definition, therefore, excludes flightless birds, water fowl, birds of prey, and more. The second word "ave," which includes all the birds, was described to be "more scientific" and not a word commonly used by preschool children. For the purposes of this study, the word "ave," that is representative of the entire class of animals, was used.

4.2.2 Questionnaire analysis

Each questionnaire received a non-weighted score and weighted score. The non-weighted score was calculated by giving one point to each correct answer given out of 16. Weighted points were given after the final assessment to each question based upon how many activities the question pertained to, making the questions that were discussed more often, more important, and reflective of children's knowledge acquisition. The initial assessment was

graded again using the weighted point system after all activities were conducted. For the free-answer question, “what is your favorite bird” children were given four points if they named a type of bird (such as “duck” or “pigeon”), two points if they replied with a bird, but not a specific type (such as “the bird that flies”), one point if they replied with a description with no bird vocabulary (such as “the one at my grandma’s house”), and zero points if they replied with anything else. The system is to reflect their knowledge and preference for a type of bird, or bird vocabulary.

4.2.3 Results

4.2.3.1 Knowledge

A total of 62 initial questionnaires were administered (Male n=34; Female n=28. Average $Age_{Initial}$=3.58 years, SD=0.74 years; Average Age_{Final}=4.05 years, SD=0.84 years). A paired, one tail T-Test revealed a statistically reliable difference between the means of the initial and final scores of the children in both the non-weighted and weighted scores (Table II), $t(61)=14.16$, $p \leq 0.05$, $t(61)=13.00$, $p \leq 0.005$.

Table II. Average, standard deviation (SD), and Effect Size (ES) of attitude, non-weighted, and weighted knowledge scores of the initial and final questionnaires.

	Attitude Score	Knowledge Score	Weighted Knowledge Score
Average $_{Initial}$	49.5%	34.6%	37.8%
Average $_{Final}$	75.4%	65.4%	73.4%
SD	31.6%	22.0%	25.1%
ES	0.82	1.40	1.42

Chi^2 tests were performed to determine if responses were distributed evenly across the given choices. In the initial questionnaire results, children tended to favor answer “4” for 10 of the 14 questions that had four response choices. The correct responses to Q14 and Q18 were response “4;” however,

the Chi^2 test revealed that children's correct responses to Q18 were most likely random (Table Ⅲ).

Table Ⅲ. Frequency of multiple-choice responses chosen for each question and significance derived from Chi^2 tests in the initial assessment. *p<0.05; **p<0.01; ***p<0.001

	4	Not 4
Q09	21	41
Q10	16	46
Q13	21	41
Q14†	28	34***
Q15	26	36**
Q16	32	30***
Q17	25	37**
Q18†	21	41
Q19	24	38*
Q20	28	34***
Q21	28	34***
Q22	38	24***
Q23	27	35***
Q24	37	35***

† Question whose correct response is "4."

The children favored answer "4" in five of the 16 questions, where two of the five questions' correct answer was indeed "4"(Table Ⅳ).

Table Ⅳ. Frequency of multiple-choice response chosen for each question and significance derived from Chi^2 tests in the final assessment. *p<0.05; **p<0.01; ***p<0.001

	4	Not 4
Q09b	01	61
Q10b	03	59
Q13b	05	57
Q14b†	47	15***
Q15b	08	54
Q16b	29	33***
Q17b	10	52
Q18b†	29	33***
Q19b	01	61
Q20b	02	60
Q21b	04	58
Q22b	25	37**
Q23b	17	45
Q24b	24	38*

† Question whose correct response is "4."

The results of fifteen out of sixteen questions improved significantly (Table V). A Chi^2 test was performed to determine if correct verses incorrect answer frequency was random. Twelve of the sixteen questions showed that children chose the correct response a disproportionate amount of times than could be considered random (Table V).

Table V. Percentage of students who answered the question correctly in initial and final questionnaires. Asterisks indicate *p*-value associated with Chi^2 tests *p<0.05; **p<0.01; ***p<0.001; † Low Effect Size; †† Medium Effect Size; ††† High Effect Size

	% Initial	% Final	ES
Q09	49	93***	0.95†††
Q10	59	95***	0.83†††
Q11	61	59	0.00
Q12	31	70***	0.77†††
Q13	51	90***	0.84†††
Q14	46	77***	0.62†††
Q15	31	75***	0.87†††
Q16	10	23*	0.35†
Q17	44	72***	0.55††
Q18	34	48*	0.26†
Q19	30	97***	1.36†††
Q20	18	66***	0.98†††
Q21	38	79***	0.81†††
Q22	07	30***	0.59††
Q23	21	39*	0.39†
Q24	33	51*	0.36†

In addition to statistically comparing averages, effect size was also determined. As mentioned, Hattie (2009) found the average ES of any intervention treatment is 0.40 (Equation 1).

$$ES = \frac{Average_{(Final)} - Average_{(Initial)}}{SD}$$

Equation 1. Effect Size is the difference in average scores divided by the pooled standard deviation of the samples. (Hattie 2009 p 8)

Fifteen of sixteen questions showed improvement in children's responses. Chi^2 tests showed twelve answers were most likely not chosen at random in favor of the correct response. However, using ES as an indicator of

significance demonstrates only eleven out of sixteen questions had above average improvements (Table V).

Looking more broadly at the averages of attitudes and knowledge scores in the initial and final questionnaires, a high ES is also indicated (Table II).

4.2.3.2 Attitude

Children's affinity for birds significantly increased (Figure 13). More children reported that they liked birds "a lot" in the final questionnaire, than in the initial, and zero children reported that they did not like birds, compared to six children in the initial test. Because there were many children who reported liking birds initially, high increases may not have been observed due to ceiling effects.

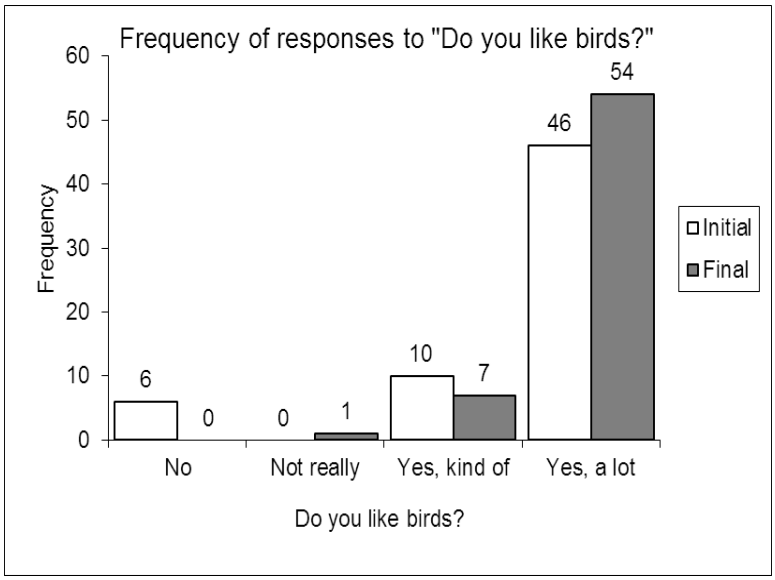


Figure 13. There were increases in children' affinity toward birds.

Large differences between the favorite birds reported in the initial and final questionnaires were observed (Figure 14).

Answers were coded also into categories – Species, "Bird," Description, Not a Bird, Unsure, and No Answer. "Species" requires that the student name a bird such as "Eagle," and not necessarily "Bald Eagle." "Bird" refers to any name given containing the word "bird" or referring to non-specific bird such as a sports team mascot or cartoon character. "Description" includes any color, location (i.e.

"The one at grandma's house"), and behavior (i.e. "The ones that fly"). "Not a Bird" means that the response is definitely not a bird, such as "cars" or "monster." "Unsure" means that the child responded with a non-word answer. Finally, "no answer" means that they either responded that they did not have a favorite, or upon being asked which their favorite is, they had no answer.

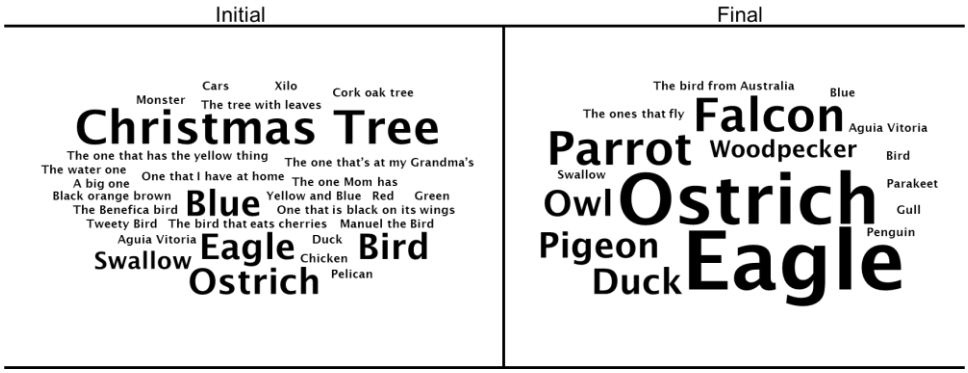


Figure 14. Word graphic displaying reported Initial and Final favorite birds. Each word was given 10px per time named. Larger-sized words, therefore, reflect more frequently-named species. Both Initial and Final word graphics use the same scale.

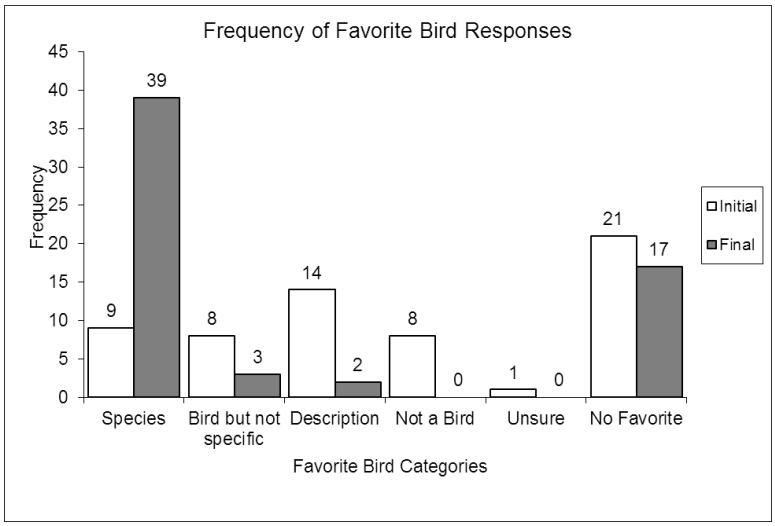


Figure 15. Favorite bird results of initial and final questionnaires.

Attitude scores, increased significantly on average $t(61)=4.97$, $p<0.05$, (Table II), however, fifteen individuals' attitude scores decreased, which accounts for nearly 25% of the population surveyed.

Comparing the average parental participation (Scale of 1 to 7) of the fifteen children with attitude scores showing negative ES (Average parental participation=0.33, SD=0.72) and the parental participation of the other children with attitude scores not showing negative ES (N=47, Average parental participation=0.94, SD=0.18), there appears to be a significant difference $t(60)=1.83$, $p<0.05$. Upon further investigation, the ES of attitude scores differs greatly as parental participation increases from no participation to participation in 3 or more at-home and volunteer activities (Figure 16). It is clear that the students whose parents participated more showed a high effective size in regards to attitude.

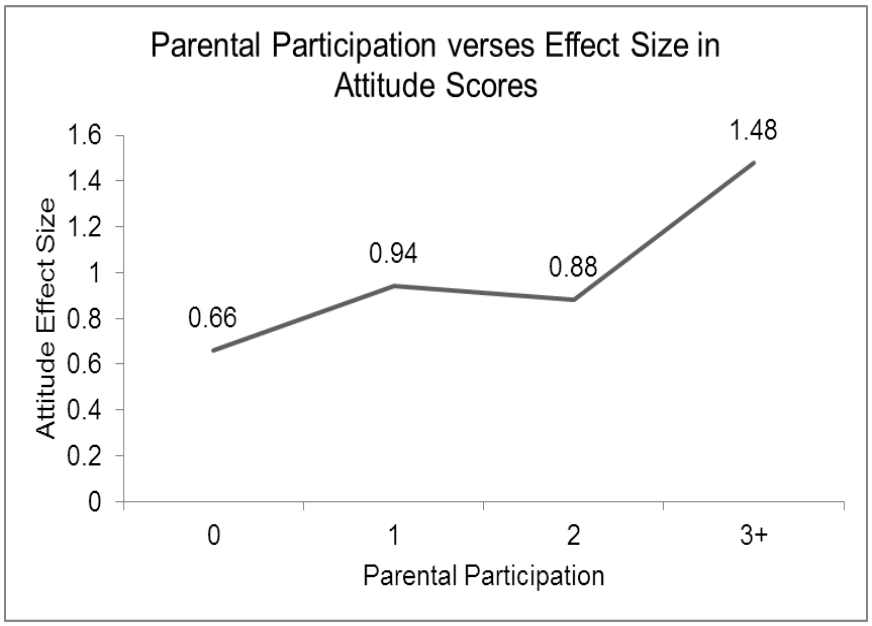


Figure 16. Children whose parents participated in three or more activities showed higher Attitude ES.

Presence in activities (ranging from present during 5 activities to 8 activities with one child present for 3 activities), did not prove to be a factor of attitude change due to the high presence of all students in activities, which did not allow for comparison between high (50-100%) and low (0-50%) presence. Comparison within students with high presence in activities did not reveal significant results (Table VI).

This leaves the question of how many or which activities specifically are sufficient for having a high ES on children's knowledge and attitudes.

Table VI. Attitude and Knowledge ES compared to high presence levels.

Presence	Attitude	Knowledge
5*	0.83	1.30
6	0.97	1.47
7	0.66	1.40
8	1.06	1.50

* One child present for three activities is included in this category.

4.2.4 Discussion

The results indicate that children demonstrated higher attitudes and knowledge regarding birds after participation in the activities.

Family participation in at-home activities and volunteer activities did not show to be related to knowledge acquisition in this case. Family participation did, however, demonstrate higher changes in positive attitudes regarding birds. This might be because family members who are interested themselves in nature and ecology were more likely to participate and also naturally pass their ecocentric values onto their children (Robertson, 2008).

Using a questionnaire may not be the best method to understand the views or knowledge of young children who might be confused by the questions, answers, or vocabulary, or who, in general, do not perform well on assessments that mimic the style of a standardized test (Katz, 1997; Chen & McNamee, 2007).

Furthermore, questions were determined before designing the activities to reflect what children's general knowledge of birds might be after EcoEd programming, and are only representative of a sample of teaching/learning objectives. The questions chosen may not accurately demonstrate the progress achieved, and may lead to restrictive teaching bias on the part of the instructor

for children to achieve specific learning goals related to a standard of test performance (Chen & McNamee, 2007; Harlen, 2009; NRC, 2011), which in turn can lead to restricting the means of assessment, and so on (NRC, 2011).

Furthermore questionnaires alone do not allow for understanding the reasoning behind the answers chosen (Ergazaki & Ampatzidis, 2012). For example, Question 22 asks, “Which bird lives in Portugal?”(Annex IV). Almost 62% of the children answered “parrot” in the first questionnaire. This might be because of family members who have parrots as domestic animals, because the children saw parrots at a zoo, or possibly a couple of domestic parrots can be seen easily and frequently leashed to a stand or in a cage outside homes nearby to the preschool. Alternatively, children may have chosen “parrot” because it was the last choice given, as mentioned previously. Nevertheless, the reasoning behind this answer cannot be found in the questionnaire, but would need to be answered through a follow-up, personal interview.

Moreover, the word “ave” was used instead of the more commonly known word, “pássaro.” Consequently, when administering the initial questionnaire, some children may have confused the word “ave” with the Portuguese word, “arvore,” which means “tree”. This is most likely the reason why “Christmas tree” was the most common response to the question “Which [is your favorite bird]?” It might also be the reason why some children answered Question #9, “What is a bird?” with the response, “a tree.” Because of the possible confounding with the vocabulary, results from the questionnaire can neither entirely reflect the attitude, nor the knowledge questions since the responses may have been derived from mistakenly thinking some of the questions about trees instead of birds. In addition, the first questionnaire was

conducted in the third week of December, leading up to the widely celebrated Christmas holiday, which may account for the number of students who said their favorite bird was “Christmas Tree.”

To correct this discrepancy, the questionnaire could add a question, asking whether or not the children understood what “ave” means. Alternatively, a picture with many types of birds displayed could be presented to the children prior to asking questions. It might better suit researchers to develop a questionnaire-style survey using only or mostly visual aids.

4.3 Drawings

Besides being creative outlets for children, children’s drawings can also be used as a method of assessing their knowledge and understanding about a topic (Dove et al., 1999; Prokop et al., 2008; Russo et al. 2008; Smidt, 2010; Chang, 2012). Expression through drawing can help children who may have difficulties communicating verbally to demonstrate their knowledge or opinions (Dove et al., 1999), especially to an unfamiliar adult (Malkiewicz & Stember, 1994). Indeed, studies have shown that some children are capable of drawing something they remember seeing, but have trouble describing it verbally (Malkiewicz & Stember, 1994).

Drawings are often used in the medical field to make psychological diagnoses using standardized, quantitative analyses (Malkiewicz & Stember, 1994). In this case, however, drawings are not being assessed on level of artistic ability, or the skills used while drawing (i.e. pincer grasp). Drawings are being used to give children the ability to express themselves in an informal, comfortable way using a pre-literate means of expression without requiring them to express themselves verbally.

Teachers can gauge teaching effectiveness by comparing drawings, along with the statements made whilst drawing, from before and after a lesson to be able to show what children learned and how they progressed on their understanding of concepts (Dove et al., 1999; Prokop et al., 2008; Chang, 2012). For example, if there are differences between a child's drawing of an animal's body before and after a lesson, an increase in understanding at least on the level of the physical characteristics of the species would be indicated (Chang, 2012). However, the characteristics included in a drawing may be limited by the drawing ability of the child (Dove et al., 1999, Figure 17). If a child believes they are not able to draw certain characteristics, they may leave those characteristics out of the drawing on purpose (Dove et al., 1999).

FIgure 17. Example of final drawing. Student stated that he could not draw a bird, but that he could draw a feather instead. Drawing is of feather (left) and nest (right).

In addition, children may be at different levels of development in regards to their drawing ability (Bird & Diamond, 1975). Therefore, it is important when developing criteria for analyzing a drawing to be mindful of the various

developmental stages - Scribbling, Symbolism, and Visual Realism (Bird & Diamond, 1975) – that children will experience at this age.

1. Scribbling –Children around two- to three-years old are learning to use art tools. There is little to no resemblance between the drawing subject and the drawing itself (Figure 18).

Figure 18. Example of scribbling done by 2-year-old child.

2. Symbolism – Children around three- to four-years old draw shapes to represent objects that do not realistically look like the object (Figure 19).

Figure 19. Symbolism. Line on right was chicken, circles were eggs with chicks inside, and lines in corner were nest.

3. Visual realism – When a child reaches the Visual Realism Stage, around four- to five-years-old, there is more resemblance between the subject and the drawing (Bird & Diamond, 1975 p 10; Figure 20).

Figure 20. Example of Visual Realism. This drawing, done by a 5-year-old student, is discernible as a bird. It possesses obvious body parts that are more realistic.

Though drawings can be used as indicators of progress in knowledge, various methods to determine children's attitudes towards a subject based solely on a drawing have shown to be inconclusive (Burkitt, 2004). However, one study analyzing children's drawings before and after participating in either an educational program on oral hygiene that was solely computer-based, or that was computer-based with hands-on, tangible elements, demonstrated that children who participated in the hands-on elements drew multiple actions or contexts of oral hygiene or placed themselves in the drawing. The differences in drawings between the groups can be an indication of a higher level of engagement and interest with the subject and activity on the part of the children who participated in the additional hands-on elements (Sylla et al., 2011).

4.3.1 Procedure

At the end of each child's questionnaire, they were asked to draw a picture of a bird and a nest. What may appear to be scribbling to an adult may represent an entire back story to the child. So, analyses of the drawings were not done simply visually, but also with investigative questions. To minimize the possibility of lost meaning or misinterpretation by the assessor (Dove et al., 1999; Prokop et al., 2008), notes were taken of the statements that each child made and the vocabulary used while they drew. If there were ambiguous aspects of the drawing, children were asked to explain their drawing or to explain what specific elements represented. This aspect of the drawing activity can allow children, who feel comfortable, to talk with the adult in an open dialogue, rather than creating an atmosphere where the teacher talks only to (as opposed to with) the child (Chang, 2012).

To minimize the effect of leading the student to the desired response (Maxwell, 2005), only two probing questions were asked: "Can you tell me about what you drew?" and "What is this?"

Example 1	*Example 2*
The assessor is unsure if a child drew a smile or a beak. They ask the child, "is this a beak?" The child responds, "Yes."	The assessor is unsure if a child drew a smile or a beak. They ask the child, "What is this?" The child responds, "It is a beak."

In Example 1, the child's response indicated possible understanding of the word, but not their ability to produce the word independently. It is possible that the child responded "yes" without really knowing to what they were agreeing. The assessor cannot definitely mark "beak" as present in the child's drawing since the intention to draw the beak is not obvious.

In Example 2, the child's response indicated their knowledge of the word, "beak," as well as their intention to draw a beak instead of a smile or a nose. The assessor can definitely mark "beak" as present in the child's drawing.

The statements made while drawing and/or the responses to the two probing questions (if asked) were written down and used to analyze which elements children included in their drawings and subsequently give an initial and final score to the drawings.

After the child had completed their drawing, they were also asked what their bird was called, and their responses were noted.

4.3.2 Drawing analysis

The drawings were analyzed based upon whether or not the child drew a bird/nest, the presence or absence of a list of basic bird body parts (head, eyes, beak, wings, legs, talons, feathers), the presence or absence of eggs and/or chicks with the nest, and if the child drew a specific type of bird.

Assessment should be consistent. That is to say if multiple people assess the same drawing, the scores should be similar if not the same (Schweinhart, 1993). To ensure the scoring process is reliable and that assessor bias was not a factor in the scoring, a random sample of five different drawings was given to three volunteers who were unfamiliar with the project. The volunteers were asked to mark whether the various elements were present or absent using the drawing and transcribed notes that were taken while the child drew as indicators.

T-tests determined that the differences between the author's scores and the volunteers' scores were insignificant (Table VII), suggesting that the scoring system is reliable and consistent.

Table VII. Fifteen of the 62 drawings were scored by three volunteers unfamiliar with the project. The volunteers' and author's scores did not differ significantly.

Volunteer	Volunteer Scores					Assessor Scores					T-value	p-value
1	34	72	80	24	64	26	64	73	24	73	0.85	0.45
2	60	59	84	84	84	60	59	92	60	92	1.35	0.25
3	56	56	59	56	00	59	48	63	59	00	-1.81	0.87

4.3.3 Results

In the initial drawing, the average amount of attributes each child included in their initial drawings of birds (M=2.02, SD=2.37) was less than their final drawing average (M=4.10, SD=2.43) (Figures 21, 22; Annex V).

Since there was a great difference between the number of children who drew birds, drew nests, and named their birds between the initial and final drawings (Bird $N_{initial}$=39, N_{final}=59; Nest $N_{initial}$=33 N_{final}=54; Name $N_{initial}$=22 N_{final}=50), there could be differences in percentages simply because of the increased participation. So, the total number of children who drew those particular elements acted as the denominator for comparison instead of the total amount of children.

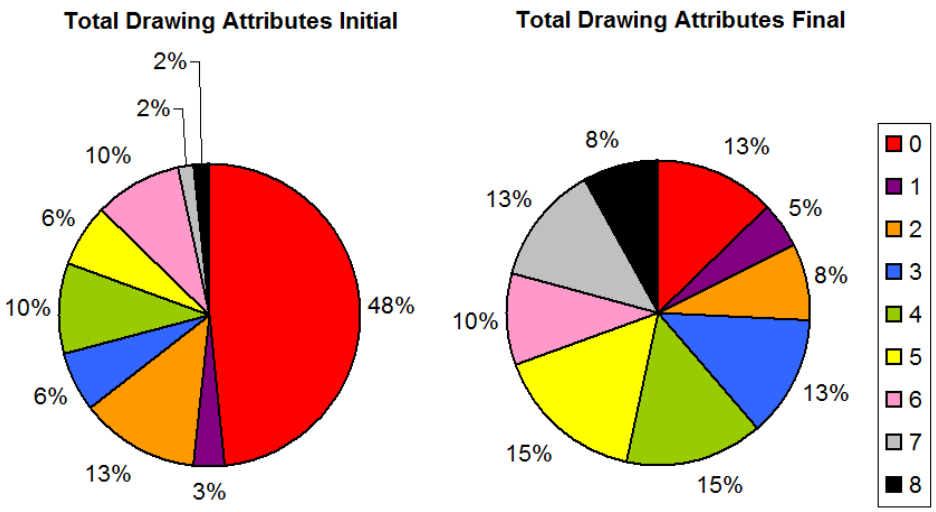


Figure 21. Total amount of anatomical attributes (Head, body, beak, etc.) that children drew in their bird drawings.

Figure 22. Initial bird not a specific bird. Final drawing is of a chicken who is trying to fly because “chickens can’t fly well.” The second nest is underneath the bird and contains eggs, whereas the first nest lacks dimension and interaction with the bird. Initial score=64%, Final score=92%.

The most common elements in both the initial and final drawings were a head, a body, and eyes (Figures 22, 23). The least common elements in both the initial and final drawings were talons, a beak and feathers Nests were frequently depicted as round, and sometimes shaggy looking. Initially, nests rarely included eggs and almost never included chicks. In the final drawing, however, the frequency increased in eggs and nearly tripled in chicks.

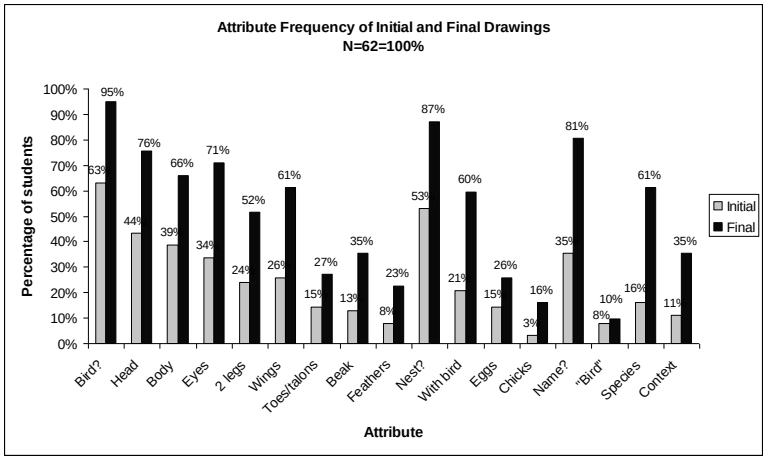


Figure 23. Percentage of attribute frequency in children’s drawings where Total Number of Children questioned=100%.

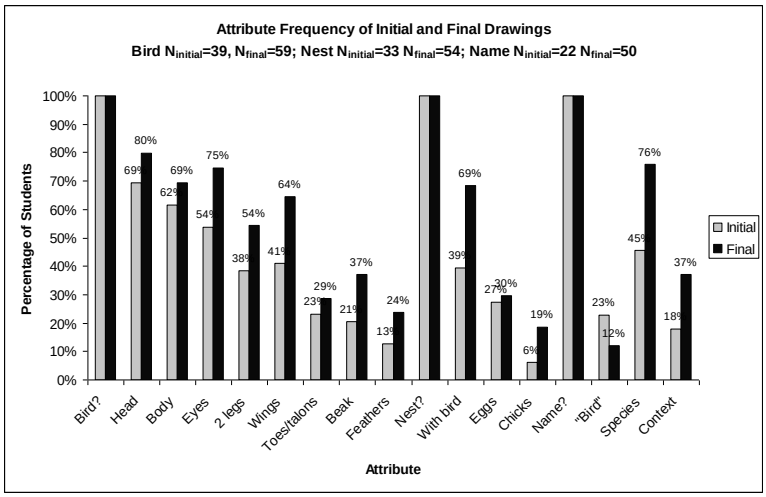


Figure 24. Percentage of attribute frequency in children's drawings where Total Number of Children who drew the attributes=100%.

Besides the difference in elements, the differences in the names given to the birds were considerably different (Figure 24; Table VIII).

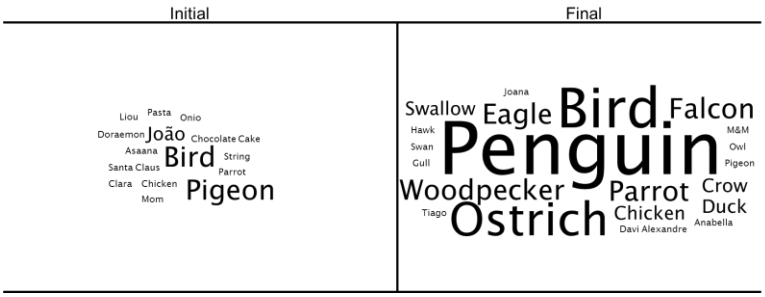


Figure 24. Word graphic displaying the differences between the names of the birds drawn in the initial and final drawings. Each word was given 10px per time named. Larger words reflect more frequently given names. Both Initial and Final word graphics use the same scale.

Table VIII Chart showing frequency of response categories to the question, "What is your bird called?"

	Not a bird	Species	"Bird"	No Answer
Initial	12	5	3	43
Final	5	39	6	13

A paired, one tailed, T-Test revealed a statistically reliable difference between the means of the initial (M=30.3%, SD=24.0%) and final (M=58.1%, SD=24.0%) drawing scores of the children, $t(61)=9.25$, $p \leq 0.05$; ES=1.0. When recalculated to exclude the children who did not draw a bird initially, there was still a significant difference of the initial (M=38.2%, SD=20.4%) and final

(M=68.2.0%, SD=21.8%) drawing scores of children, t (47)=7.49, p ≤0.05; ES=1.22.

There were no significant differences between drawing scores and either presence in activities, parental participation, or attitude score. Though drawing and questionnaire scores were linearly correlated (Figure 25), there were still discrepancies between questionnaire answers and between questionnaire answers and drawing attributes. For example, Q12 asks, “Do all birds fly?” Eighteen students answered, “Yes,” but half of them answered Q15, “Which of these birds do not fly?” correctly with “Ostrich.” Moreover, three children drew birds that do not fly. Another example: two of the seven children answered “What do birds eat with?” incorrectly, drew beaks in their drawings. Lastly, two of the three children who answered “How are birds born?” incorrectly, drew eggs in their drawings.

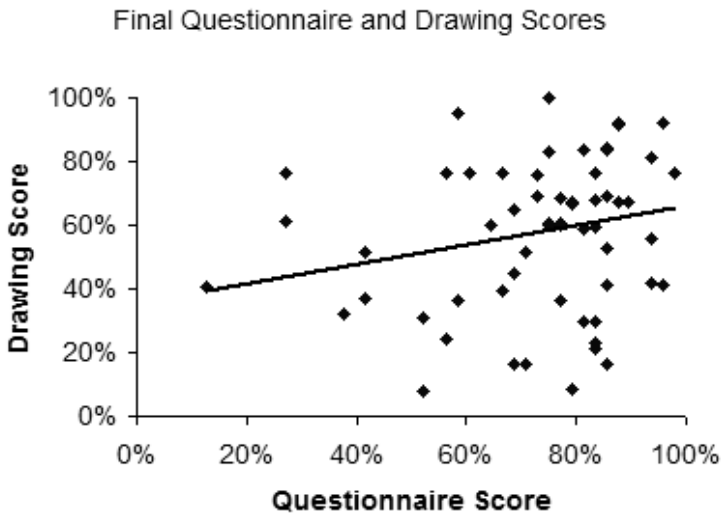


Figure 25. There is a positive linear correlation between Final Questionnaire and Drawing scores.

4.3.4 Discussion

There are some limitations to analyzing the drawings. Some children were not verbal when asked investigative questions. So, there is a possibility that some children’ drawings contained attributes of bird anatomy or a context,

but if it was not obvious, it was not counted. During the initial drawing, it is also possible that the children were uncomfortable speaking with an unfamiliar adult. Those children perhaps did not draw or verbalize about their drawings for this reason.

Another limitation arose in the scoring of elements. A student drew a swan sitting (Figure 26), and their drawing is naturally missing legs. This does not mean that the student does not picture the bird without legs or that the student does not know how many legs birds have. Scoring the drawing objectively, in this case 7 out of 8 – excluding the legs - is not completely indicative of their knowledge due to the position in which they drew the bird.

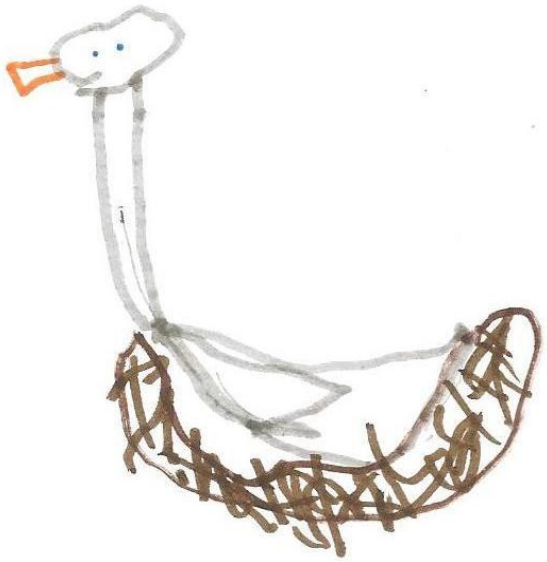


Figure 26. Drawing of a swan sitting in a nest.

In addition, because the children were asked to draw a nest, some children did not draw nests because it did not go with the context of their drawing. For example, one student drew a parrot in a cage (Figure 27). When asked to draw a nest, the student responded the bird did not have a nest since it lived in a cage. Their score for the nest, therefore, was zero. Again, this is not

indicative of the student's knowledge of nests. A more general request like "draw a place for the bird to live," may be more appropriate.

Figure 27. Drawing of a parrot in a cage.

Lastly, between the initial and final drawings, there was a dramatic increase in the amount of drawings that contained a context (habitat, storyline, action, etc) (Figure 28). The development of these contexts might indicate a higher level of engagement in the activities and the subject amongst those children (Sylla, 2012), but is not reflected in the score. This calls for a need to change the drawing criteria in future studies to include qualitative measures to account for "context."

Figure 28. Initial (left) and final (right) drawings of birds. Initial drawing of a non-specific bird and nest scored 73%. Final drawing of a mother and baby owl in a tree scored 100%.

Due to these elements, more extensive criteria for scoring, with qualitative aspects included would be more suited for a summative assessment using drawings. Because of the discrepancies between the questionnaire answers as well as between the questionnaire answers and the attributes included in the children's drawings, it is recommended that both methods of assessment be utilized for more in depth analysis of children's knowledge acquisition in young ages.

4.4 Structured, group discussion

The third method of summative assessment was a structured, group discussion. This method could be used as a formative assessment since continuous interpretation of children's statements, commonly used in the Reggio Emilia pedagogical approach (Smidt, 2013), allows teachers to use their judgment to assess progress rather than using tests (Harlen, 2009) and having to wait for the tests' results (Smidt, 2013). Indeed, writing down the incorrect statements the children make, allows the assessor to know in which direction they might start their educational approach, which subjects to explore, and which misconceptions the children might have before preparing a project in a formative assessment. Instead of maintaining a strict syllabus of activities, it is recommended to allow for spontaneity or reinvention so teachers can best suit the activities to the needs of the children (NRC, 2001; Kim & Lim, 2007; Shermis & Divesta, 2011).

However, this method can also be used to help teachers to decide if they can start a new theme and to see what children have learned. In this case, the statements made specifically in the structured, group discussion before and after the bird project were used as a summative assessment – to understand if learning goals had been met.

4.4.1 Procedure

Children in each class were simply asked “What are birds?,” and the discussion followed. Discussions with the children were audio-taped and transcribed (Smidt, 2013). Teachers were asked beforehand to not probe for information, but that asking general questions that would arise naturally was acceptable.

The transcriptions were analyzed by coding (Maxwell, 2005). This involved transcribing the discussions, reading each transcript closely to determine codes, rereading the transcripts to categorize the codes into themes, and then generating comparisons between the initial and final discussions (Miles & Huberman, 1994).

4.4.2 Structured, group discussion analysis

The analysis of the data demonstrated five general categories - incorrect statements, correct statements, novel statements, repeated statements, and anecdotes. Then further sub-categorization revealed six different themes - anatomy, feeding behavior, locomotion, habitat, life cycle, and species.

4.4.3 Results and discussion

Though a structured, group discussion allows for analysis of statements directly from the mouths of the children, there are nonetheless drawbacks. A group discussion is difficult to analyze in that the guiding questions asked by the teacher may not be the same before and after. In this case, the teacher was asked to pose the same questions as in the initial discussion to avoid this problem. However, other issues came in transcribing the discussions for analysis. Only one classroom’s discussion was distinguishable enough to be transcribed fully. This is due to children speaking over each other and the lack of fully-developed language skills of some children, making their statements

incoherent in the recording, as well as the lack of fully-developed Portuguese language skills of the author. Lastly, it is possible that the children knew more than they discussed, but it simply did not come to mind at the time. In wanting to minimize discussion intervention by the teacher and allowing the children to simply discuss what comes to mind naturally, some of the knowledge of the children may be left out.

Analyzing the novel statements made showed that indeed the topics discussed changed (Figure 29). In the first discussion, children spoke mainly about what birds look like - that they have wings, beaks, feet, etc. - and that birds fly. In the second discussion, after participating in the ecological activities, children discussed much less about the body parts that birds have and about birds flying, and they talked much more about more complex subjects like the different habitats in which a variety birds live and what certain birds might eat. This may suggest an increase in breadth of information they know or can discuss confidently. This also suggests that birds, as a theme, can lead to teaching about other ecological concepts such as animal habitats and feeding behavior.

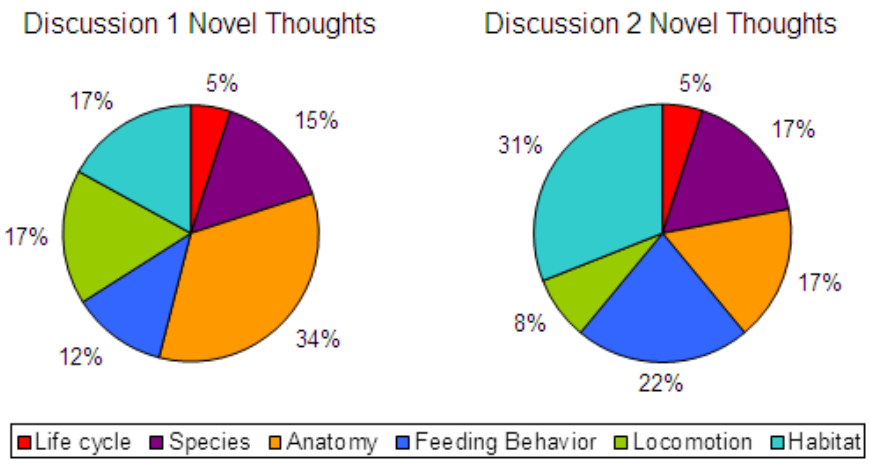


Figure 29. Percentage of novel statements made on particular aspects of birds.

Secondly, the amount of incorrect and anecdotal statements made also changed (Figure 30). The amount of incorrect statements decreased significantly, chi^2 (1, N=9)=8.604, p=0.003. Incorrect statements made in the first discussion included misconceptions of what animals are birds (i.e. a butterfly is a bird because it flies), and incorrect physiological attributes (i.e. hair, fur, arms). Anecdotal statements, that might suggest that children are noticing and observing birds more, and so tell more personal stories regarding their observations, increased; however, the change was not significant, chi^2 (1, N=11)=1.18, p=0.28.

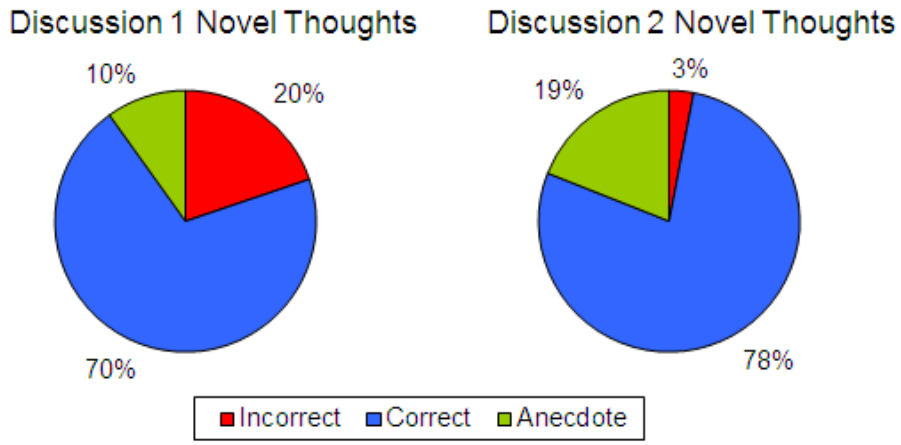
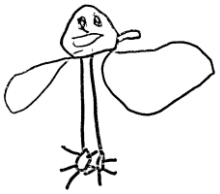


Figure 30.Types of novel statements made during the final conversation.

Lastly, educators reported the children introducing the bird project and bird concepts in other contexts and consequent projects on other subjects after the study concluded. Further investigation into the statements made, and the long-term impact of participating in the project is needed. However, anecdotes from teachers about the continuation of bird discussion up to three months after the study concluded is a positive sign of knowledge acquisition and attitude development.

Chapter 5: Conclusions



Conclusions

This study aimed to develop an educational approach to teach ecology, an area that is declining in regards to knowledge and attitudes among children, but which is a critical aspect of environmental education in early childhood, a life stage that is critical in developing pro-environmental attitudes and behaviors.

To accomplish this, collaborative action research was employed among multiple entities across the globe (including Australia, France, Indonesia, Portugal, the United Kingdom, and the United States) from multiple domains (including education, early childhood education, science education, environmental education, ecology, art, and humanities). From the collaborative action research, this study proposed a framework for designing EcoEd activities focusing on the aspects of Discovery, Play, Expression and Connection – terms that arose often through literature review, semi-structured interviews with specialists, and collaborative action research. It is unknown which specific activities have the highest effect size, though the combination of multiple hands-on activities following the guidelines of the conceptual framework as well as using multiple constructivist pedagogical approaches like those encouraged by Paulo Freire, Reggio Emilia, and The Green School, showed high effect sizes in attitude and knowledge regarding birds.

The author hypothesized ecologically-focused, hands on educational activities will improve children's ecological understanding and attitudes.

Results suggest that after one passive and six interactive activities surrounding the theme of birds, children showed an above average improvement in knowledge, as analyzed by a questionnaire, drawing analysis, and structured, group discussion comparison. In addition, children's attitudes regarding birds increased. Though children's knowledge regarding birds did not

appear to be affected by parental/familial participation, the attitudes of children whose parents participated three or more times in at-home or at-school volunteer activities showed much higher effect sizes than children whose parents participated zero to two times.

The contribution of the collaborative action research was essential to the success of this study. In addition to the literature review, advice and strategies were shared and discussed with multiple entities, allowing for the well-rounded approach and security in appropriate strategy. In addition, frequent meetings were held with the educators of JISASUC to develop and/or ameliorate the program to meet the interests and needs of the children. The feedback and insights from the educators were critical since they made note of comments made by children after the activities as well as during the in-between period from activity to activity, and also comments made by parents in regards to statements made and actions done by the children at home relating to the project. These means of formative assessments ensured the most suitable path to continue with the designed activities, at times requiring re-strategizing and re-designing the program.

In this study, the combination of qualitative and quantitative assessment was beneficial in understand the change in children's knowledge and attitudes. Multiple means of summative assessment allowed for better understanding of the overall impact of the program. Questionnaires, though useful, do not allow for gauging the reasoning behind the children's responses. In addition, if a child guesses correctly or misunderstands a question, there is less accuracy in regards to the knowledge they acquired based on the score they received. Drawings and structured, group discussions allowed seeing the evolution of

understanding in some children. The development in understanding of bird physiology as well as, in some cases, bird habitats and feeding behavior was seen through drawings. The differences in topics discussed during the structured, group discussion suggested that the children became more knowledgeable and/or confident in sharing ideas about more complex topics such as habitat and behavior.

Starting ecological education in early childhood may be a beginning step to developing and fostering a life-long commitment of stewardship to nature and the environment. Ecological education approaches should aim to lessen the separation between nature and society by focusing not only discovery and knowledge acquisition, but also, as suggested by the framework, on hands-on play in nature and with natural objects, allowing students to express themselves verbally as well as artistically about nature and nature concepts, and fostering a connection to nature and natural spaces by encouraging familial participation, exposure to natural places, and relating the ecological concepts to aspects of the culture. Approaches that reflect traditional teaching styles are discouraged

Further investigation in previous experience in ecological related themes, parental interest, place of residence, and cultural effect on knowledge and attitude scores is needed to draw more conclusions on the societal impact on ecological awareness prior to participation in an EcoEd program. Follow-up assessments to track the longer-term impact of the preschool activities on the children's ecological knowledge and attitudes would be beneficial to understand how lasting the impact is of such programming. Lastly, it would also be interesting to investigate the impact that early childhood ecological education has on parents' and families' ecological knowledge and attitudes.

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Links

Activity 5 (Chapter 2.1.5) – Bird sound observation
https://drive.google.com/folderview?id=0BwQvXBHa9m2oRjJkanNqMHk1M2s&usp=sharing

Activity 6 (Chapter 2.1.6) – Meeting the chicks
https://docs.google.com/file/d/0BwQvXBHa9m2oT2dCUWVfclNqT1k/edit?usp=sharing

Annex I: Interviews

I.I Dr. Helena Freitas

The following is an e-mail interview conducted with Dr. Helena Freitas, Professor at the Universidade de Coimbra, President of the Portuguese Ecological Society, and Vice-President of the Board of the European Ecological Federation. A short-answer-style questionnaire was e-mailed, and responses were sent back.

No altering was done to the questions or responses, but some social, personal, and/or anecdotal parts of the interview were omitted by the author for privacy purposes. The questions are written after a hyphen. The responses from the interviewee are written in *italics* and do not reflect emphasis.

- What are the main topics that better characterize your research?

Ecology; Mediterranean ecosystems; Forest and Agriculture; Ecology and management of exotic and invasive species; Nature conservation, diversity and distribution; Tree physiology; Plant and Fungal diversity; Metal-tolerance and bioremediation; Environmental policy; Bioenergy

- Within the realm of your research and experience, how would you define “Environmental Education”?

The development and implementation of educational tools and methods to support a friendly relationship with the environment, and to promote an individual and societal commitment with sustainable practices.

- In which aspects could the definition of “Environmental Education” differ from “Ecology Education”?

Ecological education is “ecology and nature-oriented”, that means based on ecological principles and knowledge (the scope is much more limited); environmental education is a societal approach aiming at a generalization of some sort of code of conduct.

- Taking your research and experience into account, how important is “ecology education” for society's path to a sustainable future?

Very important, as ecology establishes the scenarios of an ecosystems’ balance for Human well being, and brings up the importance of the relationship with nature. The more we know about the planet’s ecology, the more we will enjoy it and the more we assume its protection.

- Taking your research and experience into account, how important is “early childhood education” for society's path to a sustainable future?

Very important as children grow up in the “ecological context” and the family joins it easily.

- How can one apply "Ecology Education" approaches to preschoolers?

Bringing nature to the school! Showing the diversity of life and the interdependence of life cycles.

- What suggestions would you make to someone who wants to implement "Ecology Education" for the first time?

Learn as much as possible about nature and the diversity of life.

I.II Dr. John Hattie

The following is an e-mail interview conducted with Dr. John Hattie, Director of Melbourne Educational Research Institute and author of the book, Visible Learning. A short-answer-style questionnaire was e-mailed, and responses were sent back.

No altering was done to the questions or responses, but some social, personal, and/or anecdotal parts of the interview were omitted by the author for privacy purposes. The questions are written after a hyphen. The responses from the interviewee are written in *italics* and do not reflect emphasis.

- Please state your full name, title, and associated organization.

John Hattie, Director of Melbourne Educational Research Institute -- UoMelbourne

- Please describe the breadth of your research in regards to the main topics you have studied in depth.

I am a measurement, research design, and educational psychologist by training.

- Taking into account your research and experience, how important is “early childhood education” for society’s path to a sustainable future and why?

It has always been important but recently we seem to have decided to focus on it as a “readiness” for school notion. I recall when Piaget first came to the US he was consistently asked what he termed the American Question – how can we speed up the transition of young children through the early stages. His answer was always – and why would you want to. There are so many critical learning skills that can be taught in this early childhood phase and we need a healthy debate on what these are -- e.g., concepts about print, the love of the story, order and estimation of number, delay of gratification, communication and cooperation skills, competition to criteria and so on. My problem with most early childhood programs are that they are either too school prep based or too nothing but professional baby-sitting. My reading of the evidence is that by age 8 there is a wash out effect from participation in current early childhood programs as they do not emphasize the learning skills ….

- Why do some educators struggle to introduce science concepts to students?

Because they do not have sufficient content and progression knowledge of science. They cannot move even to the surface let alone the deep processes of early science.

- Is it appropriate for an educator to implement science, environmental, and/or sustainability curriculum to preschoolers? If yes, what is the best approach? If no, why not?

I would like a healthy debate about what the underlying concepts are but can imagine many such concepts being introduced very early … Play is a powerful medium, but living in a sustainable environment, responsibility waste disposal ….

- If an educator decides to implement an environmentally-themed project for preschoolers, how would the educator appropriately assess the success of such a project?

Preschool science is not my expertise so tough to answer. I would be looking for a) the number of students involved and successful, the nature of the collaboration, the student questions and b) the science surface and deeper notions --- this is better asked of a preschool science person.

- What suggestions would you give to an educator who wants to implement science education (whether it is related to the environment, sustainability, or other field of science) at a preschool level?

Just do it

- If there are any other topics of interest or information you would like to share, please do so.

Not for now

I.III Dr. Jane Johnston

The following is a transcript of a personal interview conducted via internet with Jane Susan Johnston, Associate Professor at Bishop Grosseteste University in Lincoln, United Kingdom, and co-editor of the peer-reviewed Journal of Emergent Science.

Some social, personal, and anecdotal parts of the interview were omitted by the author. Verbal references to works were replaced with accurate citations and noted with a footnote. The questions from the interviewer are written after a hyphen. The responses from the interviewee are written in *italics* and do not reflect emphasis. Words written in brackets [ ] were inserted by the author, whereas parentheses ( ) reflect the words of the interviewee.

- Can you please state your full name, your title and associated organization?

Right. My full name is Jane Susan Johnston. I am a Reader in Education, which is often known as an Associate Professor and I work at Bishop Grosseteste University in Lincoln in the UK.

- Can you describe, in general, the subjects you have studied in depth?

My research interests are connected in the intersection of three areas. There's Primary Science Education, Early Years Education, and Teacher Development/Professional Development of teachers and practitioners. So my research is really within that realm. In a nutshell, it's to do with Early Years Science or what I call, Emergent Science.

- Within the realm of your research background could you come up with a definition of "environmental education?" What would be your definition?

It's education about the world in which you live, the world around you. I quite like the term that the Early Years Foundation Stage document from many years ago, I think it was called "Curriculum Guidance in the UK," and they actually called "science" (and geography and history), "knowledge and understanding of the world." I actually think that sums it up.[1]

- Expanding from that, would you say that there would be a separate definition between "environmental education" and "ecology education?" If so, how would they differ?

I suppose in some ways it might be semantics. It might also have to do with the level. The sort of level that I am working with, working with very young children, I would have thought that "environmental education" probably sums it up, and generally sums it up for the general populous. Ecology might be looked up on as the science of Environmental education.

- How important is "early childhood education" for society's path to a sustainable future?

Absolutely essential.

- In what ways and why?

Education starts and environmental education starts pre-birth. Children before they're born are learning things about their environment in which they are living in the womb. From the moment they are born, they continue to develop and learn about the world in which they live. If we don't capitalize on that, it brings enormous issues for society later on in life.

- In the same structure, but switching "environmental education" with "early childhood education," how important is it for sustainability to incorporate that into curricula?

Again, it's absolutely essential. I was fascinated about 20 years ago when I did some research in Finland. We asked teachers of primary school children what they thought "science" was. For the Finnish teachers it was very much about the environment. There science curriculum is very much about geography, biology, and ecology. Whereas, if you ask British teachers at the same time, they say that it's all about experimenting and inquiry and observing. It seemed to me at that time that there was an awful lot of our understanding of science and of environmental education and the importance of it, which was socially, politically, and historically due to these factors. In Finland, for example, they were really concerned about the pollution that was coming from the Soviet Union at the time, now Russia. They were also very concerned about pollution in the Baltic Sea and things like that. So, I think we all need to have that same sort of attitude.[2]

- How can one apply different scientific approaches for preschoolers? From my research I have found that some educators feel teaching science concepts is too advanced for children between the ages of 3 and 8 years old. So how can we apply science in a way that is appropriate for this age?

I completely disagree with that viewpoint. It actually is a viewpoint of people who are scientists first and educators second. If you are an educator first and a scientist second then you understand the way in which children develop. Any concept can be studied and explored and understood at a very simplistic level, and it can also be explored at post-doctoral levels and even higher levels. Again, if I go to the very young child who sits in a [stroller] and can't walk but they play the game "throw the toys out of the [stroller]," what they do is look immediately at the ground and they know that their toys fall to the ground. So, they are beginning to know something about gravitational force. They don't understand gravity. It's a big concept for adults to understand, but [children] begin to observe and make links between things at a very young age. So I think for very young children, the approach is to allow them to explore their everyday lives, make connections between the scientific things they observe and other phenomena, so that they can start to get a more well-rounded understanding of that concept.

- Can you give suggestions about ways to assess science education at such a young age?

The way in which it's done in our early years program, which is quite a good way, is really just to observe the children and make notes of the comments that they make and things that they do.

Which will tell you that they can do something, or they do understand something, or they don't understand something. So if you're out in the environment outside and they observe some birds and they make a comment about what birds like to eat or that they fly or they have feathers, then you can make a note of that, and that gives you evidence if they understand this or that. It also gives you evidence on something else you can do to 1) captivate their interest (because it's all about awe and wonder at this age) but 2) what sorts of activities from you could help them with their next stage of their understanding.

- What suggestions would you give a teacher who wants to implement science education for the first time at a preschool level?

It's about play, and with play I use the word "expiration" as well which at this stage means "play." I think it's about setting up experiences whether it be role-play, that has scientific opportunities within it, whether it's "expirations" of natural phenomena, for example, putting a big bowl of ice or snow on a table and letting them play with it, to giving them a range of some toys to play with so they can begin to explore the ways in which the toys are moving, etc. So it's all about play, and then asking them questions that will stimulate their curiosity that will encourage them to think about something deeper, and playing along side them as a role model in awe and excitement about the world.

- Is there anything you would like to add before we end?

Well I think you probably have done your own reading and research. There are quite a lot of early years science resources that are out there. [Sue Tunnicliffe] is very up on early years and working with zoos and the natural environment with birds and other animals and nature. She has got a very particular interest in a similar way, but we have the same viewpoints on those things.

1. The following is the exact quote and citation referenced: "explore and recognise features of living things, objects and events in the natural and man made world and look closely at similarities and differences, patterns and change" SCAA (1996) Nursery Education: Desirable Outcomes for Children's Learning on entering compulsory education. London:DFEE:4

2. The citation for the study conducted: Johnston, J., Ahtee, M. & Hayes, M. (1998) Elementary teachers' perceptions of science and science teaching: Comparisons between Finland and England, in Kaartinen, S. (Ed) *Matemaattisten Aineiden Opetus ja Oppiminen* (Oulu, Oulun yliopistopaino): 13-30.

I.IV Charlotte Souter

The following is an e-mail interview conducted with Charlotte Souter, Outdoor Exploration Pre-Kindergarten Faculty for The Journeys School of the Teton Science Schools. A short-answer-style questionnaire was e-mailed by the author, and responses were sent back.Follow-up questions based upon the responses were subsequently e-mailed, and responses were sent back.

No altering was done to the questions or responses, but some social, personal, and/or anecdotal parts of the interview were omitted by the author for privacy purposes. Website addresses included in the responses were omitted from the text and added to a reference list at the bottom of the annex. The questions from the author are written after a hyphen. The responses from the interviewee are written in *italics* and do not reflect emphasis. Text written in brackets [ ] was inserted by the author, whereas parentheses ( ) reflect the words of the interviewee.

- What are the main topics that best characterize your educational approach? Is there a pre-defined curricula or requirements?

Our Pre-Kindergarten follows the Reggio Emilia approach. Two years ago, I attended the Teton Science Schools Graduate program[1] which teaches how to incorporate place-based and experiential education. Journeys School, which is Pre-K through 12th grade[2] is part of the Teton Science Schools. In my work, as the Outdoor Explorations curriculum coordinator/teacher I strive to combine the project aspect of Reggio and the place-based approach that is so important to children's appreciation of their natural surroundings.

The curriculum for Reggio is student driven, with teachers in the role or researchers. The following is an example of what we are doing this year. Next year, we will evaluate our students' interests to determine how to explore our natural surroundings with the group.

For Outdoor Exploration, we have begun each year (I have been working in the school for 1.5 years) by introducing our children to different outdoor areas of our Campus. During these times, we take pictures of children interacting with one another and within nature and document their conversations and observations, to better understand their interests. I think of the fall (late August through mid-December) as a time to get to know our children, to help them to feel comfortable and excited about moving around outside, and to observe their prior knowledge and interests in nature. By the end of the fall, the children have experienced hiking, snow, rain, sunscreen application, getting to know their friends, looking for signs of animals, the jungle gym, forts, and practice getting on their outdoor clothes; My co-workers and I have experienced what our young students are excited about in nature. This year, children seem(ed) very excited about birds, particularly the ravens that frequent the roofs above our play yard.

Winter is a very long season for us in Jackson, Wyoming. The snow in the Valley begins to stick in November and continues through April. In the mountains, I have seen the snow stick as early as August and stay in some capacity throughout the summer months. This said: snow is an important and very present natural part of our children's lives. In early January, we began an exploration of snow. This is meant as a time to get children comfortable and excited to spend time outside in the cold. We introduce sledding, snowshoeing, cross country skiing, shoveling, snow science (crystals, layers of snow, snow pits, etc.), building with snow, have fun playing with avalanche beacons, and practice putting on "The Big Five" (hat, mittens, snow pants, coat, boots) as independently as possible.

With children excited about moving in and on the snow we are now ready to begin our outdoor investigation of birds, which will likely take us through the end of the school year.

*To introduce this more focused exploration of birds (which will begin this week), I came up with a series of questions to ask the children and different ways to explore birds within our community. Some examples of questions are: What birds do you know? What birds do you see in Jackson? What would you like to know about ____ bird? An example of an exploration may be: How many birds can we count outside today? This would also be interesting to repeat as the birds begin to return in the spring… and a great way to discuss migration. I also hope to take journeys (field trips) to The Raptor Center[3], the National Museum of Wildlife art[4] (which is featuring a book about crows), the National Elk Refuge[5] (which has trumpeter swans, eagles, geese, and of course elk), the Snake River (to see osprey and eagles), and perhaps to the bagel shop to watch the crafty ravens remove the lid to the dumpster to steal stale bagels. *We are lucky to have the resources and support of our school to take these journeys.* I also hope to invite "local experts" in to talk about their experiences with birds. For example, one of my friends is a serious bird enthusiast, working in the field during the spring, summer, and fall, and I have asked him to join us in March. And one of my professors does a great raven call, and I am hoping he will come in to help our kids make bird sounds. Finally, we will read books, watch YouTube videos, and continue to research how children are interpreting birds. In all of these explorations, the point is not for my kids to know*

everything there is to know about birds, but rather to pique what could become a lifelong interest, appreciation, and/or understanding of these creatures. In the same way, the questions we ask about birds do not have a correct answer and any ideas that the children contribute to conversation is important to their learning, the building of their confidence, their creativity, and our understanding of how they see the world.

Although birds will be our main exploration for the remainder of the winter and into the spring, we will also be planting vegetables, participating in a dance class, and having fun in the snow, mud, and trails!

- Within the realm of your educational approach, how would you define "Environmental Education"?

I would say that environmental education is the idea of taking care of our natural resources. In my approach, I teach children to care for their natural surroundings. We practice staying on the trails, respecting all living things (flora, fauna, friends…), picking up trash on Campus, recycling and terracycling, and perhaps most importantly, appreciating nature as it is.

- In which aspects could the definition of "Environmental Education" differ from "Ecology Education"? If there is a difference, how are we able to incorporate "Ecology Education" within "Environmental Education"?

I believe that ecological education refers to how living things are connected within the environment. We are a part of the environment because we live in a certain area. The most important part of my job is helping children to establish their Sense of Place. This connection to different aspects of their communities will hopefully contribute to their sense of responsibility to the environment and the goals of environmental education.

- If there is a difference between "Environmental Education" and "Ecology Education," can you give specific examples of how "Ecology Education" is incorporated into your educational approach?

I believe that ecological education is a big part of my educational approach. One of my favorite quotes is "Talking to trees *and hiding in* trees *precedes saving* trees." **(Sobel, D. (2008). *Childhood and nature*: *Design principles for educators*. Portland, ME: Stenhouse Publishers)** *I strive for my children to have positive, interesting, and exciting experiences in their natural surroundings, to begin to understand their Place within nature and how they fit into their various communities.*

- How can one apply these different "Environmental Education" and "Ecology Education" approaches to preschoolers?

See answers 1 and 7

7. What suggestions would you make to teachers who want to incorporate "Ecology Education" into their daily curriculum for the first time?

- *I would say the first things that one should do is go for a very slow walk on your own. Take the time to sit in nature, write down your thoughts, draw, and notice things that you walk by every day without seeing.*

- *Next, go on a very slow walk and think about how children are seeing this world. Again, sit, write, draw, and notice what they may be seeing for the first time.*

- *Once you are comfortable with how you fit into your Place, open these experiences up to your kids. At first it can be nerve racking to have small children outside and exploring. Wherever I go outside, I take a backpack with medical supplies in case someone takes a fall, needs to blow their nose, to carry extra mittens, etc. There are opportunities for teachers to take basic wilderness first aid to become a Wilderness First Responder (WFR), Wilderness First Aid (WFA) and more. One of the reasons I feel confident outside with my kids is because I have taken my WFR. Another reason is because I have practiced supervising preschool aged children outside every school day for the past 1.5 years. Practice makes one more confident and I believe that every day outside with kids is an important part of my growth as an educator.*

- *Find out what your children are interested in and be flexible to their learning. To incorporate ecology, I do research on my own, try to ask my students meaningful questions, accept their understandings of how and why things work in nature, bounce ideas off of my co-workers, and think of ways to engage the children outside.*

- *One fun way to incorporate ecology and get kids comfortable with their surroundings is to make up searches (with clues) and to hide things for children to discover. Last week, for example, "The Fairies of Jackson Hole" left our children a note in the class mailbox. The search led them to many of their favorite places on Campus, where they dug in the snow for clues, and eventually led them to their afternoon snack with the aid of a clue and an avalanche beacon. Earlier this year, there were rodents (laminated photos of local rodents) hidden all over our play yard. The children located the photos, counted them to make sure they were all there, and all the while learned some of the rodents that live in our area.*

- *Taking children to neat places outdoors and allowing them to play and explore is wonderful. You can ask yourself, how are the children using their environment and surroundings in their play?*

- *Look at natural items up close with small groups of students. If a child notices something or I see something of interest, we'll stop and have a closer look. Perhaps not all of the children are with you, but by taking the time for small investigations, we are sharing the importance of all things in nature: from larger than average snow crystals, to brown leaves clinging to an aspen in the dead of winter, to stopping to ask a raven "what are you doing up on our roof?", and so much more!*

- *Pay obvious attention to children's interests outside and ask questions about their observations.*

- *Bringing in "local experts" of children's outdoor interests. A couple of weeks ago in the midst of our exploration of snow, for example, a mother (a renowned mountaineer and skier, who recently took her Avalanche III course) came in to share some of her knowledge and excitement for snow crystals, snow pack, and to teach the kids how to use beacons outside. As mentioned above, this spring we hope to visit different places with birds and to have guest speakers join us to talk about birds.*

- *Have fun! If you are not enjoying your time outside, you students will pick up on it. Be creative in order to engage both your students and yourself (create games, searches, songs, etc).*

- *It is okay not to feel great about everything in nature. I, for example, am not a huge fan of holding snakes (we do not have any native poisonous snakes in Jackson). When we do encounter snakes outside, we observe them, talk about them, and make sure that they are safe as they travel to their destination. Last year, a friend walked by just as a snake was visiting the children's play yard. We asked him to pick the snake up and the kids were very excited to see this "expert" handler in action…*

- In the realm of Reggio Emilia, are family and community members involved in the school-based education process of the preschoolers? Are there specific activities that involve family/community groups (either planned or unplanned) in your curriculum/approach?

The goal for our program is to make it as much like the happenings in Reggio Emilia, Italy as possible. Our lead teacher, has been practicing the Reggio philosophy for ten years or so and visited the schools in Italy last fall. Every year we try to involve family and community members as much as possible in our explorations. Some examples of community/parent involvement are:

** This year, [two colleagues] are heading up a Remida Project (using non-recyclable materials to create art), which will hopefully take place during our communities EcoFair[6] We will involve the community by asking local businesses for specific items that they may consider "trash" or "re-usable" (such as springs, buttons, pipes, etc) and have community members help to create a piece of art.*

** In terms of the regular happenings in our classroom and outside: we invite local experts/parents in to talk to children about their expertise; and invite parents/family members to join us on our outings.*

** We host three Parent Nights a year, where parent come in to learn more about what is going on in the classroom, mingle, and do projects for their children. During the second parent night, we give parents a challenge and put them to work... Two weeks ago, parents created costumes of Native Americans, trappers, and pioneers for our older children and built store fronts (with wood and power tools) for our younger children. The children have continued to work on the projects that their parents began...The older children working on their costumes and the younger children will paint their storefronts...*

** In the spring we have an art show at The Center for the Arts in Jackson. We have an "art opening" where parents and kids get to come in and see their work, which stays up for three weeks or so. This year, the art show will focus on photography, which children have been practicing all year in the Studio, classrooms, and outside*

** Most of my parental/community involvement comes from our journeys. This year for Outdoor Explorations, we've visited the National Park and the Snake River, we'll go to the Raptor Center, the Elk Refuge, the National Museum of Wildlife Art, and perhaps the Mountain Resort. This is a way for children get out into the community and for community members to see our kids in action. Parents/relatives are always invited on these journeys. We also invite local experts into the classroom and to explore with us on our Campus: particularly snow and bird enthusiasts.*

** The classroom teachers also take kids on journeys regularly, into the community and with parent volunteers.*

** If we know what a parent/community member has a special talent/interest we invite them to join us for a demonstration or to talk to the kids*

[The following is in response to a personal anecdote by the author explaining the barrier of working in an urban environment]

** I am lucky because, as you noted, most of the parents that I interact with are very environmentally conscious. Most people live in Jackson because of their love of the outdoors, in one way or another. When I was in grad school, one of our main focuses what helping children establish a "Sense of Place." Sense of Place, to me, is being proud, fascinated, and responsible for where you are. During this time, I taught in communities all over Wyoming: usually rural and in one case a city. We sought particular places in each area to visit with children outside: riverside parks, island parks, fields, hikeable areas, wind farms, etc. I believe that no matter where you are, urban or rural, there are beautiful places to explore. You do not even necessarily need to travel outside of your school zone. What about a garden, to explore the insects and plants? What about looking up on buildings for birds? Where can you walk from your school? What natural things are going on just outside of your school? I was recently looking for a workshop on nature preschools and came across this place outside of Baltimore*[7] http://www.explorenature.org/ *They may have some ideas of how to incorporate natural explorations into a city area...*

- Can you explain "terracycling" and "avalanche beacons?"

** Our Terracycle program was started a couple of years ago by one of our elementary students*[8]*. Pretty much, we collect packaging that would not usually be recyclable and send it to the terracycle company, where they turn it into usable items. We recycle also, but terracycling is a great way to be conscious of the packaging that we go through, particularly at lunchtime.*

** Avalanche beacons/transceivers are devices that skiers wear when they are skiing in the backcountry (outside of monitored skiing zones, like ski areas). We have a lot of backcountry skiing in Grand Teton National Park and Teton Pass. Each skier wears a beacon, so in the case of an avalanche, their partners can find them in the snow (there are two modes: transmit and search). Most of our children are familiar with beacons because they see their parents wearing them to go skiing. Beacons in Outdoor Exploration are a fun way to search for things in the snow and to talk about snow science. We hide on beacon and give the children a second, set on search. The closer the children get to the hidden beacon, the faster the searching beacon beeps, until the first is located. We do not go into talking about people buried in the snow, although most of our kids know that this is what they are used for from their parents.*

1. http://tetonscience.org/index.cfm?id=graduate_program_home
2. http://www.tetonscience.org/index.cfm?id=journeys_home
3. http://www.tetonraptorcenter.org/
4. http://www.wildlifeart.org/
5. http://www.fws.gov/nationalelkrefuge/
6. http://www.jacksonecofair.org/
7. http://www.explorenature.org
8. http://www.terracycle.com/en-US/

I.V Lady Sue Dale Tunnicliffe

The following is an e-mail interview conducted with Dr. Sue Dale Tunnicliffe, Senior Lecturer in Science Education at the Institute of Education in London, United Kingdom, and co-editor of the peer-reviewed Journal of Emergent Science. A short-answer-style questionnaire was e-mailed, and responses were sent back. A follow-up question was subsequently e-mailed and a response received.

No altering was done to the questions or responses, but some social, personal, and/or anecdotal parts of the interview were omitted by the author for privacy purposes. The questions are written after a hyphen. The responses from the interviewee are written in *italics* and do not reflect emphasis.

- Before responding to the questions, please state your name, title, and associated organization.

Dr Sue Dale Tunnicliffe, Senior lecturer in Science Education Institute of education, London, Zoology graduate started teaching advanced level zoology, and university entrance A level biology moved down the school system!

- What are the main topics that better characterize your research?

Learning biology especially taxonomy particularly spontaneous comets from pre school and primary children and interpretation of museums and zoo animals and natural history dioramas. Questions used science learning

- Within the realm of your research and experience, how would you define “Environmental Education”?

Learning about all components s of environment including geographical and geological, learning needs of animals, predator prey relationships, food chains, habitats, and factors affecting habitats. Soils weather human etc. Characters flora and fauna, indicator species

- In which aspects could the definition of “Environmental Education” differ from “Ecology Education”?

Help they seem to be used interchangeably by many, EE though seems more proactive, recognizing, preserving creating habits, recycling etc. and that genera of activity not ecological I really see ecology as biology. I am old ecology did not exist when I was young.

- Taking your research and experience into account, how important is “ecology education” for society's path to a sustainable future?

Ah! Now it gets political too, quite honestly politicians are governed by other things - like swaying opinion so they are reelected and have short term varies (unelected upper chambers don't as much) not knowledge and according to their political agenda will ignore advice and expert knowledge but are influenced by public opinion expressed often via media - I do know a lot about this and it is quiet frightening Leaning about the environment in schools can help raise awareness but the bottom line seems to be 'not in my backyard'- look at USA and oil production., Political donations from interested bodies

- Taking your research and experience into account, how important is “early childhood education” for society's path to a sustainable future?

Vital, but not lecturing at them.

- How can one apply "Ecology Education" approaches to preschoolers?

By letting them explore their local environment

- In which ways would “Ecology Education” best be assessed in a pre-school class?

Not in school, pre school is before school, talking to the children? Have a research student looking at preschoolers concepts of metamorphosis.

Interviewed 4 and 5 year olds about what animal, and plants they knew, where they'd found out about them and habitats, not really published yet we did it with 6 countries, paper with Nordina. Will attach one which was USA England

- What suggestions would you make to someone who wants to implement "Ecology Education" for the first time?

Think careful about it means, what does Ecology mean? Analyze down to the very basic concocts and build upwards. People who have degrees or agenda etc. find this very difficult. Forget the party line and mantra; look at the local environment, culture, and experiences of children.

- Why do some educators struggle to implement science concepts, specifically at the early childhood level?

I think there are several aspects, one is they do no know the subject, feel under confident, soundly the demands of govt requirements, testing on literacy and numeracy, only focus on that which is tested and that is driven too by the head teachers, senior management. Thirdly because teacher trainers do not know and thus ignore the subject - science knowledge of some of the trainers is poor as many were secondary school science teachers, lastly environmental education does not fit the science boxes and if they are from other disciplines will miss the science aspects.

I.VI Alan Wagstaff

The following is a transcript of a personal interview conducted via internet with Alan Wagstaff, Learning Manager and Curriculum Coordinator for The Green School in Bali, Indonesia. Follow-up questions based upon the responses were subsequently e-mailed, and responses were sent back.

Some social, personal, and anecdotal parts of the interview were omitted by the author for privacy purposes. The questions from the interviewer are written after a hyphen. The responses from the interviewee are written in *italics* and do not reflect emphasis. Words written in brackets [ ] were inserted by the author, whereas parentheses ( ) reflect the words of the interviewee.

- Can you just simply describe some of the main topics that would characterize the educational approach at the green school? Is there special, pre-defined curricula or requirements?

The educational approach, the pedagogy, is unique and there are no degrees of unique! There is only “unique.” I say that with impunity because we have just been visited by a group called CIS – The College of International Schools –they are the accreditation body that we’re interested in. They represent over 300 international schools and we [were accepted into their] improvement cycle. They asked us to choose the sorts of people we wanted on our permanent review team. And we said “Well, it doesn’t really matter, but could we have at least one person from a school

that had created a pedagogy, curriculum, and teaching strategies of their own?" And their answer was "well that's a set of nil because there's no one who has done that."

In short there are three tiers to the approach; I'm very keen to talk to you - especially about the first. There is a unique pedagogy, there is a unique curriculum in very great detail, and there are innovative and some unique strategies to deliver our curriculum. The main thing that I'm interested in communicating to you is the first – i.e. the pedagogy - and I think the reason why I want to do this will become clear when we get into that.

- So there are pre-defined curricula or requirements? Was your curriculum or the way that you approach the educational requirements or things that you want to teach - is it inspired by any educational approach? Or do you really think that it's innovative and unique to yourselves?

Why it's derived is unique. When you get to the strategic level, how you deliver it in a classroom, then of course there are many things that are shared. It's important that, if you are going to understand the education that we're doing and the ways that we're doing it, you have a clear view of, first, the pedagogy or perhaps more accurately, the rationale for why we do what we do. So it's really ***that*** *which I would advise you to get clear on.*

- Within the realm of the educational approach in The Green School, how would you define "environmental education?"

With your permission; I should talk to you first about the pedagogy because it doesn't make, once you hear that… you'll realize it doesn't make any sense - for me to go down any avenue in Green Studies, Environmental work and try and define or describe that. So, is that okay? I'll try to be brief.

- That's fine with me.

It start's with this: however you want to define the environmental component of work, it seems to me, as the lead learner of the school, that there's very little point in presenting educational sustainability in any form to the students if the education itself is not sustainable: the entire package of education. The way that education is presented, and it's more or less the same internationally, is in my view not sustainable. If you attach any form of environmental awareness to something that is not sustainable (I think it's fair to say, you could even make the case that it's not even humane) then it's a bit like attaching religious studies to an ordinary exam-based curriculum like Cambridge or IB. This is like creating a satellite going around education, and the satellite could be called environmental studies it could be called Green Studies it could be called Philosophy, but basically you put a moon around an earth and the earth is already not sustainable. It's very easy to demonstrate - so please let me.

It's quite clear that whatever schools do by way of by polishing a few of the windows of this building called "Education" it's quite clear that the unacknowledged purpose of schooling is to get kids to University. If you talk to parents and go to high schools, and you look at the way schools present themselves online, almost the first thing they talk about is the number of people they sent off to Ivy League places. They might deny that that's the real purpose, but that's just espoused theory. Theory as practiced is definitely as if the mission is to get people to university. Not only is that the mission but pedagogies are designed by people at universities, curriculum is designed by people at universities - who pass them out to districts; who pass them out to principals, and they glue together this thing and it perpetuates the status quo - everything. It perpetuates the subject-centric, test-centric, school-centric, exam-centric, timetable. This view of education has been around since 1840. So my contention is that this is a view of education controlled by one sector.

It's one sector of the community. It's not controlled by the students. Clearly I'm talking about the continuum of difference between subject-centric school and student-centric schooling. The reason why that view of education persists is very, very complicated… so let's just leave that.

There's one more thing that I want to add to all this argument for you which is from research, we actually do know now…. the effect size of just about everything we can do in school. So instead of saying "I put my stake in the ground and I teach children... and I move them along - I need to say 'What impact have I made in comparison to the average impact possible?" So then, are we actually on the side deficit to average, or the other side? And most of the time when teachers use a null-point analysis the effect is well to the deficit side of the average - in fact. John Hattie cynically points out if we just put children together in a room with a bunch of books and bits to play with they'll improve. So it's not just about improving; it's, "how do they improve in regards to the average possible improvement?"

We actually know which behavior in childhood predicts success in life. It's not a guessing game anymore. We know of all things, what is going to predict success. By success, he [Hattie] means three things: lasting relationships, a job that you go to and you enjoy going to it, and ways that allow you to live comfortably. Not necessarily luxury but you can get through okay. So, it turns out to have nothing to do with the exams, is has nothing to do with your status in the classroom, nothing to do with the university you go to at all - or not much, very low, but the strongest correlate for all of that success is simply how long you stay in school. The longer you stay in school, the more likely you are to have a happy, successful life. It's nothing to do with your attainment whatsoever. So there's your start. Kids don't want to go to school, they don't like it; they're being told from age 11 that they're either in the "dumb math group" or not. How are they going to stay in school? Those two-thirds [that don't like school] are going to get out as fast as they can, and they are going to take more days off. You can test this, to find out which group is disengaged in school, taking time off, and it's very very clear.

And so we simply have to set school up so that the kids come to it and say "please let me drink at this trough." And I have a little story for you; I have a TED talk myself, it's an INK actually. INK is the Indian affiliate of TED. I gave this talk and at the end, my conclusion, was this: There's an English proverb that says "you can lead a horse to water but you can't make him drink." I'd like to restate that and say "if you lead a horse to water, make sure it's water before you ask him to drink." And it isn't water. It's salt.

And so the name of the game is - we have to get children to love school and stay there as long as possible. And that doesn't mean we have to give out chocolates and ice cream. We have to configure it in such a way that it is not lip-service student-centric, but that it really is focused on the student-centric view of the enterprise. I'll tell you how that can be done and how we do it in a minute because we've come down from the cloud and said "okay stick your neck out, let's do it." Can I just give you a definition of "engagement" used in this way?

- Absolutely.

So, "engagement" in this definition means kids are completely willing from their insides to give significant time to the learning experiences that they know are worthwhile (and in parentheses, even if they don't particularly like them)… that they're just willing. If you can just set things up to get that then you're going to get the love affair with learning, you'll get the engagement with the school. And then it starts to make sense to say "let's talk about being kind to the earth" and whatever.

I don't care about the definitions [of green studies] that you're trying to define. It doesn't make sense to put a moon of "green studies" "environmental studies" around an inhumane system. We've got to make the education system sustainable first and then what we'll find is that the "green" info can penetrate every single aspect, every single strategy, every single moment of the environment, the school, and its curriculum. It can fully penetrate at all levels. And then it's not just a subject.

So I'm saying it might not be useful at all to just stick in "environmental studies" as a little moon in the same way that you would stick in religion. Just think about that for a minute. It could be Christianity it could be Islamist it could be Skepticism it could be Environmentalism; compared to their exam based studies, it doesn't seem to matter to them. The kids don't feel it because it isn't penetrating the 'real stuff' of education. I think there's a perfect comparison between all of those other "-isms" and environmentalism. We have to have the environmental work penetrating everything including our beliefs about why education is going down at all.

So this is how, instead of painting the face of a rather tired human being with make-up, we decided to start again. You can go "oh we're going to make the school more student-centric" and let people choose their level, that's a little bit like face make up. What about actually saying, "We're not controlled by anything in the past, and we're just going to start again"? So what would you do? This is what we did. This is what I did. I just imagined what a person would say in 60 years and asked them what it was like, if they went to the school of my dreams: they would say "I couldn't wait to get to school everyday. Everyday when I went to school I was met and challenged and developed as a human being. It wasn't about anything except that. I went to school everyday and the core academic skills that I needed to navigate through life - I got those in a package that I was in control of, and I worked at my own level and my own pace, and I knew how much I had to do and I knew I was in control. And everyday I went to school I knew that my teachers were connecting me to the wisdom of people in the working world. I felt my school wanted me to engage in what makes the actual world tick over. So, everyday I went to school I was respected as a person, I learned core academic skills, and how to make meaningful connections in the working world." If you set it up like that - the approach I call the "three-frame day," - then you are likely to have success. Since the academic part is by ILP (or Individual Learning Program), you'll still get the same number, 30% trotting off to tertiary education, but you'll get the rest not being disaffected by learning.

A well-balanced day consists of three frames. The first one is called The Integral Frame. It is only about, in a very structured way, developing and challenging and satisfying the whole person - and we have a taxonomy for that and it's a classic taxonomy; that is we challenge everyday, something that we called the big 4. We set up a theme and everyday we challenge that theme in a physical, intellectual, emotional and intrapersonal (secular spiritual) way - that's our claim to helping the students to be 'satisfied'. Then we set things up in the core academics by ILP, then we set things up practically in the third frame of the day so that, like Enterprise Ed the kids, as they get older, increase penetration into the working world. So that's the rationale framework the curriculum and teaching strategy is founded on. The only goal is to keep the kids engaged with real learning. We can test engagement now. We have the tools to do it. There's a survey called "The Hope Survey" which I will direct you to which helps to measure that. But you can also use the word "engagement" in the way many institutions in America use it to mean "how many bums on seats." Do they turn up? So having achieved "The Holy Grail," which is Humane Education, now we can talk about Sustainability Education.

- At the Green School with your pre-school kids or really young learners, what is your approach with integrating their learning? How does the approach get translated to students who are only 3, 4, or 5 years old?

It's funny. It's kind of beautiful. You know, you're rather young and already on the journey to the various incarnations of student-centric work. Student-centric work is about a four-quadrant arrangement, and you're clearly looking for that. However, if we make the old system better, we're actually not contributing to the solutions. I feel conflicted because I don't want to make the system better. I want to take it down and rebuild it. When I first came back into Green School - because I designed it in the first place, the Green Studies teachers came to me with a problem. If you approach something as if it were an intellectual idea: as if it's something that the students have to learn about - that kind of approach is of itself loaded with antipathy. That is, the minute you put up an idea, it's over there: it's an object. "What do you think? Hm… is that right?" You're pushing it back, and the very nature of environmental studies, and all the various divisions within it mentioned in your e-mail, the nature of it all is that we don't want that. We don't want people to look at it as if they're university students. We want them to be passionate because the world is on fire. And we have got to deal with it and we want people intrinsically motivated to love the world. We want that motivation to be on the inside, so that they love the environment and are passionate, and so they feel dedicated to its custodianship. So, is it possible, is there any saving idea that will get this across in what you're saying to little kids? I think that there is. But please, when you report this: report that I am loathe to say it. When you get success [within the existing system], then unfortunately you're adding to its lifespan. You see, that's a real big problem for me.

If we passed that strategy on to that school that you used to go to with "bright maths and dumb maths," it would make that school a little bit better. And that's my problem.

So here comes the little piece of Alchemy that you're looking for. I'm a storyteller; I do most of my teaching by stories. When I first arrived at Green School, one of the really passionate Green School teachers who's literally in love with the planet and wants to save it - he's a real beautiful guy, said: "you know, Alan, I've got this real problem in my heart. I'm teaching the kids and I don't want them to look at [green studies] like they look at maths. I want them to change the world. That's my thing. As I'm doing my lesson there's a kid picking up insects and pulling the wings off. And there are kids who are saying "more teacher torture,' I'm getting the same bum's rush that teachers of maths get. What can I do to change that?"

Here's the answer. Whatever the context is, you structure it so that kids are coming to it with the Big-4 and I'll tell you now you probably mentioned two of them in what you said about your egg project, possibly 3 of them, but the fourth one so far is missing from the education enterprise - in the way that I mean it. So the Big 4 - when I look at any context: 1. How can I engage in it physically? Well I can build bird boxes like you said. I can climb trees. 2. How can I engage in it emotionally? I can write poems, I can sing songs, I can find music, and I can paint. Create: use an artistic, subjective approach. 3. How can I approach it intellectually? Well this is really simple. This is what everyone is trying to do. I'm going to save the fourth one.

What I'm going to tell you now is derived from someone else's work. If you want to make sure that what you're doing goes along with the Big-4 you can sort of test the syntax that you're using. It has a syntax which goes like this: Intellectual quadrant "geologists have shown that" "mathematicians calculate that" "scientists have proven that" "Philosophers have argued." In other words the root syntax has a group exterior. That's the nature of it. It doesn't mean it's the only syntax. It helps you to define that you are in that intellectual quadrant. The physical quadrant: the root of syntax in that is "she runs" "I sweat" "Tom climbs" it's the exterior singular. Then there's the emotional, social, subjective, cultural one, but let's call it 'emotional'. That quadrant is interior and it's plural. Religion belongs to it. "We believe" "This music makes us feel..." "The theme of this poem is." It's on the interior. Then there is the secular-spiritual or intrapersonal. We don't want to employ any religious content in that quadrant. This is way of describing [the quadrant] completely secularly where it

won't upset anyone's belief. It's simply an interior singular. "I intuit that." "I symbolize." Not "I believe." I'd like to put this down into context. Let's say my context is "The Sea." Physically – Jump in it, on a surfboard, or swim. Intellectually we can study wave formation, how wave cycles are related to wind. Emotionally – paint a picture of it. Intrapersonally – now I stand in front of the waves in complete silence, I turn my back on the group and I simply say in silence "waves, what are you saying to me? What are you telling me? What do you signify?"

There are many many ways to have that moment, but I have done such an exercise many times. And a nine-year-old kid said, having faced the waves, having asked significance questions, said, "The waves are telling me that they help to clean the earth, and I have to do the same." And that's the missing part.
We use this taxonomy for these thematic studies everyday, but we also include it in individual moments like the one I was describing. I don't want to push thematic studies with the intellect only - into the same thing as memorizing multiplication tables.

If you want a simple structure that has a chance of engaging the whole person and not just doing this antipathy thing that the intellect does, then ask yourself, whatever the context is, how can I approach it with the Big 4?

It's morally wrong to try and pretend that you're not asking the kids for something. I don't believe in going about trying to pretend your activity is not about a particular topic. It passes over to them all sorts of messages of control and ideas. If you want to do activities about baby birds, and then do activities about baby birds, don't pretend it's something else.

A great project that one of our environmental teachers brought in, was a 4-week project on the coconut economy. He knew about the 'big four', so the next minute, we had safety mats under some coconut trees, he brought one of these guys out, who showed them how to go up a tree with a rope around their waist, they climbed the tree, they grabbed a coconut, they brought it down, they did this everyday. Then they did all the intellectual things that you would expect. Then they had a song, they created an artwork, and they sat beneath their own coconut tree and said "what are you telling me?" In the intrapersonal quadrant all you have to say to children, even adolescents, is that it is simply their imagination. It's nothing to do with God or angels, it's just imagination. Let's just imagine that it's talking to us. Let's try and ask, "What is its significance?"

- I used to work for an Educational Organization, and we tried to focus on connections as well as facts. The most important thing that we did was not to teach facts, but to give kids a positive experience outdoors.

Many many young teachers are idealistic; you have a very positive, natural instinct for these things. What I've learned about schooling is you have to have a structure. Schools are conduits of crisis. If you don't have a structure than all of the idealism collapses. I feel like you have an instinct against the intellectual-only approach because you know what it does, but I would say the secret about using the Big-4 is that they are all equally weighted. It is just as important to engage the subject matter subjectively through art as it is intellectually as it is physically as it is spiritually. They're all equal. They only seem unequal when the enterprise of education focuses only on the intellect. It's not that the intellect is somehow wrong. It is only difficult or problematic when it is all that is applied. When the Big-4 is applied, suddenly that intellect part becomes beautiful. It has its place.

- Do you have teacher training at the Green School? Maybe it is difficult to find teachers who have this same approach since it is so unique. When people from different realms come

In fact, this week, we are launching a global initiative to take overseas -a road show. It's going to Australia and then it's going to America. We're going to give a presentation which opens the doorway to a three-year training that's in 54 modules. All of these things are completely worked out and we are more than happy to communicate about our positive mission. If you complete 48 of the 54 modules in 3 years you get a Green School certificate of education. What we're trying to do is get a tertiary provider interested in this. All of these modules I have demonstrated to at least 3,000 educators in Australia, New Zealand, Canada, Indonesia, and so far, everyone who has heard this message, regardless of background or age has said it is a breakthrough. But we are seriously looking for a university partner that will work with us on this.

- One thing you said was that the standard education system continues to persist even though it isn't functional. So, why is that, exactly?

This is a well researched field but my contribution is: 'Timetable'.

Schooling has 'brand image' across the world, thus many aspects of the brand go unquestioned. 'Timetable' (schedule) is one of these features.

It goes like this: The students are arriving in a few weeks. What's the timetable? Draw a grid of 5 columns and about six rows – write subject titles in the cells making sure the 'important subjects' get placed first. Maths needs at least five cells and English needs seven. What next? Science – let's say it needs 3 periods a week. We should include social studies – maybe two cells. That's taken care of the important things. What about PE? I suppose we should give it 2 cells. Hmmm not many left. Let's give one cell to Enterprise ed. and one cell to environmental ed. Now there's only one cell left. Doesn't matter – visual art, music, drama and dance are not important – let's put them in a rotation with each other. The kids can have art in one term and music in the next – and so on. Mind you, if they don't get good grades in maths and English we could use the arts rotation for more core subjects.

Not only does this view of timetable perpetuate a few myths about the hierarchy of subjects – it also locks in and drags towards itself subject-centeredness in all its glory. Another powerful force for inertia is the long training in schooling everyone has had – every mum and dad is a 12 year trained expert in subject-centered schooling. Every teacher reverts to their 12 year training when confronted with the pressures of the classroom.

Finally, because teachers habitually use 'null point referencing to assess their effects on children – everything they do promotes improvement and they point to it and say: 'Don't tell me to learn something else – see, my teaching has positive effects.' Instead, they should use norm referencing – the average impact size of all teacher strategies is 'x' - what are my effects like in comparison with this datum?'

I.VII Dr. David Wilgenbus

The following is a transcript and English translation of a personal interview conducted via internet with David Wilgenbus, Education Coordinator for the *Fondation de La main à la pâte* in Montrouge, France.

Some social, personal, and anecdotal parts of the interview were omitted by the author for privacy purposes. The questions from the interviewer are written after a hyphen. The responses from the interviewee are written in *italics* and do not reflect emphasis. Words written in brackets [ ] were inserted by the author for clarification. The interview was conducted in French. Changes in the transcript to reflect proper French grammar were made for easier reading. English translation

was completed by the author and does not reflect *ver. batim* translation, but rather reflects natural English discourse.

- Je voudrais que vous disiez votre nom, titre, et institution.

Je m'appelle David Wilgenbus. Je travaille au sein de la fondation de La main à la pâte en France. Mon rôle dans cette fondation c'est de coordonner la création des ressources pédagogiques pour les enseignants, les ressources pour les sciences, ou pour le développement durable.

- Décrivez un peu les sujets principaux de votre recherche, de la vie, et du travail que vous faites.

J'ai commencé ma carrière dans la recherche scientifique, en astrophysique. J'ai rejoint la fondation La main à la pâte il y a douze ans, et dans cette fondation, je travaille sur la création de ressources. Je ne suis pas tout seul. En fait, je travaille dans une équipe d'une trentaine de personnes, dont à peu près une dizaine travaillent avec moi sur la zone pédagogique. Nos thématiques sont en fait tout ce qui touche à l'enseignement de la science à l'école primaire donc les enfants de 3 à 11 ans et également au collège donc les enfants de 11 à 15 ans. Autour de ça, on travaille sur tous les domaines scientifiques. C'est-à-dire la biologie, les sciences de la terre, les sciences physiques, chimiques, les sciences de l'univers et également la technologie. Depuis quelques années, on a essayé de mettre en place au sein de cette fondation des projets pluridisciplinaires, et il se trouve que ce sont ces projets qui marchent le mieux. On travaille sur des thématiques qui sont liées à l'éducation au développement durable.

En fait, on s'est rendu compte il y a quelques années, il y a 5-6 ans, qu'à travers l'éducation au développement durable on arrivait à faire travailler des enfants sur la science et sur la technologie d'une façon un tout petit peu inhabituelle pour eux et que c'était souvent plus efficace pour leur faire apprendre les sciences pour les sciences.

- Moi, je travaille avec les enfants qui ont 2 à 5 ans, donc quand vous répondez aux questions, pensez aux réponses pour cet âge. La maternelle, ou l'éducation préscolaire est-ce que c'est important pour la société pour créer un avenir durable ?

Oui. On le pense très largement en France, puisque que chez nous, l'école démarre à 3 ans, en fait, pas à 6 ans comme dans beaucoup de pays. Et il y a même un débat en France pour savoir si on ne devrait pas faire commencer l'école à 2 ans, plutôt qu'à 3 ans.

- C'est vrai ? Et pourquoi ça ?

Pour beaucoup de raisons. La première raison serait l'égalité. Il y a beaucoup de parents qui n'ont pas la possibilité de garder leur enfant jeune. Cela occasionne des frais de garde, il n'y a pas forcément des places dans les crèches ou dans les jardins d'enfants, et si les parents travaillent, ce n'est pas facile. C'est une raison économique, mais il y a des raisons beaucoup plus sociales : la scolarisation assez jeune est assez favorable à la socialisation des enfants. Ça c'est quelque chose qui est vraiment un apport de l'école maternelle, au moins en France. Je ne connais pas trop en dehors de la France, mais c'est vrai que scolariser les enfants très jeunes, c'est leur apprend très tôt à vivre en groupe. Toute notre école maternelle est centrée autour de ça.

- Est-ce que c'est possible de réaliser des leçons ou des expériences scientifiques pour les enfants de l'âge préscolaire ?

Oui. Avec des enfants de 2 à 5 ans, c'est possible de faire des apprentissages scientifiques. Il faut évidemment les adapter à l'âge de ces enfants, donc on va faire des choses très simples. On peut

également faire des expériences, mais on ne va pas forcément avoir la possibilité de construire un raisonnement scientifique avec des enfants de cet âge-là. Donc on ne va pas partir sur une démarche de type « observation, hypothèse, manipulation, mise en commun, conclusion » quelque chose de très construit. On va être davantage dans la manipulation ou l'exploration. Je vous donne un exemple, on peut travailler avec des enfants de cet âge là sur les liquides par exemple. Se poser des questions sur les objets qui flottent, les objets qui coulent, des questions de volume, le fait qu'on puisse transvaser des liquides, si ça prend la forme du récipient… tout ça ce sont des choses qu'on peut découvrir de façon assez empirique sans forcément chercher à les expliquer. Avec les enfants de cet âge là, on va être dans une démarche de découverte plus que dans une démarche explicative.

- Et pourquoi, alors, quelques professeurs n'arrivent pas à enseigner bien les concepts scientifiques pour les enfants de cet âge ?

Il y a beaucoup de raisons à ça. La première justement, c'est que peut-être certains professeurs ont la tentation d'expliquer la science. Et si on essaye d'expliquer la science, on rencontre des difficultés quel que soit l'âge des enfants, que ce soit les tout jeunes, ou même avec les plus vieux, et c'est déjà difficile pour eux en général de comprendre que la science, c'est quelque chose que les enfants doivent découvrir par eux-mêmes. À partir du moment où on cherche à expliquer, on a des difficultés parce que les enfants peuvent poser des questions, qui sont des questions naïves. Parfois les enseignants sont mal-à-l'aise avec les enfants très jeunes parce qu'ils ont la tentation de vouloir expliquer les phénomènes scientifiques, et pas d'être dans une approche de découverte un petit peu empirique par l'observation, par l'expérience. Justement, on va être davantage dans l'observation que dans l'expérience. L'expérience, ça suppose un travail d'anticipation, de préparation, une démarche hypothético-déductive qui n'est pas forcement en place à cet âge là, mais l'observation, c'est quelque chose qu'on peut faire très tôt. On peut observer la course du soleil, on peut observer les comportements des animaux, on peut faire des élevages dans la classe, on peut regarder de quoi ont besoin des plantes pour grandir, de quoi ont besoin des animaux pour se reproduire, etc. On peut être dans une démarche d'observation. Si on se met dans une démarche d'explication, on va avoir des difficultés comme je vous disais. Souvent les enfants sont extrêmement curieux, ils posent des questions sur tout, et mettent les enseignants mal-à-l'aise. Une question très simple du type « pourquoi le ciel est bleu ? », par exemple, met les enseignants mal à l'aise parce la science qui est derrière est assez complexe et en dehors des choses qu'ils maîtrisent. La plupart des enseignants surtout à l'école maternelle n'ont pas de formation scientifique, ce sont des gens qui ont une formation littéraire ou psychologique et pas tellement dans les sciences.

- Si quelqu'un voulait faire un projet d'écologie avec des enfants de l'âge préscolaire, comment pouvons-nous évaluer si les enfants en savent plus qu'avant avec les leçons et les expériences?

Avec des enfants jeunes, c'est vraiment compliqué parce que ce qu'on ne va pas viser l'apprentissage de notions scientifiques avec des énoncés très clairs, on va être davantage en train de cibler des attitudes, la capacité de travailler en groupe par exemple, de s'écouter, d'argumenter, de respecter les avis des autres. Ce sont des choses que l'on peut évaluer mais difficilement avec des questionnaires formalisés. Ca va plutôt être dans l'observation de la classe que dans la mise en place d'un protocole d'évaluation très strict. Surtout qu'à cet âge-là, les enfants ne savent pas écrire ni lire. Ce qu'on peut évaluer ce sont les attitudes. Mettre les enfants dans une situation de recherche autour d'une thématique. Ca peut être lié au développement durable mais ça peut être lié aux sciences ou à la technologie. Tout à l'heure j'ai parlé des choses qui flottent, des choses qui coulent, de l'eau. On peut poser la question : « quel objet va flotter, quel objet va couler ? » et voir comment ils réagissent, voir si ce sont toujours les mêmes qui parlent ou s'il y a d'autres élèves qui prennent la parole, voir comment la parole est distribuée

dans le groupe. Est-ce qu'ils sont capables de s'écouter ? Est-ce qu'ils sont capables d'argumenter ? Est-ce qu'ils sont capables de manipuler et à partir de manipulation, est-ce qu'ils sont capables d'en déduire quelque chose ? Ou est-ce que finalement, ils restent sur leurs idées préalables quels que soient les résultats de leurs expériences ? Ce sont les choses qu'on peut observer.

- Quels sont les aspects spécifiques qui sont nécessaires pour avoir une expérience ou un projet scientifique avec succès ? Que pouvons-nous dire des aspects avec lesquels les enfants vont profiter de cette expérience ?

Alors avec des enfants aussi jeunes je pense que l'aspect le plus important, c'est l'aspect sensoriel. Quand ils seront plus âgés, ils pourront apprendre la science avec des instruments, des instruments très simples comme un thermomètre par exemple, une boussole ou des choses comme ça. Des enfants aussi jeunes à un stade de développement de leurs capacités cognitives, sensorielles ou sensoriomotrices. Je pense que la réussite d'un projet de science avec des enfants aussi jeunes passe par le fait que les enfants vont vivre cette science avec leurs corps. Il faut absolument qu'ils aient des choses à toucher, des choses à voir, des choses à sentir. Si on est que dans l'observation par exemple sans jamais pouvoir toucher, ça risque de poser problème. La clé, à mon avis, de la réussite d'un projet avec des enfants de cet âge là ça va être d'observer ou de manipuler les choses avec le corps, avec ses yeux, avec ses oreilles, avec ses mains. Beaucoup toucher, beaucoup manipuler.

- Il y a des aspects, alors, qui seront négatifs à un projet ? Il y a des choses qu'il faut éviter en travaillant avec des enfants ?

Je pense qu'il faut éviter de s'intéresser à des phénomènes qui ne font pas partie de l'environnement quotidien des élèves.

- Comme par exemple ?

Par exemple, je fais de l'astronomie, donc, si on devait faire de l'astronomie avec des enfants petits, il ne faudrait surtout pas essayer d'étudier l'exploration spatiale, l'exploration du système solaire, les galaxies, les étoiles, les planètes parce que ça ne fait pas partie du monde sensoriel des enfants, ce ne sont pas des choses qu'on peut voir tous les jours, ils n'ont pas d'expérience quotidienne de ces choses là. Je pense qu'à cet âge-là il faut se baser sur des expériences quotidiennes. Par exemple, si vous voulez faire de l'astronomie avec des élèves aussi petits, il faudrait se contenter de choses très très simples : le temps qui passe, les jours et les nuits, éventuellement on peut observer la lune, voir que la lune peut être observée la nuit mais aussi le jour. Parfois les enfants pensent que la lune ne peut être vue que la nuit. Donc, il faut éviter de traiter les phénomènes qui ne font pas partie de la vie quotidienne des enfants. Si on veut s'intéresser à des aspects techniques, par exemple, à cet âge là, ce sera compliqué parce qu'il y a un effet un peu « boîte noire », il y a de la pensée magique à cet âge là. Les enfants ne se posent pas la question par exemple de « comment marche un objet ? » A partir du moment où il marche, pour eux, cela suffit. Et ça peut être assimilé un peu à de la magie. J'appuie sur le bouton et la lumière s'allume. Il n'y a pas forcément de relation de cause à effet évidente avec les enfants petits. Il y a un aspect un peu magique. Donc je pense qu'il faut éviter à cet âge là de travailler sur les aspects techniques. Il vaut mieux se centrer sur des « sciences de la nature », observer le cycle du jour et le nuit si on veut faire de l'astronomie, ou observer les mouvements de l'eau, la façon dont on peut distinguer les liquides et les solides, en faisant des petites expériences avec les liquides et les mêmes choses avec les solides. On peut observer les fourmis ou d'autres animaux. On peut faire pousser des plantes dans la classe ou dans le jardin, et voir pourquoi certaines plantes arrivent à bien grandir et d'autres pas. Donc on comprend qu'il faut de la

lumière, qu'il faut de l'eau, qu'il faut de la terre, des choses très très simples, mais à chaque fois ce sont des choses que les enfants peuvent observer ou manipuler par eux-mêmes et qui en plus font écho à des choses qu'ils peuvent expérimenter dans leurs vies de tous les jours chez eux ou dans leurs jardins, avec la famille. Je pense qu'il ne faut surtout pas partir dans des thèmes qui ne font pas partie de la vie quotidienne des enfants.

I.VII.I English translation of transcription

- I would like you to say your name, title and institution.

My name is David Wilgenbus. I work at the heart of the La Fondation de la main à la pâte [=The Hands-On Foundation] *in France. My role in this foundation is to coordinate the creation of pedagogic resources for the teachers, the resources for science, or for sustainable development.*

- Describe the principal subjects of your research, your life, and the work that you do a little.

So, I started my career in scientific research in astrophysics. I joined the Fondation de la main à la pâte twelve years ago, and in this foundation, today, I work in the creation of resources. I am not alone. Actually, I work in a team of about thirty people, of whom about twelve work with me in the realm of pedagogy, and our themes are, and in fact, everything that has to do with teaching science in primary school, so children from 3 to 11 years old, and also in junior high, so children from 11 to 15 years old. Within that, we work in all the scientific domains. That is to say in biology, earth sciences, physics, chemistry, universal sciences and also technology. Actually, since a few years ago, we have tried to implement some interdisciplinary projects at the heart of the foundation, and we found that those are the projects that work the best. We work actually on themes that are connected to education for sustainable development.

Actually, we realized a few years ago, 5 or 6 years ago, through education for sustainable development, we were able to make children work on science, on technology in a way that's a little unusual for them and that was often more effective for them to learn science.

- I work with children who are 2 to 5 years old, so when you respond to the questions, think about your response for this age. Is nursery school, or preschool education, important to create a society with a sustainable future?

Yes, so that's what we think widely here in France, since here, school starts at 3 years old, actually, not at 6 years old like in a lot of countries. And there is even a debate in France to decide if we should make school start at 2 years old rather than at 3 years old.

- Really? Why is that?

For a lot of reasons. The reason is equality. There are a lot of parents who don't have the possibility to watch their young child. This entails daycare fees, there is not necessarily space in the nursery or in the daycare, and if parents are working, it's not easy. This is one, we could say 'economic' reason, but there are many more social reasons like education rather young is rather favorable for the children's socialization. That is something that is really a contribution from preschool, at least in France. I don't know too much from outside of France, but it's true that educating children at a young age teaches them very early how to act in a group. All of our preschool is really centered on that.

- Is it possible to implement scientific lessons or experiments for preschool-aged children?

Yes, yes, so the children from 2 to 5 years old, it's possible to do scientific teaching. It is obviously necessary to adapt to the children's age, so you would do very very simple things. You could also do experiments, but not necessarily have the possibility to construct scientific reasoning with the children of that age. So you are not going to start at a level like "observation, hypothesis, manipulation, discussion, conclusion" something very constructed like that. Instead, you would be at a manipulation or exploration level. To give you an example, you can work with children of this age on liquids, for example. Ask questions about what objects float and which sink, questions about volume, the fact that you can pour liquids, if it takes the form of the receptacle, all of those things you can discover in a rather practical way without necessarily looking to explain them. With children, students who are that age, you are going to be at a discovery level more than on an explanatory level.

- And why, then, do some teachers not manage to teach scientific concepts to children of this age well?

There are a lot of reasons for that. The first is that maybe certain teachers are tempted to explain science. And if you try to explain science, you realize the difficulties there are with the children's age. They are so young, or even with the older ones, and it's already difficult for [the teachers] in general to understand science. It's something the children must discover by themselves. From the moment you explain, you have difficulties because the children can ask questions, questions that are naïve, and something the teachers are uneasy with the very young children because they are tempted to explain scientific phenomenon, and not have a discovery approach that is a little more practical through observation or by experimentation. Rightly, you are going to be further in the observation than in the experiment. The experiment assumes anticipatory, preparatory work, a hypothetical/deductive level that is not necessarily there at this age. But observation is something that can be done very early. You can observe the curve of the sun, you can observe animal behaviors, you can raise animals in the classroom, you can look at one plants need to grow, what animals need to reproduce, etc. You can be at an observation level. If you try to be at an explanatory level, you are going to have difficulties like I said. Oftentimes the children are extremely curious and ask questions more than anything, and they make the teachers uneasy because a very very simple question like "why is the sky blue?" for example, is a simple question, it is often asked by children, but there are rather few teachers who know how to respond to a question like this because the science behind it is rather complex science, it is a little bit outside of their expertise. The most part of teachers, especially preschool, don't have a scientific background, they are people with a literary background or psychological background, and not really in the sciences.

- If someone wanted to do an ecology project with preschool-aged children, how could we evaluate if the children know more than before the lessons or experiments?

With young children, it's really complicated because what we would aim for with young children like that is to not have an objective of knowledge, actually. So, we're not aiming for learning scientific notions with really clear statements, rather we are going to be targeting their attitudes, the capacity to work in a group, for example, to listen to each other, to debate, to respect the opinions of others. Those are the things that you can evaluate but it's difficult to evaluate them with formalized questionnaires. It's going to be rather through observing the class than through implementing a very strict evaluation protocol. Most of all, at this age, the children don't know how to read or write. So, what you can evaluate are their attitudes. Put the children in a research situation focusing on a theme. It can be connected to sustainable development but it can be connected to science or technology. Earlier I talked about things that float and things that sink in water. You can ask the question, "what object is going to float, which object is going to sink ? »

and see how they react, if the same ones are always speaking or if there are other students to speak too, see how the speaking is distributed through the group. Are they capable of listening to each other? Are they capable of debating? Are they capable of manipulation and from the manipulation, are they able to deduce something? Or do they stay with their previous ideas regardless of the results of their experiments after all? These are the things you can observe.

- What specific aspects are necessary to have a successful scientific experiment or project? What can we say about the aspects from which the children will profit with the experiment?

So, with children so young, I think the most important aspect is the sensory aspect. When they are older, they can learn science with instruments; very simple instruments like a thermometer for example, a compass or things like that. With children so young, we are interested in their stage of development where they are developing their cognitive capacities, their sensory and sensorimotor capacities. I think the success of a science project with children so young will come from the fact that children are living with their bodies. It is absolutely necessary that they have things to touch, things to see, things to feel. If you are only observing for example with out ever touching anything, there will be a problem. The key, in my opinion, to a successful project with children of this age is going to observe and to manipulate things with their bodies, with their eyes, their ears, with their hands, lots of touching, lots of handling.

- Are there aspects, then, that would be negative to a project? Are there things that you must avoid when working with children?

I think you must avoid focusing on phenomenon that are not a part of the children's daily environment.

- Like what for example?

For example, I do astronomy, so, if you wanted to do astronomy with small children, you shouldn't try to study space exploration at all, solar system exploration, galaxies, the stars, the planets because that's not part of the sensory world of children, they aren't things that you can see everyday, they don't have the daily experience with those things. I think at this age, you have to base it on daily experiences. For example, if you wanted to do astronomy with students so little, you should only do very very simple things: the passing of time, day and night, eventually you can observe the moon, see the moon, you can see the moon at night but also during the day. Something the children think that you can only see the moon at night. So, you must avoid covering phenomenon that are not part of the children's daily life. If you wanted to look at technical aspects, for example, at this age, it would be complicated because there is an effect like "the black box," there is magical thinking at this age. The children ask a question like 'how does an object work? » and from the moment it works, that's good enough for them. And for them, it can be kind of likened to magic. I push the button and the light turns on. There isn't necessarily an evident relationship of cause and effect with young children. There is kind of a magical aspect. So I think it's necessary to avoid working on technical aspects at this age. It's better to focus on things like « nature science » instead, some observation things, observing the day and night cycle if you want to do astronomy, or observing the movements of water, the way you can distinguish liquids from solids, doing small experiments with liquids and then the same ones with solids. You could also observe ants, or observe the other animals. You could plant plants in the classroom or in the garden, and see how certain plants manage to grow well and others not. So they understand that you must have light, that you must have water, that you must have soil, things really really simple, but each one is something that the children can observe or handle by themselves and also mimic things they can experiment with in their lives everyday at their house or in their gardens with their family. I think you mustn't go off on themes that are not part of the children's daily lives.

ANNEX II: Mommy, why am I a bird? Story

The following is the children's story written by Anne Marie Wells and read aloud by the preschool teachers and its English translation. PowerPoint slides of the images projected while read aloud can be accessed at:

https://docs.google.com/file/d/0BwQvXBHa9m2oNlRheDN5S3dRYmM/edit?usp=sharing

Mamã, porque é que sou uma Ave?

Era uma vez uma pequena Ave. Ela era uma Avezinha muito curiosa. Adorava perguntar tudo à sua mamã. Um dia ela perguntou, "Mamã, porque é que sou uma Ave?"

A mãe respondeu, "Querida, és uma Ave porque nasceste num ovo!" Mas a resposta não fazia muito sentido para a pequena Ave. E disse, "Mas a Tartaruga, o Lagarto e a Cobra também nasceram num ovo e eles não são Aves!"

A mãe pensou, pensou, pensou, e respondeu, "Bem, és uma Ave porque tens asas que te permitem voar!" A pequena Ave era muito, muito curiosa, e sabia que tinha uns primos muito distantes que não podiam voar. Então disse, "Mas a Avestruz é uma Ave, tem asas e não voa! Usa as suas longas pernas para correr. O Pinguim é uma Ave, tem asas e não voa! Usa as suas asas para nadar." Por outro lado, a pequena Ave também sabia que alguns dos seus amigos tinham asas, voavam, e não são Aves. Então continuou, "O Morcego tem asas, voa e não é uma Ave! A Borboleta tem asas, voa, mas também não é uma Ave! Mamã, porque é que sou uma Ave?"

A mãe Ave percebeu que tudo o que a sua Avezinha disse é verdade. E respondeu, "Talvez porque tu cantas melodias muito bonitas, e todos no mundo adoram ouvir-te!" A pequena Ave pensou de imediato em vários os animais fantásticos e que podem cantar lindas canções. E disse, "Mas o Sapo canta bem e não é uma Ave! Os humanos também podem cantar canções muito bonitas e igualmente não são Aves! Mamã, deve haver algo especial que faz de mim uma Ave."

A mãe intrigada com as respostas do seu filho Ave pensou durante algum tempo. Por fim disse, "Bem, se os outros animais, que não são Aves, mas nasceram em ovos, têm bicos e asas, e podem voar, e também cantam canções, então deve ser porque tu tens penas!então deve ser porque tu tens penas! Que outro animal tem penas?" A pequena Ave respondeu muito entusiasmada, "Penas! A Tartaruga, o Largarto, e a Cobra não têm penas. O Morcego não tem penas! A Borboleta não tem penas! O Sapo não tem penas! Os humanos também não têm penas! Tenho penas, por isso sou especial! E por isso sou uma Ave! As aves no mundo podem ser muito diversas e cantarolar melodias muito diferentes, mas todas têm algo em comum: penas!

"O que nos distingue, Aves, dos outros animais é termos penas!"

Fim.

Mommy, Why Am I a Bird?

Once upon a time, there was a little bird. He was a very curious little bird. He liked to ask his mom about everything. One day he asked his mom, "Mommy, why am I called a bird?"

And his mother replied, "Because you were born from an egg, Dear." But this response didn't make sense to the little bird. He said, "But Turtle, Lizard, and Snake were born from eggs too, and they are not birds."

The little bird's mom thought and thought and thought and replied, "Well, because you have wings that let you fly." The little bird was very, very curious, and he knew that he had distant cousins that could not fly. So, he said, "But Ostrich is a bird, and he has wings but does not fly. He

uses his long legs to run. Penguin is a bird and has wings but does not fly. He uses his wings to swim." Indeed, the little bird also knew that some of his friends had wings, flew, and were not birds. So he continued to say, "And Bat has wings and flies and is not a bird. Butterfly has wings, flies, but is also not a bird. Mommy, why am I called a bird?"

The mother bird understood that everything her little bird said was true. And she responded, "Maybe it's because you sing very beautiful songs and everyone in the whole world loves to hear you." The little bird thought immediately about the other fantastic animals that could sing pretty songs. And he said, "But Frog can sing songs too, and he is not a bird! Humans can sing very beautiful songs too, and they are also not birds! Mommy, there must be something special about me that makes me a bird."

His mom, intrigued with her son's responses, thought about this for some time. Then she said, "Well, if other animals are not birds but are born from eggs, have beaks and wings, and can fly, and also sing songs or have beaks too, then it has to be because you have feathers! What other animal has feathers?" The little bird was really excited and responded, "Feathers! Turtle, Lizard, and Snake don't have feathers. Bat doesn't have feathers! Butterfly doesn't have feathers! Frog doesn't have feathers! Humans also don't have feathers! I have feathers; this is why I'm special! This is why I am a Bird! Every bird in the world can be very different or have very different songs, but all of them have something in common – feathers!

"What makes birds different from other animals is we have feathers!"

The end.

Notes:
Children really distracted by screen while waiting for the story.
Prof. Joana gave direction to look at the screen.
The teachers were reading the story with different voices, some interested in looking at the profs while they read.
Really interested and excited by the picture of the humans with the Panda from a children's television show.
Wanted the teachers to read the story again once it was over.

ANNEX III: Bird sound notes

Note: Children's names were replaced with their Student identification code for privacy purposes.

Class 1
Started playing bird sounds at play time away from main group
1;23 Car11 looked at me and the stereo
5:00 Car12 and Car01 came to listen at the stereo; "the birds are singing"
8:24 "birds!"
10:00 switched locations to closer to group
12:21 Car05 came over
13:13 Car02 looked at speaker
20:00 switched locations again to middle of classroom
Car08 looked at stereo
30:00 Car03 came to stereo

Class 2 (During play time)

0:22 Leo12 was interested in comp but came to see what it was
2:30 Leo04 and Leo09 came to sit and look at the computer and me
2:52 – 3:10 Leo10 came to listen
4:14 Leo06 came over
4:24 Leo01 came over
5:55 Leo08 and Leo05 came over

Leo03 stayed with me a long time.

I was sitting with my computer away from where they were playing, but close to where they sit when a formal activity happens. So gradually the students all sat on the carpeted area in their places waiting for me to talk to them. So I asked what the birds were saying when they sing and Leo10 said "there are many in the street and want to play lots of games"

Other answers were :

"we're eating"
"we're playing"
"adeus"
"they are working"
"they are crying"
"singing"
"cheeping"
"Hello"
"They are afraid of witches"
"Hello"

Class 3
Started playing bird sounds from behind a partition during their discussion about firemen. Possible not mentioning bird sounds because afraid to talk off-subject.

After 9:37 commented about bird sounds
"I hear birds like this at my grandma's "
"I think the sounds is from outside"

“I saw birds on my farm eating worms”
“birds are in the woods”
“I don’t think they’re bird sounds”
“yes they are”
“I don’t think they are real birds”
“when they sing they are flying”
“I don’t think they can be indoors”
“some birds are indoors”
“the birds are singing”
“some live here in Coimbra”
[Children imitate songs and bird noises]
“I went to the woods. There are birds there.”
“Where are birds?”
“In the woods”
“what else is there?”
“trees”
“and many birds”

Class 4 (During play time)

9:36 heard one student say they could hear birds
14:14 Pei10 came over to listen to the songs
Pei02 – “I hear bird noises on the computer”
“Maybe it’s an owl”
18:34 I hear birds
19:47 Pei07 – I hear too. Maybe something is wrong with our ears. [Checked each other’s ears]
21:12 Pei06 came to listen to the birds
21:34 Left pretending to be a bird
23:37 Pei10 came to listen to birds
25:47 Pei10 left my side and pretended to be a bird

(https://docs.google.com/file/d/0BwQvXBHa9m2oVUZYbGNaMWxtRkE/edit?usp=sharing)

27:00 Pei02 and Pei08 came over; asked them what they thought the birds were saying; “they’re just living.”
Stayed listening to birds until 36:00
End at 40:00

ANNEX IV: Questionnaire

QUESTIONÁRIO
PROJECTO DE DISSERTAÇÃO
ANNE MARIE WELLS

Elementos de identificação da criança (a ser preenchido pelo entrevistador)

1. Nome_____

2. Idade
   [0] 2 Anos
   [1] 3 Anos
   [2] 4 Anos
   [3] 5 Anos
   [4] 6 Anos

3. Sexo
   [1] Masculino
   [2] Feminino

4. Sala
   (1) Tartarugas
   (2) Leões
   (3) Caracóis
   (4) Peixes

Sobre o processo de aprendizagem na fase prévia do projeto (questionado pelo entrevistador)

5. Gostas de aves?
   [1] Não
   [2] Não muito
   [3] Mais ou menos
   [4] Sim, muito

6. De que forma gostas de aprender?
   [1] Ler os livros
   [2] Ouvir os professores
   [3] Pesquisar na internet
   [4] Fazer atividades fora da sala
   [5] Fazer atividades interativas dentro da sala

7. Tens uma ave preferida?
   [1] Sim
   [2] Não

8. Se sim, qual?

_____

Avaliação dos conhecimentos da criança na fase prévia do projeto (questionado pelo entrevistador)

9. O que é uma ave?
   (1) Uma planta
   (2) Um animal
   (3) Um fungo
   (4) Uma árvore

10. Qual destes não é uma ave?
   (1) Pomba
   (2) Cegonha
   (3) Macaco
   (4) Corvo

11. Todos as aves têm penas?
   [1] Sim
   [2] Não

12. Todos as aves voam?
   [1] Sim
   [2] Não

13. Por onde comem as aves?
   [1] Focinho
   [2] Bico
   [3] Nariz
   [4] Tromba

14. Qual destas aves tem garras para agarrar outros animais?
   [1] Pomba
   [2] Pica-pau
   [3] Pato
   [4] Águia

15. Qual destas aves não voa?
   (1) Avestruz
   (2) Andorinha
   (3) Cegonha
   (4) Papagaio

16. O que impede as aves de flutuar na água?
   [1] Óleo
   [2] Água salgada
   [3] Água normal
   (4) Terra

17. Qual é a ave que sai à noite?
[1] Melro
[2] Mocho
[3] Pintassilgo
[4] Garça

18. Como se chama o período de crescimento no ovo?
[1] Ninho
[2] Infância
[3] Gravidez
[4] Incubação

19. Como nascem as aves?
(1) Através de ovos
(2) Diretamente do corpo da mãe
(3) Através de raízes
(4) Em colmeias

20. Porque é que os patos e cisnes têm as patas espalmadas?
[1] Para ajudá-los a nadar
[2] Para ajudá-los a voar
[3] Para ajudá-los a caçar
[4] Todas as aves têm patas espalmadas

21. Porque é que os mochos têm garras?
[1] Para ajudá-los a nadar
[2] Para ajudá-los a voar
[3] Para ajudá-los a caçar
[4] Todas as aves têm garras

22. Quais são as aves que moram em Portugal?
[1] Águia-perdigueira
[2] Pinguim
[3] Avestruz
[4] Papagaio

23.Qual destas aves é um predador?
[1] Pardal
[2] Galinha
[3] Falcão
[4] Colibri

24. O que comem os pardais?
(1) Outras aves
(2) Nozes
(3) Insetos
(4) Ratos

Questões abertas de cruzamento com as anteriores (pedido às crianças para ilustrar)

25. Desenha uma ave

26. Diga o nome dela

27. Desenha um ninho

QUESTIONNAIRE
DISSERATION PROJECT
ANNE MARIE WELLS

Children's identification (to be filled out by the interviewer)

1.Name_____

2. Age
[0] 2 years
[1] 3 years
[2] 4 years
[3] 5 years
[4] 6 years

3. Sex
[1] Male
[2] Female

4. Classroom
(1) Turtles
(2) Lions
(3) Snails
(4) Fish

About the learning process in the initial phase of the project (asked by the interviewer)

5. Do you like birds?
[1] No
[2] Not really
[3] Kind of
[4] Yes, a lot

6. How do you like to learn?
[1] To read books
[2] To listen to the teachers
[3] To search the internet
[4] To do activities outside the classroom
[5] To do interactive activities inside the classroom

7. Do you have a favorite bird?
[1] Yes
[2] No

8. If yes, which?_____

Evaulation of the children's knowledge (asked by the interviewer)

9. What is a bird?
(1) A plant
(2) An animal
(3) A fungus
(4) A tree

10. Which of these is not a bird?
(1) Pigeon
(2) Stork
(3) Monkey
(4) Crow

11. Do all birds have feathers?
[1] Yes
[2] No

12. Do all birds fly?
[1] Yes
[2] No

13. What do birds eat with?
[1] Snout
[2] Beak
[3] Nose
[4] Trunk

14. Which of these have talons for catching other animals?
[1] Pigeon
[2] Woodpecker
[3] Duck
[4] Eagle

15. Which of these birds don't fly?
(1) Ostrich
(2) Swallow
(3) Stork
(4) Parrot

16. What prevents birds from paddling in the water?
[1] Oil
[2] Salt water
[3] Normal water
(4) Earth

17. Which bird comes out at night?
    [1] Black bird
    [2] Owl
    [3] Finch
    [4] Heron

18. During what period do eggs grow?
    [1] Nest
    [2] Infancy
    [3] Pregnancy
    [4] Incubation

19. How are birds born?
    (1) Through eggs
    (2) Directly from the mother's body
    (3) Through roots
    (4) In colonies

20. Why do ducks and swans have webbed feet?
    [1] To help them swim
    [2] To help them fly
    [3] To help them hunt
    [4] All birds have webbed feet

21. Why do owls have talons?
    [1] To help them swim
    [2] To help them fly
    [3] To help them hunt
    [4] All birds have talons

22. Which of these birds livei n Portugal?
    [1] Eagle
    [2] Penguin
    [3] Ostrich
    [4] Parrot

23.Which of these is a predator?
    [1] Sparrow
    [2] Chicken
    [3] Falcon
    [4] Hummingbird

24. What do sparrows eat?
    (1) Other brids
    (2) Nuts
    (3) Insects
    (4) Mice

Open-ended questions (ask the child to draw)

25. Draw a bird

26. What is it called?

27. Draw a nest

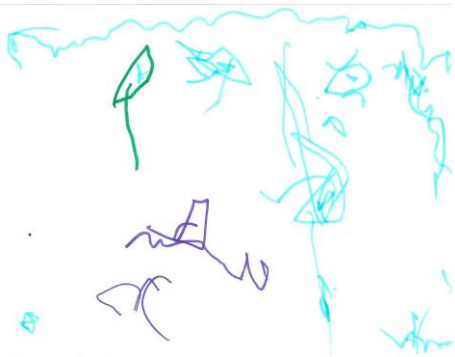
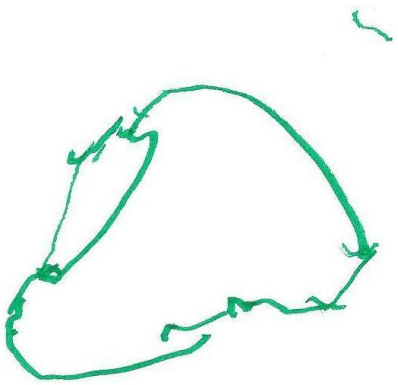
ANNEX V: Children's drawings and statements and analysis

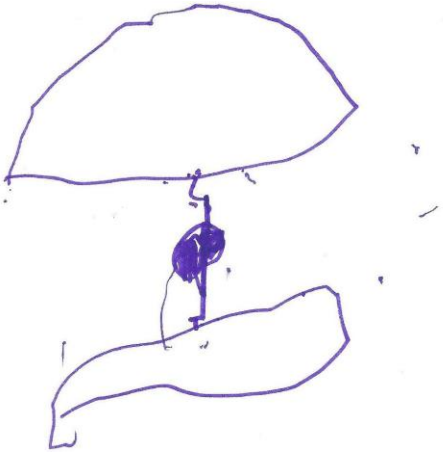
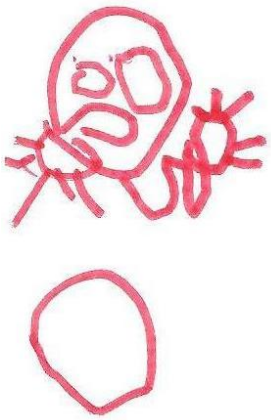
Drawings and statements

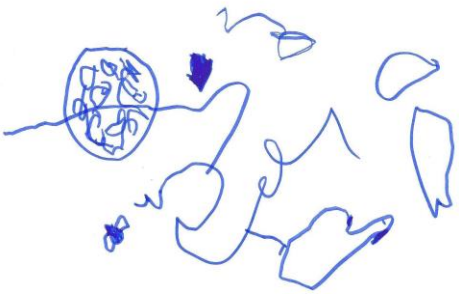
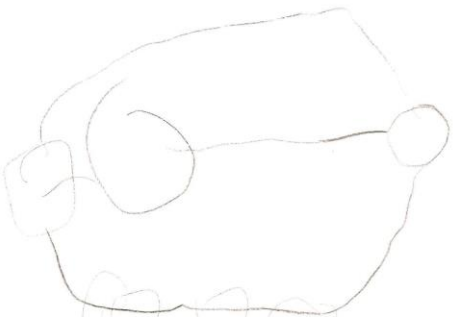
The following annex shows the preschoolers' (I)nitial drawings on the left and (F)inal drawings on the right. First line of each corresponding paragraph consists of three letters and two numbers which were used to identify the participants. The second line refers to (M)ale or (F)emale and the child's age. The ages of children who had a birthday before the final drawing are demonstrated with their age before followed by a hyphen and their current age. Transcriptions of the notes taken while the child drew with responses to probing questions are included.

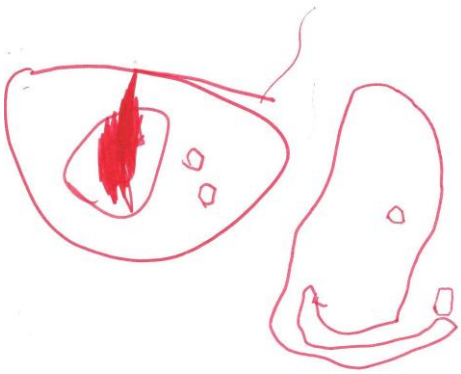
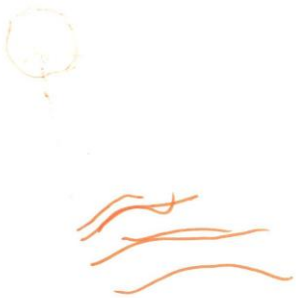
Some drawings were altered because they were not visible after scanning due to their light coloration. Children's names were erased electronically from the pictures for privacy purposes.

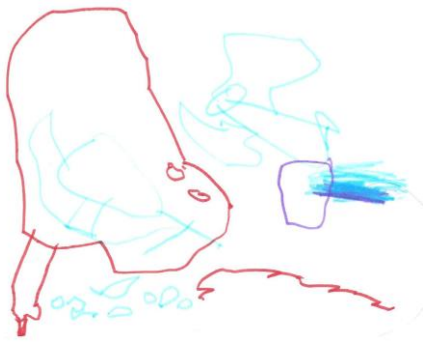
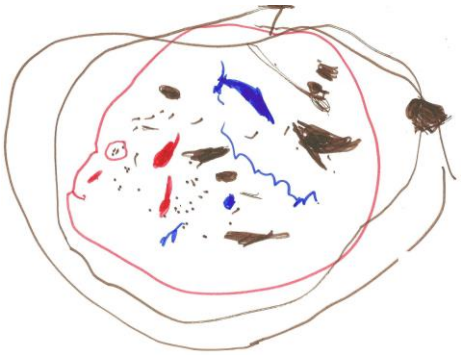
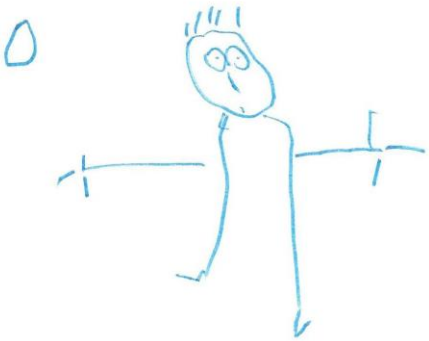
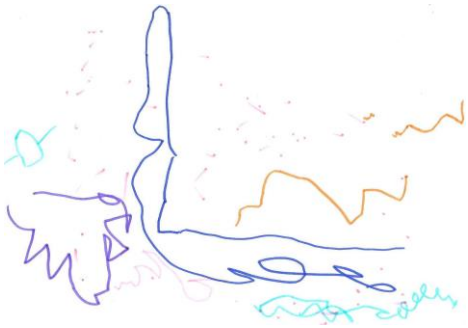
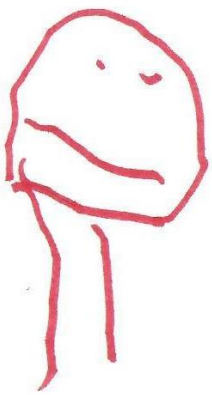
Tables showing the initial and final presence/absence of drawing attributes for each drawing and the scores used for analysis are attached afterward.

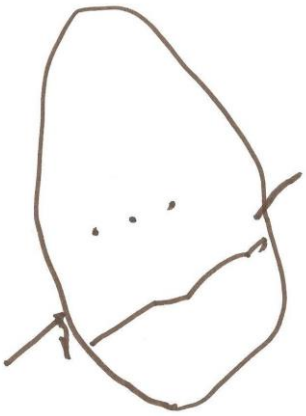
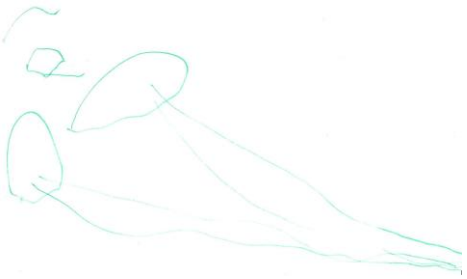
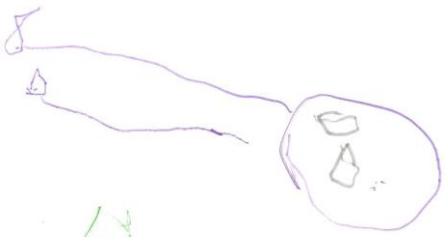
Car01M3-4 I: Pink is bird; brown is nest; colored the bird in with brown; no name F: Parrot in a cage, no nest because bird is in a cage		
Car02M3-4 I: Drew balloons, bird flying in the sky and tree because "birds need trees," when asked what he drew, he said "bird" no nest. F: Drew wings, legs, mouth; name=Davi Alexandre		
Car03M3 I: Didn't want to draw a nest, when asked what did you draw?, responded "a saw" F: "Ostrich," said "feathers," "wings" "nose"		

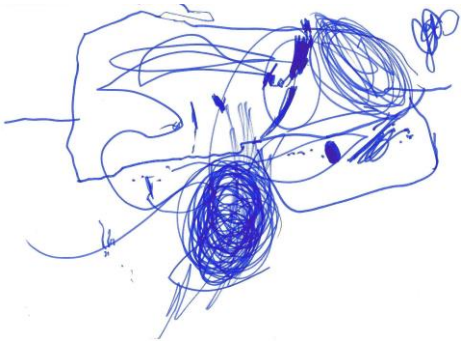
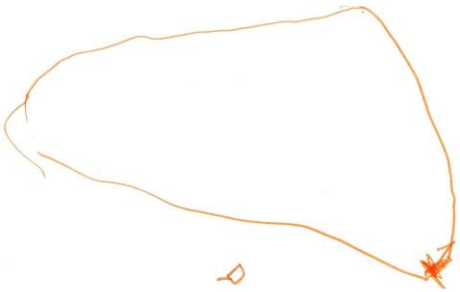
Car04M3-4 I: Didn't draw a bird F: Name=penguin		
Car05F3 I: Drew a parrot F: Ostrich with an orange beak, pink things=legs, green=toes, blue=feathers, green/pink=nest and story about the bird.		
Car06M3-4 I: Didn't draw a bird F: Duck, wings, nest with eggs.		
Car07F2-3 I: Didn't answer questions about drawing F: Didn't answer questions about drawing		

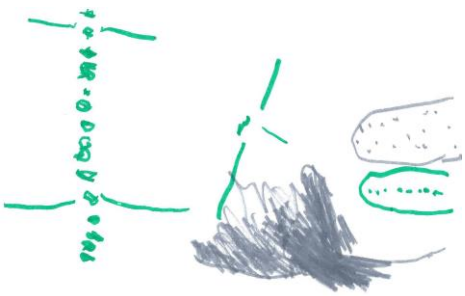
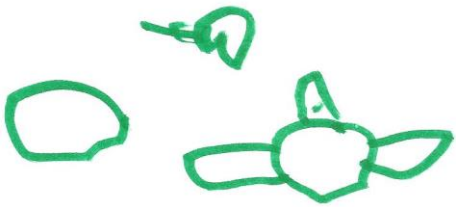
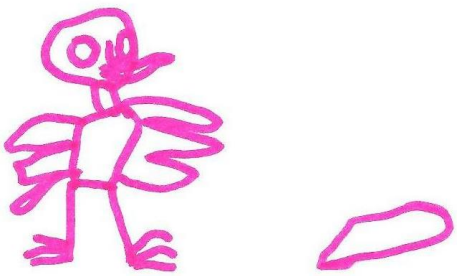
Car08F3-4 I: Didn't answer questions about drawing F: name is bird, nest with eggs and other birds and food.		
Car09F3-4 I: Pink in corner is bird, said "wings, beak" nest is on left of bird and scribbles underneath. Name=bird F: Blue and red are fish, pink is nest, purple is bird, blue are wings, a penguin with hair.		
Car10F3 I: "It's moving its wings," scribble in center=sky, shape on side=nest, no name, drew circle but said it was the pencil holder with fruit purée inside. F: Said it was a bird, nest with eggs, doesn't have a name		
Car11M3 I: A really fast car F: Blue on bottom is a nest with eggs. Birds don't have names. Sun with rainbow.		

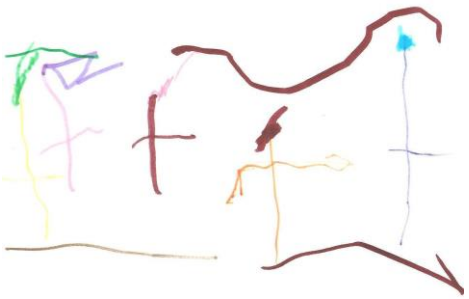
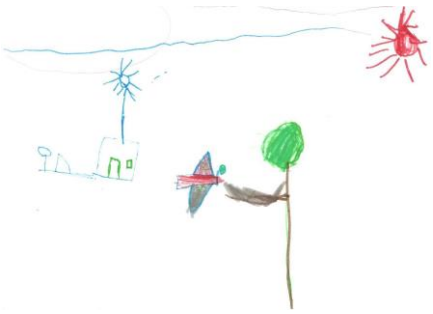
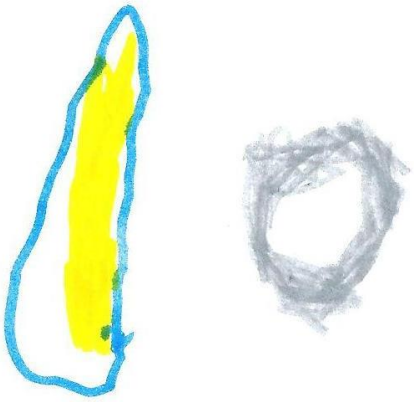
Car12M3-4 I: Chicken (line on right) with “patas” and head, drew eggs and chicks inside the eggs. Lines on left are nest F: Duck and a pond. No nest because ducks live in the water.		
Car13F3 I: Didn’t draw F: Penguin, doesn’t fly, whenever I pointed to a part of the penguin drawing and asked “ what is this?” she answered “ a penguin.” Green to left is nest.		
Car14M3-4 I: Said he couldn’t draw a bird, and didn’t answer questions about drawing. F: Penguin, line is nest		
Car15F3 I: Didn’t draw F: wings, woodpecker, feet (patas), nest=lines		

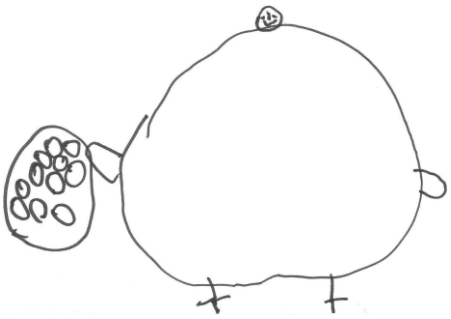
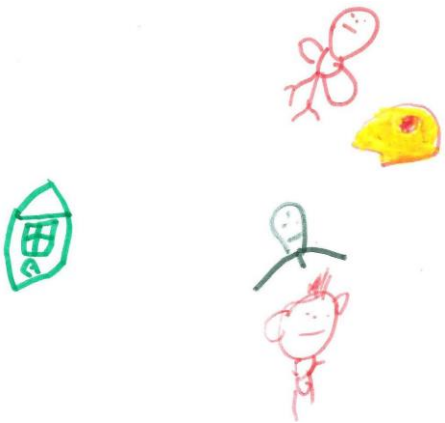
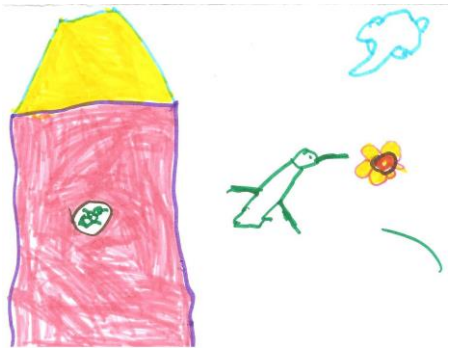
Leo01F3 I: Didn't answer questions about drawing. When asked to draw nest, drew circle shape on left. F: Red is a bird, when asked about different parts, answered that it was a bird, nest and eggs underneath.		
Leo02F3 I: Nest is red circle around bird (blue), eggs are red dots and circle, brown is a chestnut, drew circle around bird as nest. Name=Clara F: Nest is circle to side, "hair" "nose" " arms"		
Leo03F3-4 I: blue=water, orange=birds, light blue=nest and baby bird name=Massa F: bird house and sun and bird and nest, name is "passarinho"		
Leo04M3 I: "eye" " beak" " wing" "feathers" F: Didn't want to draw, didn't answer questions about drawing.		

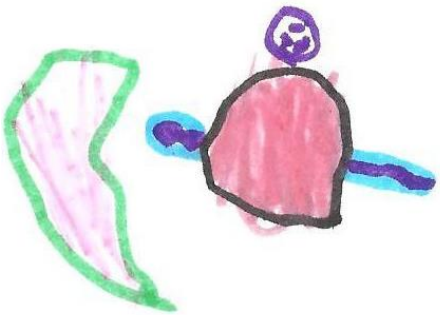
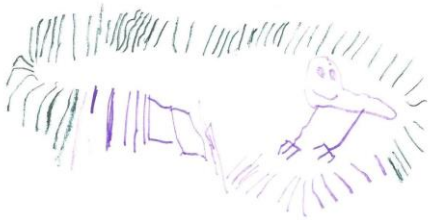
Leo05M3 I: didn't want to draw a bird or a nest F: It's an ostrich.		
Leo06M3-4 I: Didn't want to draw F: Eagle, it's a bird that flies, "legs," "wings" "this bird doesn't have a nest"		
Leo07M3 I: mother and father bird, named " Ana and " Santa Claus" nest is small circle (baby) F: it's a bird named "monstro"		
Leo08F3 I: Didn't answer questions about drawing F: Orange=chicks, red=nest, pink/blue is nothing		

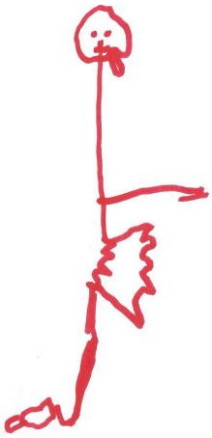
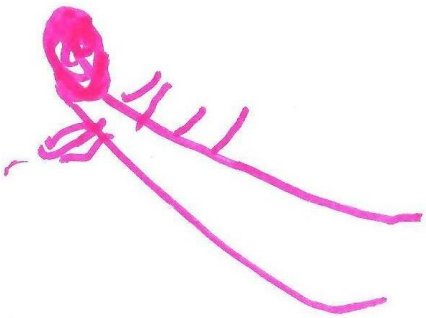
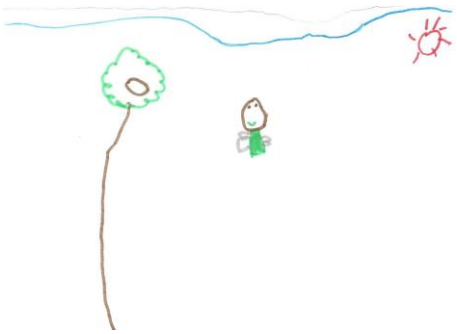
Leo09F2-3 I: Green is bird, orange is nest F: Blue=penguin, purple=worm, yellow=chick, gray=egg, red=grapes, brown=dog		
Leo10F3-4 I: “Chocolate cake” nest is circle in corner F: Pink=dog, chasing the pigeon (green and red above), “wings” green is grass, dog going to grab bird for its house.		
Leo11F3 I: Distracted by music playing in classroom. No bird, nest in corner, two nests, no name. F: Crow, brown legs, feathers, brown circle is nest with eggs. Yellow is a chick. The crosses on bottom are “nothing”		
Leo12M3 I: name is “bird,” nest is small circle with line. F: Pink and green is a parrot. Red and green is a nest.		

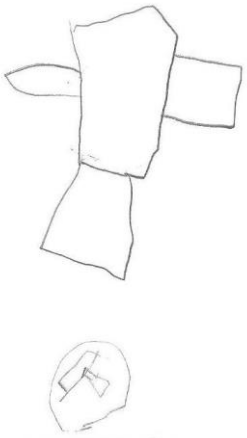
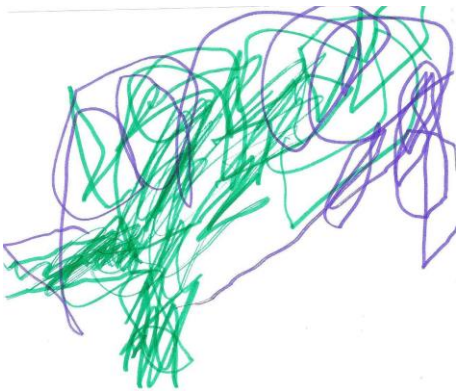
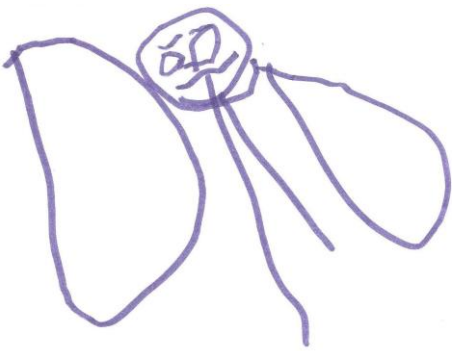
Leo13M3 I: a plane with windows, but then drew a bird (green diagonal lines) and a nest (gray) F: Bird with nest. Other mark is “nada”		
Tar01M4 I: nest and bird, no name F: A tree with a woodpecker with a hill for bike, “mouth”		
Tar02M4 I: When asked, what did you draw, didn’t answer F: When asked what did you draw, didn’t answer		
Tar03F4-5 I: when asked what she drew, said “bird.” nest to side. F: Baby owl in tree with nest. Mom owl flying to bring food.		

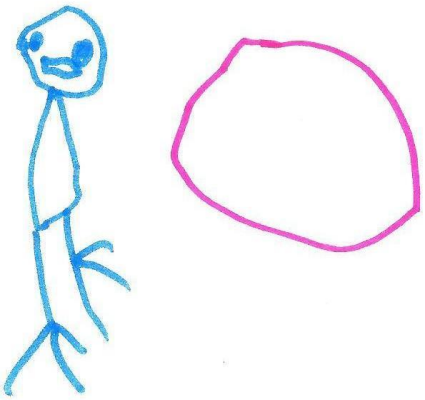
Tar04M3-4 I: Drew pigeons F: Drew a gull with nest to side.		
Tar05M4-5 I: When asked “what did you draw,” answer was “I don’t know.” F: When asked “what did you draw,” answer was “red.”		
Tar06M4-5 I: Bird in city and nest in a tree. F: Bird with nest in tree, bird house to left.		
Tar07M3-4 I: Bird=blue and yellow, nest=gray F: Said couldn’t draw a bird, but could draw a feather (left), nest (right)		

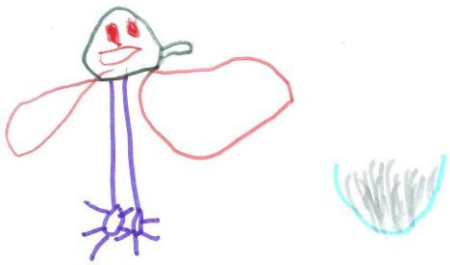
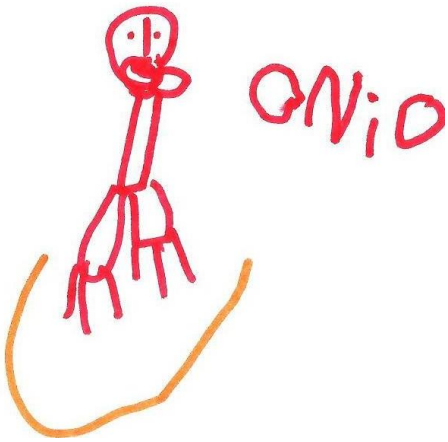
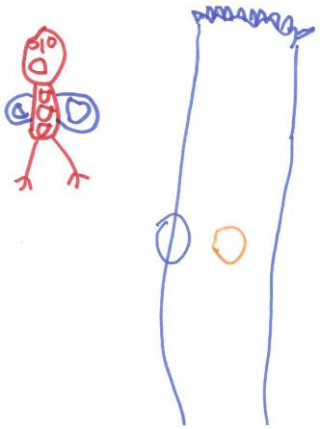
Tar08F4-5 I: Bird in right corner, nest in middle. F: Wings, feet (patas), nest with eggs, name=Joana		
Tar09M4 I: Blue is bird, yellow is nest, name is Pigeon. F: It's an ostrich with a nest and eggs.		
Tar10M4-5 I: Black and red are birds. Drew himself, his house, and the nest is yellow with red, but did not say the dot was an egg. F: Bird eating from a flower. Bird house with baby bird inside. Blue is a cloud, green line is testing the marker.		
Tar11M4 I: A tree F: A tree with a nest to the side.		

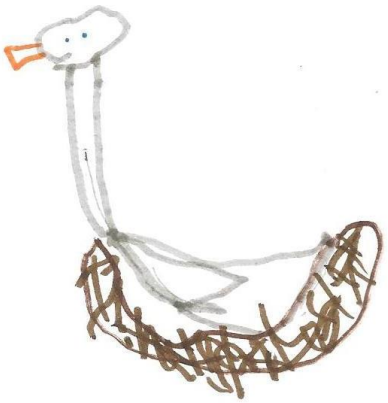
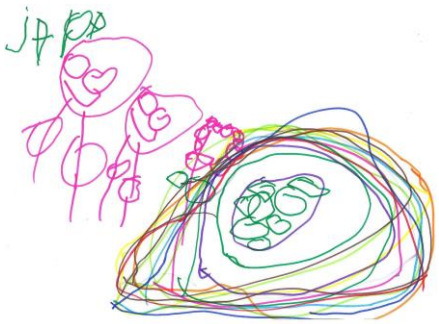
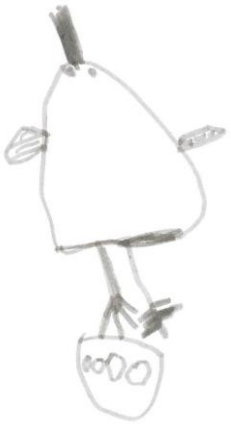
Tar12F4 I: Didn't want to draw bird. Drew parents and traced her hand and colored it. F: Mom and dad birds with chicks in nest. Pink is eggs, and blue and gray are chicks coming out of the eggs. Light blue are feathers.		
Tar13F4 I: Drew bird, when asked name answered "João." Rainbow and sun. F: Two penguins in ice. Circle around penguins is nest.		
Tar14F4-5 I: Drew bird, when asked the name, said "João" F: It's a swallow with a nest next to it.		
Tar15M4 I: Used word "talons", nest is underneath, no name F: Chicken in nest, mouth, body, talons		

Tar16M4-5 I: Feathers, wing, beak, started to cry about drawing, no nest or name F: Hawk		
Tar17F4 I: Didn't answer questions about drawing F: Chicken with 2 nests below with eggs		
Tar18F4 I: Thought "arvore" not "ave" drew nest with eggs, not sure what circle on side is, when asked said "nest" F: Bird flying, wings, mouth. Drew nest in tree because nests are in trees		
Tar19M4 I: Scribbles, did not describe picture or answer questions. Looks like trees, but can't be sure. F: Bird with nest and eggs, wings, feet, egg, mouth name=M&M		

Tar20M4 I: Didn't draw F: Didn't answer questions about drawing		
Tar21M4 I: Bird and drew eggs in nest, name=João F: Penguin in ice, he's going swimming, no nest because he doesn't think penguins have nests		
Tar22M4-5 I: Bird with no head. Wings and tail, nest underneath with eggs F: Name="bird"(ave); nest under bird		
Tar23F4 I: Didn't answer questions about drawing F: Said it was a bird, but did not answer questions about specific aspects of the drawing		

Pei01F5 I: “Hands” “feet”(pés) “mouth” nest=circle underneath, no name F: Pink underneath is nest, “swallow”		
Pei02M5-6 I: no name, ears F: It’s a penguin in a nest		
Pei03M5 I: Eggs in the nest, wrote the name=Doarnomb (Doraemon?) F: Ostrich, beak, nest, belly, feet (patas)		
Pei04F4-5 I: Mouth, nest is underneath, no name F: Falcon, beak, feet (patas), wings, nest is yellow circle to left.		

Pei05F5-6 I: Wings, feet, thing on face=nose, no name F: Falcon, beak orange=nest		
Pei06M5 I: Wings, feet, toes, name=Cordinhas [name of city nearby] F: Falcon, when the falcon goes to eat animals, the toes go like this [child spread fingers], head, eyes, beak, talons, nest has eggs		
Pei07M4 I: “Feet” nest is underneath, name=Onio F: Mouth, nose, wings, Eagle, “doesn’t have hands” “has feathers” “talons” nest is orange, “has leaves” blue=tree with hole to go to the nest		
Pei08M5 I: Not birds, drew flower, nest is half-circle to side F: Drew mouth, but then independently corrected drawing and drew beak, webbed feet, but is a parrot. Nest is circle to side.		

Pei09F5-6 I: Beak, pigeon F: Swan, brown underneath=nest		
Pei10F3-4 I: Flower at side; “mom and me”; nest w/ eggs F: The bird is making eggs; beak; feathers; doesn’t have a name		
Pei11M4-5 I: Feathers, “toes” “wings” “mouth” nest underneath. Name=Asaana F: Nest and eggs; chicken “mouth” feathers, talons, “it’s trying to fly because they can’t fly well”		

Drawing analysis

Class 1

Initial

Student ID	Age$_{Initial}$	Sex	Bird?	Head	Body	Eyes	Legs	Wings	Toes/talons	Beak	Feathers	Total Attributes	Nest?	With bird	Eggs	Chicks	Name?	"Bird"	Species	Weighted Total	Non-weighted Total	Context
Car 01	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.8	3.7	0
Car 02	3	1	1	0	1	0	0	1	0	0	0	2	1	0	1	0	0	0	0	40.0	33.3	0
Car 03	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Car 04	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Car 05	3	2	1	1	0	1	0	0	0	0	0	2	0	0	0	0	1	0	2	28.3	44.4	0
Car 06	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.8	3.7	0
Car 07	2	2	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	16.7	22.2	0
Car 08	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25.0	33.3	0
Car 09	3	2	1	1	1	1	0	0	0	0	0	3	1	1	0	0	1	1	0	51.1	59.3	0
Car 10	3	2	1	1	1	0	0	1	0	0	0	3	1	0	0	0	0	0	0	39.4	25.9	1
Car 11	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Car 12	3	1	1	1	0	0	1	0	0	0	0	2	0	0	0	0	1	0	2	28.3	44.4	1
Car 13	3	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	16.1	14.8	0
Car 14	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Car 15	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Totals			8	4	3	2	1	2	0	0	0		5	2	1	0	3	1	4			2
Averages	2.9											0.8								17.4	19.0	

Final

Student ID	Age$_{Final}$	Sex	Bird?	Head	Body	Eyes	Legs	Wings	Toes/talons	Beak	Feathers	Total Attributes	Nest?	With bird	Eggs	Chicks	Name?	"Bird"	Species	Weighted Total	Non-weighted Total	Context
Car 01	4	1	1	0	0	0	0	1	0	0	0	1	1	1	0	0	1	0	2	37.2	63.0	1
Car 02	4	1	1	1	0	1	1	1	0	0	1	5	1	1	0	0	1	0	0	65.0	55.6	0
Car 03	3	1	1	1	0	1	1	1	0	0	0	4	1	1	0	0	1	0	2	60.6	74.1	0
Car 04	4	1	1	1	1	0	0	1	0	0	0	3	1	1	0	0	1	0	2	52.8	70.4	0
Car 05	3	2	1	1	1	1	1	0	1	1	1	7	1	0	0	0	1	0	2	75.6	74.1	0
Car 06	4	1	1	1	1	0	0	1	0	0	0	3	1	1	1	0	1	0	2	61.1	81.5	0
Car 07	3	2	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	24.4	25.9	0
Car 08	4	2	1	1	1	1	1	0	0	0	0	4	1	1	1	1	1	1	0	67.2	74.1	1
Car 09	4	2	1	1	1	1	1	1	1	0	0	6	1	0	0	0	1	0	2	67.8	70.4	1
Car 10	3	2	1	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0	0	32.2	29.6	0
Car 11	3	1	1	1	1	1	0	1	0	1	0	5	1	1	1	0	1	0	2	76.7	88.9	1
Car 12	4	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	2	29.4	59.3	1
Car 13	3	2	1	1	1	1	1	0	1	0	0	5	1	0	0	0	1	0	2	60.0	66.7	0
Car 14	4	1	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	2	29.4	59.3	0
Car 15	3	2	1	1	0	1	1	1	0	0	0	4	1	1	0	0	1	0	2	60.6	74.1	0
Totals			15	10	7	8	7	8	3	3	2		15	10	4	2	13	1	22			5
Averages	3.5											3.5								53.3	64.4	

Class 2

Initial

Student ID	Age$_{Initial}$	Sex	Bird?	Head	Body	Eyes	Legs	Wings	Toes/talons	Beak	Feathers	Total Attributes	Nest?	With bird	Eggs	Chicks	Name?	"Bird"	Species	Weighted Total	Non-weighted Total	Context
Leo 01	3	2	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	16.7	22.2	0
Leo 02	3	2	1	0	1	0	0	0	0	0	0	1	1	1	0	0	1	0	0	33.9	40.7	0
Leo 03	3	2	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	26.1	37.0	1
Leo 04	3	1	1	1	1	1	0	0	0	1	0	4	0	0	0	0	0	0	0	38.9	18.5	0
Leo 05	3	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	8.3	11.1	0
Leo 06	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Leo 07	3	1	1	1	0	0	1	0	0	0	0	2	1	1	0	0	1	0	0	41.7	44.4	0
Leo 08	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Leo 09	2	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	19.4	37.0	0
Leo 10	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1.7	11.1	0
Leo 11	3	2	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	25.0	33.3	0
Leo 12	3	1	1	0	1	0	0	0	0	0	0	1	1	0	0	0	1	1	0	27.2	40.7	0
Leo 13	3	1	1	1	1	0	0	1	0	0	0	3	0	0	0	0	0	0	0	31.1	14.8	1
Totals			7	3	4	1	1	1	0	1	0		8	5	1	0	6	2	0			2
Averages	2.9											0.8								20.8	23.9	

Final

Student ID	Age$_{Final}$	Sex	Bird?	Head	Body	Eyes	Legs	Wings	Toes/talons	Beak	Feathers	Total Attributes	Nest?	With bird	Eggs	Chicks	Name?	"Bird"	Species	Weighted Total	Non-weighted Total	Context
Leo 01	3	2	1	0	1	1	0	0	0	0	0	2	1	1	1	0	1	1	0	51.7	66.7	0
Leo 02	3	2	1	1	0	1	1	0	0	0	0	3	1	0	0	0	0	0	0	39.4	25.9	0
Leo 03	4	2	1	1	0	0	0	1	0	0	0	2	1	1	1	0	1	1	0	51.7	66.7	1
Leo 04	3	1	1	1	0	1	1	0	0	0	0	3	0	0	0	0	0	0	0	31.1	14.8	0
Leo 05	3	1	1	1	0	1	0	1	0	0	0	3	0	0	0	0	1	0	2	36.1	48.1	0
Leo 06	4	1	1	1	1	1	1	1	0	1	0	6	0	0	0	0	1	0	2	59.4	59.3	0
Leo 07	3	1	1	1	0	1	1	0	0	0	0	3	1	0	0	0	1	0	0	41.1	37.0	0
Leo 08	3	2	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	16.7	22.2	0
Leo 09	3	2	1	1	1	1	0	0	0	1	0	4	1	1	0	1	1	0	2	68.9	85.2	1
Leo 10	4	2	1	1	1	1	1	1	0	0	0	5	1	0	0	0	1	0	2	60.0	66.7	1
Leo 11	3	2	1	1	1	1	1	0	0	1	1	6	1	1	1	1	1	0	2	84.4	92.6	1
Leo 12	3	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	21.1	48.1	0
Leo 13	3	1	1	0	1	0	0	1	0	1	0	3	1	0	0	0	1	0	0	41.1	37.0	0
Totals			12	9	6	9	6	5	0	4	1		10	4	3	3	10	2	12			4
Averages	3.2											3.1								46.4	51.6	

Class 3

Initial

Student ID	$Age_{Initial}$	Bird?	Head	Body	Eyes	Legs	Wings	Toes/talons	Beak	Feathers	Total Attributes	Nest?	With bird	Eggs	Chicks	Name?	"Bird"	Species	Weighted Total	Non-weighted Total	Context
Tar 01	4	1	1	1	1	0	0	1	0	0	4	0	0	0	0	0	0	0	38.9	18.5	0
Tar 02	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Tar 03	4	1	1	1	1	1	1	1	1	1	8	0	0	0	0	1	1	0	73.3	55.6	0
Tar 04	3	1	0	1	0	0	1	0	0	0	2	1	0	0	0	1	0	2	36.7	55.6	0
Tar 05	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Tar 07	4	1	1	1	1	1	1	0	0	1	6	1	0	0	0	0	0	0	62.8	37.0	1
Tar 08	3	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	24.4	25.9	0
Tar 09	4	1	1	0	1	0	0	0	0	0	2	1	0	1	0	0	0	0	40.0	33.3	0
Tar 10	4	1	1	1	0	0	0	0	1	0	3	1	0	1	0	1	0	2	52.8	70.4	0
Tar 11	4	1	1	1	1	1	1	1	0	0	6	1	0	1	0	0	0	0	71.1	48.1	1
Tar 12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Tar 13	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	25.0	33.3	0
Tar 14	4	1	1	1	1	0	1	0	1	0	5	1	0	0	0	0	0	0	55.0	33.3	1
Tar 15	4	1	1	0	0	0	1	0	0	0	2	0	0	0	0	1	0	0	25.0	22.2	0
Tar 16	4	1	1	1	1	0	0	1	0	0	4	1	0	0	1	1	0	0	57.2	51.9	0
Tar 17	4	1	1	1	1	0	1	0	1	1	6	0	0	0	0	0	0	0	54.4	25.9	0
Tar 18	4	1	1	0	1	1	1	0	0	1	5	0	0	0	0	0	0	0	71.7	55.6	0
Tar 19	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Tar 20	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Tar 21	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0
Tar 22	4	1	1	1	1	1	1	1	0	0	6	1	0	1	0	1	0	0	72.8	59.3	0
Tar 23	4	1	0	1	0	0	1	0	0	0	2	1	1	0	1	0	0	0	48.3	44.4	0
Tar 24	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.8	3.7	0
Totals		16	12	11	10	5	10	5	4	4		11	1	5	2	6	1	4			3
Averages	3.9										2.7								35.5	29.3	

Final

Student ID	Age$_{Final}$	Sex	Bird? b	Head b	Body b	Eyes b	Legs b	Wings b	Toes/talons b	Beak b	Feathers b	Attributes	Nest? b	With bird b	Eggs b	Chicks b	Type? b	"Bird"	Species	Weighted Total	Non-weighted Total	Context b
Tar 01	2	1	1	1	1	1	0	0	0	0	0	3	0	0	0	0	1	0	2	36.1	48.1	1
Tar 02	2	1	1	0	1	0	0	1	0	0	0	2	0	0	0	0	0	0	0	23.3	11.1	0
Tar 03	3	2	1	1	1	1	1	1	1	1	1	8	1	1	0	1	1	0	2	100.0	100.0	1
Tar 04	2	1	1	1	0	1	0	0	0	0	0	2	1	1	0	0	1	0	2	45.0	66.7	0
Tar 05	3	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	16.1	14.8	0
Tar 07	3	2	1	1	1	1	0	1	0	0	0	4	1	1	0	0	1	1	0	58.9	63.0	1
Tar 08	2	1	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	16.1	14.8	0
Tar 09	3	2	1	1	1	1	1	1	1	0	0	6	1	1	1	0	1	0	0	81.1	70.4	0
Tar 10	2	1	1	1	1	1	1	1	1	1	0	7	1	1	1	0	1	0	2	92.2	96.3	0
Tar 11	3	1	1	1	1	1	0	1	0	1	0	5	1	1	0	1	1	0	2	76.7	88.9	1
Tar 12	2	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	8.3	11.1	0
Tar 13	2	2	1	1	1	1	0	1	0	0	1	5	1	1	1	1	1	0	2	76.7	88.9	1
Tar 14	2	2	1	1	1	1	0	1	0	1	0	5	1	0	0	0	1	0	2	60.0	66.7	0
Tar 15	3	2	1	1	1	1	1	1	0	0	0	5	1	1	0	1	1	0	2	76.7	88.9	1
Tar 16	2	1	1	1	1	1	1	0	1	0	0	5	1	1	0	0	1	1	0	66.7	66.7	1
Tar 17	3	1	1	1	1	1	0	1	0	1	0	5	1	1	0	0	1	0	2	68.3	77.8	0
Tar 18	2	2	1	1	1	1	1	0	0	0	0	4	1	1	1	1	1	0	2	68.9	85.2	0
Tar 19	2	2	1	1	1	1	0	1	0	0	0	4	1	1	0	0	0	0	0	55.6	40.7	1
Tar 20	2	1	1	0	1	0	1	0	0	0	0	2	1	1	0	0	1	0	0	41.7	44.4	0
Tar 21	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.8	3.7	0
Tar 22	2	1	1	1	1	1	1	1	0	1	1	7	0	0	0	0	1	0	2	67.2	63.0	1
Tar 23	3	1	1	1	1	1	0	1	0	0	0	4	1	1	1	0	1	1	0	67.2	74.1	0
Tar 24	2	2	1	1	0	1	1	1	0	0	0	4	0	0	0	0	1	0	0	40.6	29.6	0
Totals			21	17	17	17	9	14	4	6	4		18	14	5	5	17	3	22			9
Averages	2.3											3.8								54.4	57.2	

Class 4

Initial

Student ID	Age$_{Initial}$	Sex	Bird?	Head	Body	Eyes	Legs	Wings	Toes/talons	Beak	Feathers	Total Attributes	Nest?	With bird	Eggs	Chicks	Name?	"Bird"	Species	Weighted Total	Non-weighted Total	Context
Pei 01	5	2	1	1	1	1	1	0	0	0	0	4	1	1	0	0	0	0	0	55.6	40.7	0
Pei 02	5	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	16.7	22.2	0
Pei 03	5	1	1	1	1	1	1	0	0	1	0	5	1	0	1	0	1	0	0	65.0	55.6	0
Pei 04	4	2	1	1	0	1	1	0	1	0	0	4	1	0	0	0	1	1	0	50.6	51.9	0
Pei 05	5	2	1	1	0	1	1	1	0	0	0	4	1	0	0	0	1	0	0	48.9	40.7	0
Pei 06	5	1	1	1	1	1	1	1	0	0	0	5	1	0	0	0	1	0	0	56.7	44.4	0
Pei 07	4	1	1	1	1	1	1	0	1	1	0	6	0	0	0	0	1	0	0	56.1	37.0	0
Pei 08	5	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	25.0	33.3	0
Pei 09	5	2	1	1	1	1	1	0	1	1	0	6	1	1	0	0	1	0	2	76.1	81.5	0
Pei 10	3	2	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	16.7	22.2	0
Pei 11	4	1	1	1	1	1	1	1	1	0	1	7	0	0	0	0	1	0	0	63.9	40.7	0
Totals			8	8	6	8	8	3	4	3	1		9	5	2	0	7	1	2			0
Averages	4.5											3.7								48.3	42.8	

Final

Student ID	Age$_{Final}$	Sex	Bird? b	Head b	Body b	Eyes b	Legs b	Wings b	Toes/talons b	Beak b	Feathers b	Attributes	Nest? b	With bird b	Eggs b	Chicks b	Type? b	"Bird"	Species	Weighted Total	Non-weighted Total	Context b
Pei 01	5	2	1	1	1	1	1	1	1	1	0	7	1	1	0	0	1	0	2	83.9	85.2	0
Pei 02	6	1	1	1	1	0	1	1	1	1	0	6	1	1	0	0	1	0	2	76.1	81.5	0
Pei 03	5	1	1	1	1	1	1	1	1	1	0	7	1	1	1	0	1	0	2	92.2	96.3	0
Pei 04	5	2	1	1	1	1	1	1	1	1	1	8	1	0	0	0	1	0	2	83.3	77.8	0
Pei 05	6	2	1	1	1	1	1	1	1	1	1	8	1	1	0	0	1	0	2	91.7	88.9	0
Pei 06	5	1	1	1	1	1	1	1	1	1	0	7	1	1	1	0	1	0	2	92.2	96.3	1
Pei 07	4	1	1	1	1	1	1	1	1	0	1	7	1	1	0	0	1	0	2	83.9	85.2	1
Pei 08	5	1	1	1	1	1	1	1	1	1	1	8	1	0	0	0	1	0	2	83.3	77.8	0
Pei 09	6	2	1	1	1	1	0	1	0	1	1	6	1	1	0	0	1	0	2	76.1	81.5	0
Pei 10	4	2	1	1	1	1	1	1	1	1	1	8	1	1	1	0	0	0	0	95.0	66.7	1
Pei 11	5	1	1	1	1	1	1	1	1	0	1	7	1	1	1	0	1	0	2	92.2	96.3	1
Totals			11	11	11	10	10	11	10	9	7		11	9	4	0	10	0	20			4
Averages	5.1											7.2								86.4	84.8	