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TEACHING SCIENCE IN PRESCHOOL SETTINGS: A CASE STUDY OF LEARNING BY DOING

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Abstract

This article presents the implementation of an experiment-based approach to teaching science to preschoolers. The research relied on the principle of "learning by doing" derived from the Child-Centred Education theory of Pedagogy. The experimental group was formed of 18 children aged 4-5 years who were taught about the concept of the water circuit in nature by a group of 3rd graders who used the experimental method. The same concept was presented only by the teacher to a control group (N=18). The level of comprehension of the concept was measured to see if there were differences between the two groups. The experiment group scored 30% higher in comprehension, memorisation and practice than the control group. The main focus of the study is to develop an environment where classes are associated by different levels (primary and preschool) so that the older children may teach younger children concepts otherwise hard to understand. Alternative educational groupings could generate a more profound comprehension of difficult subjects. The results of the study encourage the idea of breaking the boundaries between age-groups and subjects. The current generation has found interest in technology development, regardless of age. Also, older children can use their theory comprehension filters as foundation for teaching structures to younger children. The guided use of technology in the classroom should be the main preoccupation of teachers in order to enhance student performance and love for learning. Such pairing methods can help both teachers and students together. We believe this program can be multiplied in any school.

Key words*:* child-centred education, learning by doing, preschool, Science

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Introduction

The present study was realised in the Romanian-Finnish School in Bucharest with a group of 5-year-old students, in collaboration with their primary school counterparts (3rd graders). It is important to underline the fact that this educational project, founded in Romania in 2010 with the purpose of sharing best practices from the renowned Finnish educational system, has at its core the idea of *learning by doing, exploring real life inside the classroom* and *creating learning experiences.*

The vision of this project is to implement a realistic approach based on the Finnish educational model, which puts the child / student in the centre of education, using two main actors: very well-trained teachers on one hand - and parents, involved in school activities through the support offered to the school and teachers, on the other hand.

The mission of the school is: "Quality education for all!", reflected in the Romanian-Finnish working principles: child-centred education, learning by doing, recycling, connecting with reality, the team parents-teachers-children. The Science Domain has become important and teachers have been encouraged to use experiments in teaching important concepts from the natural world. Therefore, intuitive pedagogical methods are used throughout the country to ensure valid and interesting learning experiences.

Many scientists and researchers have argued that Science education should begin in early childhood because it has an important impact on many aspects of the child's development. (Eshach & Fried, 2005; Watters, Diezmann, Grieshaber, & Davis, 2000). One of the reasons to start teaching Science early is because children think about nature and enjoy observing it (Eshach & Fried, 2005; Ramey-Gassert, 1997). Also, it is known and proven their motivation to explore the world and everything around them (French, 2004).

In order to develop a solid foundation for the scientific concepts that they will come across in their academics lives, children should be provided with a quality Science learning experiences (Eshach & Fried, 2005; Gilbert, Osborne, & Fenshama, 1982). This foundation for understanding key scientific concepts allows children to learn more abstract ideas (Reynolds & Walberg, 1991). Their understanding of scientific concepts is influenced by the way the children think about the world. Children tend to view things from a self-centred point of view and often attribute human characteristics (feelings, purpose or will) to objects and phenomena (Piaget, 1972; Bell, 1993).

Bownman et al. (2001) have concluded that: "Children who have a broad base of experience in domain-specific knowledge (for example, in Mathematics or a certain area of Science) move more rapidly in acquiring more complex skills" (Bowman, Donovan, & Burns, 2001, pp. 8-9).

Teachers should help children to develop their inquiry skills, designing their own

investigations and posing their own questions (Banchi & Bell, 2008). When each concept is associated with an immediate natural effect, this generates an energetic, thorough learning experience.

According to Worth (2010) different roles of Science should be learn by children:

- the *exploratory role*: knowing about what happens in the world around us (ex: why water evaporates, how electricity works).
- *the predictive role:* "what might happen if…"
- the *resolving role:* scientific knowledge help on solving problems such as the spread of diseases or the problem with unclean water.
- the *development role* is seen when technological development that serves our needs and interests is guided by Science (ex: high-speed travel and talking on the telephone).

Many scientists and researchers also speak about the fun and creativity of doing science. Richard Feynman (1997) once said about his work: "*Why did I enjoy doing it (Physics)? I used to play with it. I used to do whatever I felt like doing… [depending on] whether it was interesting and amusing for me to play with"* (Feynman, 1997, p. 48).

Description of the case-study

The parents' approval was obtained after a previous meeting during which they were presented with the details and the objectives of this study. All the parents that agreed with the child's participation signed an agreement. All dates are confidential and the results were registered in an Excel database.

The present study was focused upon measuring the memorisation and understanding of science related concepts regarding the *water circuit in nature* for a group of 5-year-old students (N=30) from the Romanian-Finnish School in Bucharest. Memorization is a language education activity focusing on the objectives of preschool education and children's age particularities. The formative value of this activity focuses on the development of the voluntary logical memory of preschoolers, based on the specific nature of the psychological processes at this age.

Memory is a psychic process consisting of three successive phases: acquisition phase, (storage) phase, retention phase and two-point reactivation phase (update): recognition and reproduction. Along with thinking, memory is at the core of learning (*Dictionary of pedagogy*, 1979, p. 269).

The children were separated into 2 groups (experimental and control) in order to see the difference of understanding and memorization when using traditional teaching (teacher only) or interactive, collaborative teaching. The two lessons were documented and organized by the

teacher, according to the curriculum, and had the same structure for both groups but with different methods of information transmission. The results of the study were recorded by mean number of correct answers and also quality of answers.

The experimental group

A group of 15 3rd graders prepared an activity about *The Cycle of Water in Nature* for their preschool counterparts. The activity was developed using the following methods:

- dramatization "*The story of the Waterdrop"*;
- condensation experiment;
- brainstorming (for the scientific concepts);
- multimedia usage;
- small group work.

Scientific concepts presented: water aggregation phases- liquid, solid, vapor; the cycle of water; vaporisation, condensation.

The framework objectives of the study were:

- to stimulate preschool children curiosity about explaining and understanding the environment;
- to develop the ability to understand the environment and to stimulate curiosity towards investigating it;
- to use appropriate language when presenting phenomena in nature and the environment.

The operational objectives were:

- to establish characteristic water attributes based on previous knowledge and experience;
- to identify the states of water aggregation based on the drama "The Story of a Water Drop";
- to list situations where water aggregation can be encountered – brainstorming;
- to use the following terms correctly: solid, liquid, gaseous, evaporation, vapours, condensation (small group work).

The 3rd graders introduced the activity through the use of *The story of the Waterdrop.* At the end of the story, the preschool group was divided into small groups, each group with an appointed leader. At this point the groups devised a concept-map about the use of water in nature and created a poster with it. At the end, the experiment was done in each of the groups by the leader (a 3rd grader). All of the concepts used in the experiment were formally explained and in the small groups, the preschool children repeated the definition of the concepts. After the experiment, the children watched together a short clip about the circuit of water in nature and the lesson ended with the children playing the *Weather Game* and imitating the different sounds that water makes

according to its aggregation state.

Because children learn very well one from another, at the end of the lesson, the 3rd graders gave feedback to the younger children about each of the new concepts learned and repeated each definition again.

Time: 30-35 minutes

The control group

The same concepts were presented in the control group (N=15). The main difference was related to the methods used. The scientific knowledge transmitted was explained theoretically only with the use of pictures. The lesson was *traditional* and had nothing spectacular about it.

Time: 30-35 minutes

Results

The evaluation of the activity was done by the teacher a week later, using a worksheet with images (Figure 1). The teacher asked the children in the experimental group the same questions as on the date of the experiment and 66.7% of them remembered the explanations and scientific knowledge transmitted. The responses in the control group were 53.3% in relation to the quality of correct answer (identifying and defining concepts inside the scientific knowledge acquired) but there were also 13.3 % incorrect answers (Figure 2).

After the activity, there was a focus-group with the 3rd graders. They all said that their own curiosity had been stirred because of the preparation time needed for the activity and had found new and interesting facts about water and nature, also about the dangers of the climate changes. They had fun and enjoyed "teaching" the preschool children.

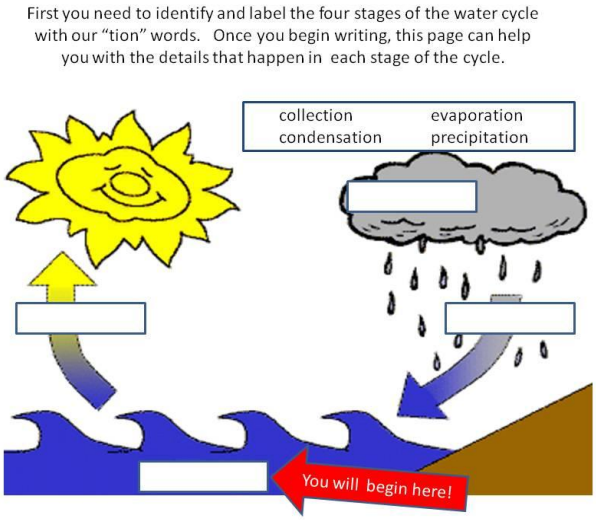

Figure 1. Support for evaluation of children

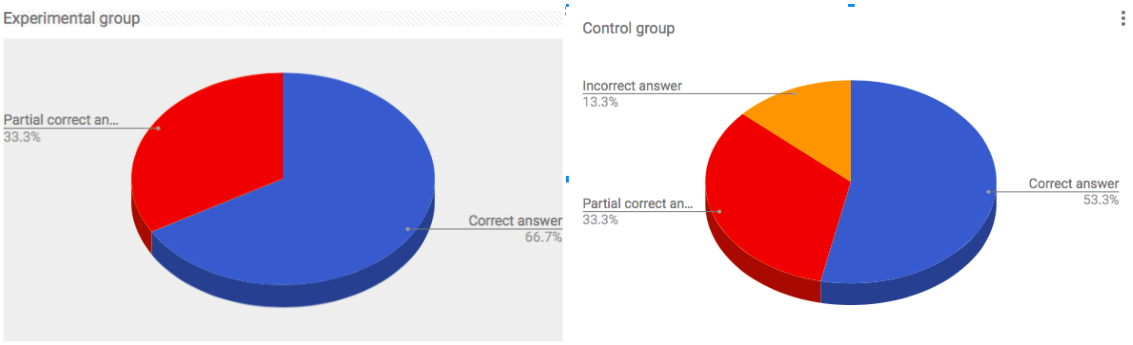

Figure 1. The graphical representation of the percentages of the results of children in the experimental and control group

Conclusions

This present study was a great opportunity to validate the benefits of an ongoing collaboration between primary school children and preschool children. This type of collaborations fosters the development of responsibility, empathy, creativity, attention to details and better knowledge of concepts otherwise forgotten.

Based on the drama "The story of a water drop" interpreted by the 3rd graders, the preschool children from the experimental group answered correctly in a percentage of 66,7% while the other group gave correct answers in a percentage of only 53,3%. Moreover, in the experimental group there were no incorrect answers in comparison with the control group, where there were 13.3% incorrect answers. When they were asked to answer questions about the water circuit in nature, the children in the first group used the following words correctly: solid, liquid, gaseous, evaporation, vapours, melting, condensation, while the control group did not always understand the meaning of these terms.

Moreover, the preschool teachers were encouraged to use this collaboration with primary school children in teaching difficult concepts in science for a steadfast foundation of knowledge. For further development, we challenge the educational community of preschool teachers to create groups of learning, using the *Big Brother* model that the Romanian-Finnish School has put together, in order to enhance the learning experience of younger children, fostered by their older colleagues.

Discussions

It is very important to understand that Science should be part of everyday routine in preschool. What we can accomplish as teachers is to stimulate science curiosity by answering children's questions about science. When we do this, we expand the preschoolers' desire to learn and

encompass science in their life. Why is grass green? Why don't turtles have teeth? Why is the sea water salty? George Tokieda, a Science teacher at the Brearley School in New York City, claims that: "Science is our attempt to understand the things we see — to make sense of the world around us. Scientific concepts are a way of explaining to ourselves and our children how the world works. Science shows children the interconnections of life and teaches them that the things they observe are not just haphazard events."

Through exploration and discussion, preschoolers learn that science is part of their lives — and that it's a lot of fun! We see fit to develop activities in their preschool curriculum that can be used as opportunities. We shall here present several examples:

1. **Botany in the park:** A teacher takes a stick, draws a rectangle around a tree and asks children to see what they can find. She is expanding observational skills, according to Sprung. When preschoolers spend time observing, they learn which trees lose their leaves in winter and which ones have buds in spring. They collect leaves and sort them by size and shape. They watch the birds and squirrels and other animals, and learn to share their observations through discussions, drawings, charts, and graphs.

2. **Physics on the playground:** Seesaws, slides, swings, and bouncing balls make the playground a natural physics lab. The seesaw demonstrates principles of balance, the slide is an experiment in gravity, and swings are laws of motion in action, according to Sprung. The teacher can encourage children to think and wonder by challenging them to balance the seesaw with kids of different sizes. He/she can relate the way the seesaw balances to the balance scales in the classroom. He/she can encourage students to look under the seesaw to see how it works and which parts move. In this way, they investigate principles of weight and mass.

3. **Explorations at the water and sand tables:** Children make sieves with different size holes and pour sand or water through them, noting how the size of the hole affects the results. At the water table, they learn the properties of water as they predict whether objects will sink or float, then test their predictions.

4. **Chemistry in the kitchen:** While they help prepare vegetable soup, preschoolers name the ingredients as they sort them and add them to the pot. The teacher asks questions about the colour, texture and smell of the carrots, onions, and tomatoes. She may ask what a tomato will look like when she cuts it open. As the soup simmers, the class will predict which vegetables take longer to cook. The teacher may take pieces of carrots or potatoes out for children to poke with toothpicks in order to test their hypotheses. They may add spices and compare tastes. Later, when they eat the soup, the children can talk about the differences in taste and texture among the vegetables.

5. **Relativity in the block corner:** Children build towers and balance blocks of different sizes and shapes to construct bridges, exploring concepts of spatial relations, gravity, and balance. Sprung finds that preschoolers learn basic principles of Physics by building ramps of different heights and racing cars down them, predicting which car will finish first.

6. **Meteorology at circle time:** The preschool day often begins with a discussion about the weather. Is the sun out today? How does the sun feel on our skin? Why is the sun important? Is it raining? How does rain feel? Why is rain important? Some classes may keep a container to measure and compare rainfall. Is it colder or warmer than yesterday? How do we know? Is it cold enough for snow? Children record their observations in diagrams and charts.

7. **Horticulture on the windowsills:** The class might grow beans. Each child has a tiny clay pot. He plants a seed in the pot, filling it with soil and patting the dirt down around the seed. Every day he will water the plant and record its growth on a chart. He will learn what seeds need in order to sprout and, later, what they need in order to grow.

8. **Biology in the fish tank:** Some classrooms have rabbits, gerbils, or guinea pigs; others have fish or earthworms. These creatures teach children how living beings interact with their environment and react to different stimuli, says Tokieda. Preschoolers take responsibility for caring for the animals: recording the temperature in the fish tank, learning about the earthworm's habitat, finding out what the rabbit and gerbils and guinea pig eat and measuring out their food. Children observe the animals' habits, measure and weigh them, and record their growth in pictures and chart.

Why should science be part of the Early Childhood Education Curriculum? At this young age, children build a foundation for future learning and scientific understanding. The preschool child is naturally curious. There is nothing that you need to do to promote their wonder and fascination in relation to the world. Their curiosity makes this the perfect time to answer questions and help them create an understanding of how the world works.

These young and curious children are able to dive into topics such as Physics, Biology and Chemistry without bias or fear. When teaching Science in preschool we should be reminded that: you have to use real science terminology; often, there is no substitute for scientific words, but do not worry, just like learning any other word, the more the child hears it the more he/she will understand it. A child should have multiple experiences on the same topic in order to gain understanding. Doing one experiment or project will not bring understanding. It is the repetition of a topic in different forms that will help the child to learn. Often times, doing the same project or experiment multiple times is also beneficial, it allows the preschool child to revisit what they know and gain deeper understanding and confidence. Let us be reminded that corporate

knowledge and the development of necessary competencies to discover the world should be the main objectives of preschool curriculums. The focus of daily activity should not be on academic, strict procedures but on raising children who use their natural curiosity in learning about the world outside them.

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