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"BALANCE" ... IN PRESCHOOL: A PROPOSAL ON HOW TO TEACH NATURAL SCIENCES USING EDUCATIONAL ROBOTICS

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Abstract:
This current study is a teaching proposal that approaches the concept of balance in an interdisciplinary way in kindergarten. Based on the Greek Kindergarten Curriculum, an educational intervention is proposed in the context of the thematic unit: "Child and Environment" and falls under the second axis: "Natural Environment and Interaction". When the infants build a simple seesaw machine ("robotic" seesaw) using the LEGO® Education Early Simple Machines Set, they start wondering about how it works. Acting collaboratively, the infants' experiment with simple machines and make assumptions, each time experimenting according to the given instructions. Throughout the learning process, the teacher provides clear instructions and completes the findings of the infants, in order to draw the final conclusions that will lead to the solution of the problem. In this way, the infants are given the opportunity to develop computational thinking skills that can potentially open up new professional horizons in the future.

Keywords: natural sciences, educational robotics, computational thinking, balance

1. Introduction

In recent years there has been a growing interest in educating preschool children in Natural Sciences (Ravanis & Bagakis, 1998). Young children, by nature, enjoy observing, asking questions, and exploring elements of the natural environment. This means that the search for answers and the exploration of the natural world around them make Natural Sciences an accessible scientific field that attracts children's interest to a great extent.

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In the new Greek pilot Kindergarten Curriculum (IEP-YPETHPA, 2011), the design and implementation of educational interventions, aimed at engaging preschool children in Natural Sciences, are considered essential elements of the teaching practice. In this way, infants, very early, seem to form the first ideas and interpretations of concepts and phenomena of the natural world.

2. Importance of Engaging Infants in Natural Sciences

According to Hadjigeorgiou (2001), a preschool education program should be oriented towards Natural Sciences, so that the child can cultivate all relevant skills of scientific reasoning and fully develop his/her mental capacity.

In this direction, the new Greek Kindergarten Curriculum (IEP-YPETHPA, 2011) adds that the involvement of infants with Natural Sciences contributes to:

- harnessing their curiosity and inner motivation to explore the world around them,
- sustaining scientific literacy, so that they can systematically explore their surroundings,
- developing a positive attitude towards science.

Therefore, it becomes clear that the role of kindergarten lies in encouraging and organizing actions that promote social interaction and shaping the appropriate learning environment for experimentation and discovery (Besi & Grammatikou, 2010).

All of the above indicate that the acquaintance of infants with scientific methodology practices can become a major asset in students' development and can better prepare tomorrow's citizens to meet the requirements of the 21st century (Vergou, 2010).

3. Educational Robotics and Preschool

In recent decades, Educational Robotics is constantly gaining the attention of the global educational community, as the rapid development of technology invites professionals of the future (young children) to meet modern requirements. In this context, several researchers claim that 65% of preschool students will be engaged professionally as adults in tasks that are still unknown today (Davidson, 2011). Consequently, it becomes explicit, that Educational Robotics is oriented towards all ages and aims at introducing students to scientific practice as a lever for the development of their cognitive and social aspects.

In general, Educational Robotics is a teaching approach that enables students to get in touch with new technologies and opens up new avenues in the learning process through synthetic tasks and social peer interaction. It is a pedagogical approach that is part of classic constructivism and subsequently of constructionism developed by Papert.

In short, the combination of learning in a playful way and the active integration of the child in the learning process through experimentation and personal expression, makes imperative the integration of Educational Robotics in kindergarten at preschool age (Frangou, 2009).

3.1 Educational Robotics and Natural Sciences

Psycharis & Kalovrektis (2017) support that since robotic technology is part of the Natural and Exact Sciences, these sciences are in turn the basic structural elements of robotics. Therefore, using robotic models as processing objects enables the learner to understand the principle of an axiom of Natural or Exact Sciences.

As a result, educational robotic packages are currently considered a powerful teaching tool that contributes to children's better understanding of mathematical and natural concepts through studying the behaviour of models in problem-solving activities (Alimisis et al., 2010; Kazakoff, Sullivan & Bers, 2013).

From this viewpoint, in recent years, Educational Robotics has started to move away from the laboratory environment and move into the classroom so as to achieve teaching goals through the implementation of complex tasks of processing, experimentation, discovery, formulation of cases, or even their rejection (Eleftherioti, Karatrantou & Panagiotakopoulos, 2010). Moreover, according to Komis (2004), some of the main goals of the pedagogical approach that promotes the utilization of educational robotics are:

- Problem-solving through the handling and construction of objects-models
- The socialization of those involved.
- The promotion of the interdisciplinary and cross-disciplinary approach.

The above objectives are fully in line with the philosophy and content of the new Greek Kindergarten Curriculum mentioned above and allow learners to find solutions to problem-solving situations by contrasting their views with those of their cooperation group (Depover, Karsenti & Komis, 2010).

In any case, it seems that the involvement of children in the world of Natural Sciences at an early age in combination with technology contributes to the increase of children's interest in science.

4. Computational Thinking and Preschool

Computational thinking has been first used by Papert (1996) but has become popular in recent years after being defined by Wing (2006). It is a certain mode of approach or way of thinking that all people could use, not just computer scientists, to solve complex problems by breaking them down into more familiar or manageable sub-problems. According to Cansu & Cansu (2019) is a "*procedural thinking*" that could be used to define the relationship between a problem and its solution.

Looking at the existing international literature, the main terms that define the meaning of computational thinking are problem decomposition, algorithmic expression, solution implementation, and evaluation (Kalelioğlu, Gülbahar& Kukul, 2016). Barr and Stephenson (2011) argued that students must begin to work with algorithmic problem-solving and computational methods and tools from the preschool age, as many of them will work in fields that involve computing. This is an interesting way to introduce infants to computational thinking dealing with specialized games or by being engaged in other subjects (natural sciences, maths, music, etc.).

5. Teaching Proposal

The current teaching proposal places special emphasis on the investigation of the mental representations-perceptions of preschool children as regards the concept of balance. During the implementation of the teaching proposal, they will construct a "robotic" seesaw in a playful way to record their observations. After its completion, students will compare their initial mental representations with possible differences that they noticed in the previous procedure.

5.1 Methodology

The course of the teaching intervention that will be presented below was applied to 9 students of a private kindergarten in Patras, Greece, and for its realization specific steps were carefully designed that correspond to the preschool age range referred to earlier, in combination with concepts of engineering, physics and technology.

5.2 Reflection Phase

After the children had been divided into groups of three, they were given a picture, and an accompanying story was read by the teacher.

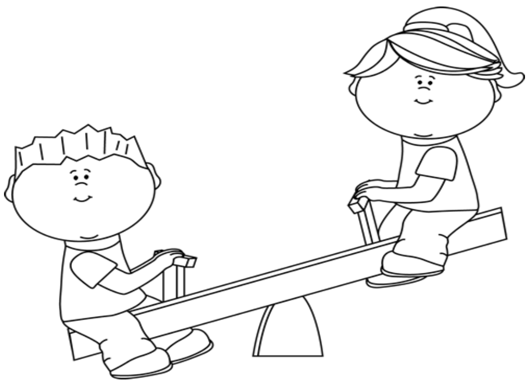


Figure 1: Problem-solving situation

> *"On their way back from school, George and Joanna stopped at the playground. The children leapt with joy when they discovered that there was something different today in their neighborhood square. The municipality had installed a new seesaw. They immediately jumped onto the seesaw and started to play. But, while George was down and Joanna was up (Figure 1), they noticed that no matter how hard Joanna was pushing towards the ground, she could not get herself down and raise George up. "*

5.3 Construction Stage

Then, the children were given bricks from the LEGO® Education robotics training package and also instructions, in the form of a schematic diagram, for the construction of the model of the "robotic" seesaw in their classroom environment. In this way, infants implement the second stage of the construction engagement consistent with the problem-solving situation that had been previously posed to them.

5.4 LEGO® Education Robotics Training Package

In recent decades, LEGO® Education has made a significant contribution to the educational process through robotics training packages that provide a range of practical solutions with lessons and unit plans tailored to the needs of students of all ages and abilities.

The package Early Simple Machines is a set that consists of 102 DUPLO® bricks with the simultaneous addition of fun plastic components that allow children to explore mechanical principles through problem-solving and collaboration.

This set is designed in such a way as to provide all the necessary supplies to children to take the first steps in engineering and physics by understanding how simple real-world mechanisms work, mechanisms that they encounter in their everyday lives. In an entertaining way, children will explore concepts and phenomena, create constructions, and make observations so as to draw conclusions about the world around them.

5.5 Formulation of Hypotheses

Having completed the modeling stage, the students orally expressed their observations-hypotheses about the reason why the heroes of the story faced the particular problem. Their hypotheses were recorded in writing on the classroom board by the teacher, in order to verify the correct answer/s at the end of the experimental process and draw the final conclusion. Some of the views heard were:

- *"The seesaw must balance from the beginning so as to move upwards and downwards."*
- *"The seesaw was broken."*
- *"Joanna was heavier than George so he could not lift her."*

5.6 Experimental Stage

In this phase, the infants try the "robotic" seesaw in three different cases based on the instructions given to them below (Table 1). This stage will contribute to the promotion of exploratory learning and the cultivation of children's critical abilities. Having carried out and completed the tests, the children will be able to express more confidently their opinions about the problematic situation faced by the heroes of the story and to propose possible solution/s.

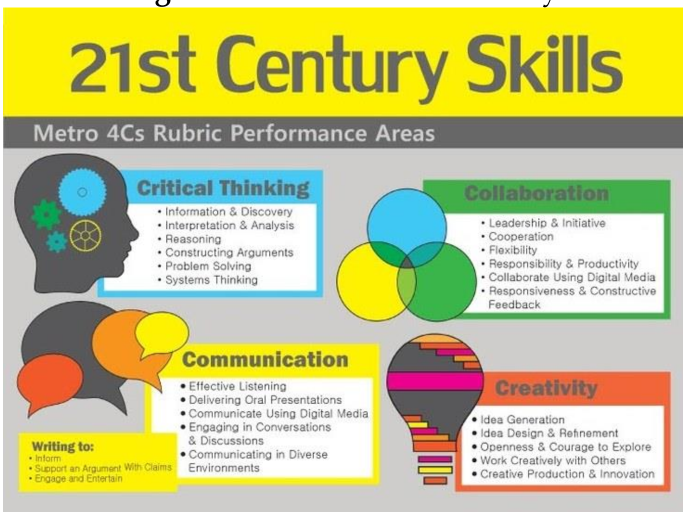
Table 1: Experimental procedure – tests

Instructions	What do I think will happen?	What do I observe eventually?
1. Add a yellow brick on one side and a green brick on the other side. Then repeat the same movement. What do you observe?		
2. Move the yellow bricks one place further in. What do you observe? Why do you think this is happening?		
3. Return the bricks, as you originally had them! Now, add only one yellow brick on one side. What do you observe in this case?		

6. Vocational Guidance and Skills of the 21st Century

Learning environments of 21st century must create the appropriate environment for integrating the 21st century skills into education (Figure 2). The concept of 4Cs refers to critical thinking, collaboration, communication, and creativity as 21st century skills that no one can deny the necessity of preparing young students for their future professional life and the demands of living in the 21st century (Saleh, 2019).

Figure 2: Skills of the 21st century



(Source: https://www.learninginnovationlab.com/kmoore-21st-century-workforce-readiness-4-cs.html)

Conflict of Interest Statement

The authors declare no conflicts of interest.

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Georgios Angelopoulos graduated from the Pedagogical Department of Primary Education of the University of Patras and works as a teacher in Primary Education. He successfully completed his studies in the Master's Program in Education at the Hellenic

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Savvas Stamatopoulos graduated from the School of Pedagogical and Technological Education of the University of Aspete and works as a teacher in Secondary Education. He successfully completed his studies for the Master's of Science in Advanced Information Systems at the Harokopio University of Athens. He is a passionate teacher who contributes to team success through hard work, attention to detail, and excellent organizational skills. A clear understanding of curriculum development, technology, computer science and consulting. Implementation, development, and design of robotics activities in special education.

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