Designing activities for the environmental dimension of light in preschool education

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Abstract

The involvement of preschoolers in the natural sciences is considered necessary, because young children seem to form very early on the first ideas, interpretations, theories about the concepts and phenomena of the physical world and they are therefore able to approach relevant issues at a first level. The purpose of this paper is to investigate preschoolers' perceptions of concepts that define the environmental dimension of light (ozone, alternative forms of energy, greenhouse effect). The research sample consists of 14 infants attending an all-day Kindergarten of Greece. The data collection was done with questionnaires, with semi - structured interviews, with observation, with recording of children's' actions and with study of children's drawings. Nvivo11 software was used for the statistical analysis of the data.

Keywords: kindergarten, light, ozone, greenhouse effect, alternative forms of energy

Introduction

From time to time, various researches have been done regarding the perceptions of infants about the properties of light, such as reflection, refraction, etc.

However, there is no much research on the concept of the greenhouse that concerns the earlier perceptions of young children, especially in kindergarten, as this concept is taught in larger classes, as well as the phenomenon of the 'ozone layer hole'. In the same pattern, the concept of utilizing the sun in renewable energy sources varies.

Literature review

One of the models used in Kindergarten for teaching science is constructivism, where students' perceptions are taken into account and they are the starting point of the learning process (Interdisciplinary unified Study Framework for Kindergarten, 2011). If students' perceptions are close to the scientific ones, then the strategy of strengthening these ideas is applied through the presentation of additional examples. The model is supported by student-central approaches where the role of the teacher is auxiliary and supportive (Kariotoglou, 2006).

Most of the research on children's perceptions and environmental sensitivity is aimed at the elderly (elementary-high school-high school) (Ergazaki et al. 2002, Zongza & Economopoulou 1999, Zogza, 1998), while they are very limited those reported in preschool age (Perdikari et al. 2007, Christidou & Hatzinikita, 2006).

Preschoolers asked about light will identify it with the source or effect, and they may still identify light with the lamp or light footprint on the wall (Driver et al., 1985). Children, do not attribute autonomous properties, identifying them with light sources that produce it or the effects it produces. Indeed, this type of light-related imagery occurs more and more frequently as children are younger (Stead & Osborne, 1980; Tiberghien et al., 1980; Anderson & Smith, 1982; Eaton et al., 1984).

Also, children can attribute to sun anthropomorphic properties as they consider it as a living organism, which at night e.g. goes to sleep or hides itself behind objects (Kalleri, 2007).

According to research, the importance of sun is not easily perceived by children, but they mainly refer to its warmth rather than to the light considered necessary for plant growth. In addition, there are also children who cite fertilizer as a plant food for growth (Zogza, 2006).

For the concept of ozone, younger children simply report the sun's rays and only from the age of 13-14 do they specifically mention "ultraviolet rays" (Plunkett & Skamp, 1994. Also, the ozone hole (or the many holes) is considered to be the main cause of the creation or enhancement of the greenhouse effect (Koulaidis & Christidou, 1999).

Method

Research purpose

The main purpose of this paper is the investigation of preschoolers' perceptions of concepts that define the environmental dimension of light.

Research questions

The research questions of the study were the following:

Can infants understand the concept of the natural phenomenon of greenhouse, after the appropriate teaching intervention? Does the didactic intervention contribute to the differentiation of children's final perceptions from their initial ones? Is it possible for infants to understand the ozone and its role in nature in kindergarten after appropriate teaching intervention? How are infants' perceptions of the environmental dimension of light reconstructed after didactic intervention?

Research hypothesis

Following the literature review of the research questions of this paper, the research hypotheses are the following:

In the research question on whether preschoolers can perceive the concept of the greenhouse effect, natural and not, after the appropriate teaching intervention, they will be able to understand aspects of these concepts in terms of their role in nature and not in their scientific approach.

In the research question on how the didactic intervention contributes to the differentiation of children's final perceptions from their initial ones after the experiments, it is expected that children, through the application of the experiments and the verification or not of their perceptions after the experiments, they will be able to reconstruct their initial perceptions and to justify them, even with the use of simple terms due to their language development and due to lack of maturity.

In the research question if it is possible for preschoolers to understand the ozone and its role in nature in kindergarten after appropriate teaching intervention, the research hypothesis is that infants will have difficulty due to their age, but that they will be able to understand its role in nature and describe it in tangible ways, through the use of appropriate for their age activities (stories, videos).

In the research question of how preschoolers' perceptions of the environmental dimension of light are reconstructed after teaching, the hypothesis is that infants will enrich their pre-existing perceptions with new ones after teaching or some infants may completely replace them with new ones. Some of the children's previous perceptions will not be differentiated after the teaching, as sometimes children's alternative ideas are so strong that they are not affected by experimental teaching either (Psyllos et al., 1993).

Research sample

Research was carried out in a full-day kindergarten during the period of January to February 2020, where the researcher also was working.

The sample of the study consisted of 14 children aged 4 – 6 years old. Of the total sample, 7 children were aged 4-5 years old and the remaining 7 children were aged 5-6 years old. Of the 14 children, 4 were boys and 10 were girls. As for the socio-cultural environment from which the children came from, 3 of them were Roma, one child came from Bulgaria and one had learning difficulties.

Finally, the issue of the concept of light was not developed at all in any of the 3 departments of the kindergarten, which helped to retrieve and investigate the spontaneous mental representations of infants regarding the concept of light.

Parents' and school manager's written permission in conducting the research was obtained.

Research tools

The present research is a mixed approach research, as it is considered more appropriate for research problems that require more exploration, understanding and description without prior knowledge of the variables (Creswell, 2011). It also studies social phenomena and focuses on differentiation, with researchers trying to understand the dynamic dimension of phenomenon (Isari & Pourkos, 2015; Robson, 2007). The data collection was done through questions, tape recordings, semi-structured interviews, observation, recording of users' actions and studying child tracing. The semi-structured interview was chosen as the most appropriate method of data collection because it has the advantage of being flexible, it adapts to the conditions of each school and to the different level of students' understanding, and furthermore it allows the researcher to extract more in-depth information than other research tools (Cohen & Manion, 1994). The semi-structured interviews were transcribed and recorded in Nvivo 11 statistical program and the resulting material was the data of the present study. Children's paintings were chosen because along with what children say about them they are considered a suitable and effective tool for young students to communicate their perceptions (Einarsdottir et al, 2009). Therefore, multimodal (triangulation) method was used in the present study. The purpose of triangulation is to increase the validity and reliability of research so as to provide the basis for the generalization of results. For the statistical analysis of the data, Nvino 11 software was used.

Activities

Pedagogical management

During the present research, preschoolers worked in plenary, individually and in groups.

They worked in plenary when they expressed their perceptions of the role of ozone in nature, after the teaching intervention. This semi-structured interview was conducted in plenary, with the aim of making the learning process for infants more effortless, natural and enjoyable, and because there were children who, due to their socio-cultural background and character, could not respond alone or in pairs to questions that were not part of an educational framework.

Preschoolers worked individually when they were asked to express their ideas and knowledge though painting. At the same time, the kindergarten teacher, after asking children, recorded exactly what they were painting. Individually, they also worked on the semi-structured interviews concerning their perceptions of the concepts defining the environmental dimension of light before and after the teaching intervention.

Infants worked in groups, while conducting the experiments. The reason for choosing this particular pedagogical management was that in this way they could better interact with each other and it would encourage infants who were more timid to participate, both due to language difficulties they faced and their low sociocultural background.

Description of activities

Activity 1: Overheating of the planet - consequences - solutions

Objectives: To help infants understand the cause of global warming and the link between global warming and the creation of the greenhouse effect. Also, to learn ways to deal with this phenomenon and suggest their own solutions.

Description:

Preschoolers watched a video about the greenhouse effect at https://youtu.be/tPMad2A7zAA and they discussed it with the Kindergarten teacher. After the teaching intervention, they separated an A4 sheet in half and on the one hand they painted the effects of the greenhouse effect, while on the other hand they painted the ways to deal with the problem.

Activity 2: The natural phenomenon of the greenhouse: **Construction of a solar collector**

Objectives: To understand the natural phenomenon of the greenhouse, the importance of this phenomenon and its use in everyday human life. Also, to understand the connection of the natural phenomenon of the greenhouse with the protection of the environment, to understand the concept of light as energy, as well as its role as thermal energy.

Description:

The children watched on YouTube the myth of Aesop: The North wind and the Sun (https://www.youtube.com/watch?v=llRH5-pj_uo), where in the story the Sun said that it gives energy.

The kindergarten teacher, in order to investigate the pre-existing perceptions of the infants, gave them the following worksheet "How can we have our sun friend? What can the sun give energy to? Draw it".

This is followed by an instructional video on renewable energy sources (https://www.youtube.com/watch?v=Q8Ofz2i9abQ). At the end, the infants were asked to draw the forms of energy that nature gives us, according to what they had watched in the educational video. The kindergarten teacher then invited the children to construct their own solar panel, as described below.

Instruments - Materials: A transparent glass cylindrical container with its lid, a piece of black cardboard, water, 1 thermometer, magnifying lens, paper

Experiment: The kindergarten teacher and the children constructed the improvised solar panel in a vertical inclination towards the sun from the time of maximum solar radiation and for about 1.5 hours. Then, the Kindergarten teacher asked the following questions to each infant separately:

- "Why did we place the glass container sideways?"
- "Why did we put the piece of black cardboard on the container?"
- "What do you think will happen in the water?"

After performing the experiment, the children tested and compared the results of their action in relation to their initial perceptions before performing the experiment.

Activity 3: The natural phenomenon of the greenhouse: Experiment with paper and magnifying lens: The Kindergarten Teacher one sunny day, when the sun had the highest energy, took a piece of paper and a magnifying glass in the school yard and after bringing the magnifying glass to a vertical angle with the sun, she asked children “What will happen with the paper and the magnifying glass?”. The teacher recorded children’s’ answers and then she left paper down for a while, until the paper began to lit up. After the teaching intervention, she asked children "How do you think the paper lit up, since we did not use matches or lighter?", recording their answers at the same time.

Activity 4: Ozone

Objectives: To understand the meaning and usefulness of ozone for the balance of the environment, natural and human.

Description: Initially, the kindergarten teacher read to the children the book 'The Invisible Umbrella' (Michailaki – Arfara, 2002): One morning, the sun began its daily walk in the sky without saying goodbye to its little friend, Christina. "But what happened to the sun today? Why didn't it smile at me?" Christina wondered. The sun was sad because everyone had put up with it. The air knew the secret. Through the pleasant story of Christina, the children learn about the problem of environmental pollution, ozone, the sun and intervene dynamically in order to sensitize the adults. Then, children painted what they liked most in the story. Afterward, children watched a video about the Ozone Hole on https://www.youtube.com/watch?v=gT5soyk1mw4. Afterwards, they painted the ozone, as they understood it from the video and as they imagined it.

- The kindergarten teacher asked children to the plenary session, recording their answers:
- "Is ozone important for life on Earth? If so, why?", "What can we do to prevent damage to the ozone?",
- "What would happen if there was no ozone or if it was too low?", "What are the consequences of the ozone hole in humans?"

Then, the kindergarten teacher read to the children: 'Leathers in the Sun's pan' (Russellman, 2019), which shows the effect of solar energy on human skin due to the ozone hole. The children drew whatever they liked.

Presentation of the research results

Activity 1: Overheating of the planet - consequences – solutions

In the global warming activity - greenhouse effect, most children painted on the effects of the greenhouse effect in the order in which they are reported smoke 'from factories, burned plants and forests', 'fires and melted icebergs', while the latter report 'floods', as shown in Figure 1.

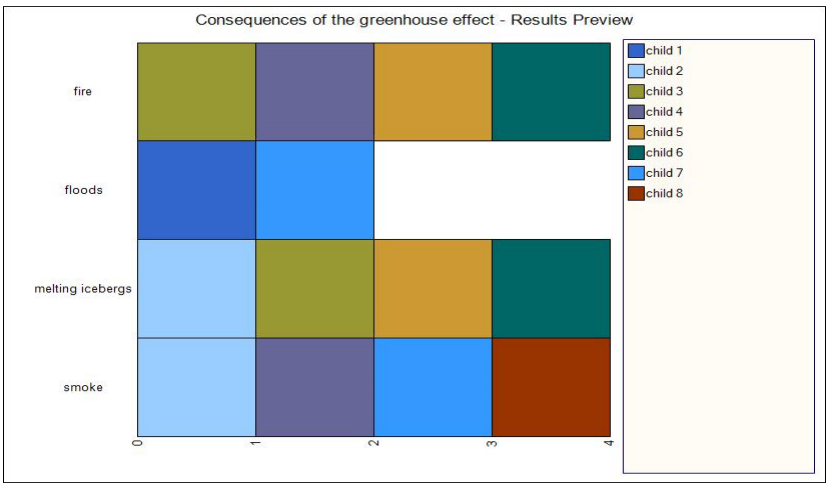

Figure 1. Consequences of the greenhouse effect

Most of the children mentioned 'planting' as a proposal for tackling the greenhouse effect, while 3 children referred to the use of "electric vehicles", 3 children referred to 'recycling' and 2 children to the use of "bicycle". Two children painted the "rain", in the sense that "it waters plants, flowers and trees". One child referred to "light bulbs – lamps" that do not consume much energy, a response coded as the use of low-energy light bulbs (Figure 2).

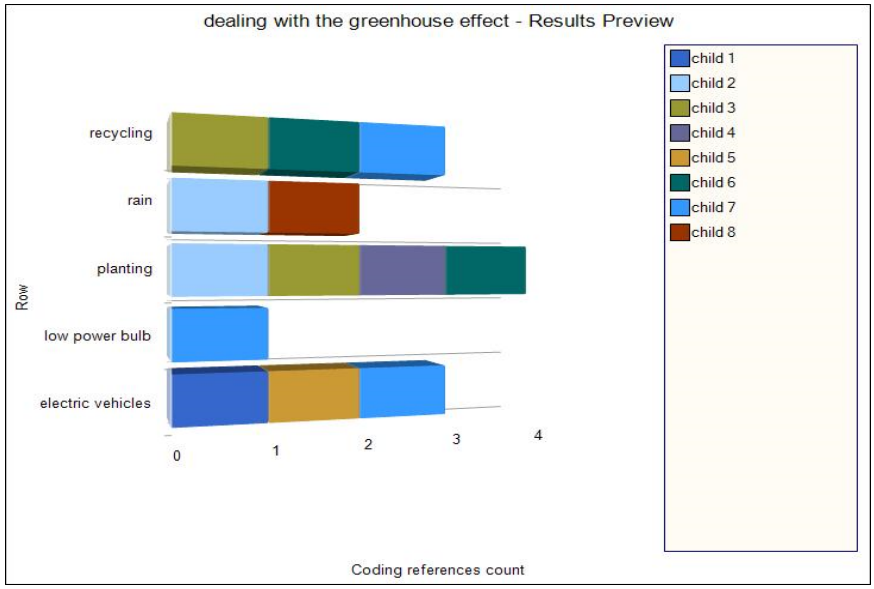

Figure 2. Dealing with the greenhouse effect

Activity 2: **The natural phenomenon of the greenhouse: Construction of a solar collector**

When asked why we placed the glass container sideways, 3 children answered "because the container has water", 2 children answered "to be warmed up the water", 2 children did not answer, while 1 child answered that "we just placed it sideways, without any purpose" (Figure 3).

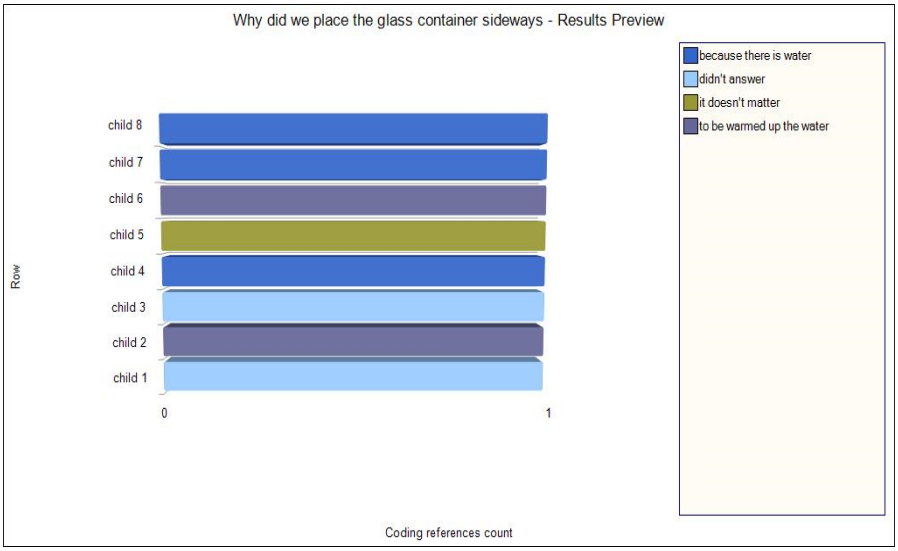

Figure 3.'Why did we place the glass container sideways?'

When asked why we placed a piece of black cardboard on the glass container, 3 children did not answer, 2 children answered "to be warmed up", 1 child answered "to see if it will be warmed up or not", 1 child answered "to take light" and 1 child replied "so we can catch it" (Figure 4).

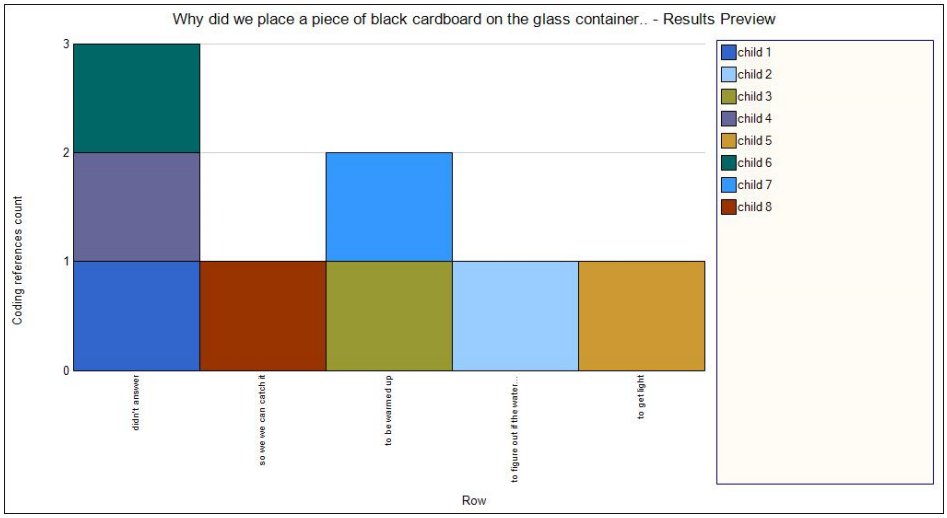

Figure 4. 'Why did we place a piece of black cardboard on the glass container?'

When children were asked what would happen to the water we put in the glass container, 4 of them answered that the water would be warmed up, 2 children did not answer, one child answered that "the water will be disappeared" while another child gave two answers, one of which was that 'the water will freeze, because it is cold outside in the yard' and the other was that "the water will turn yellow, because the sun is yellow". Children's answers are given in Figure 5.

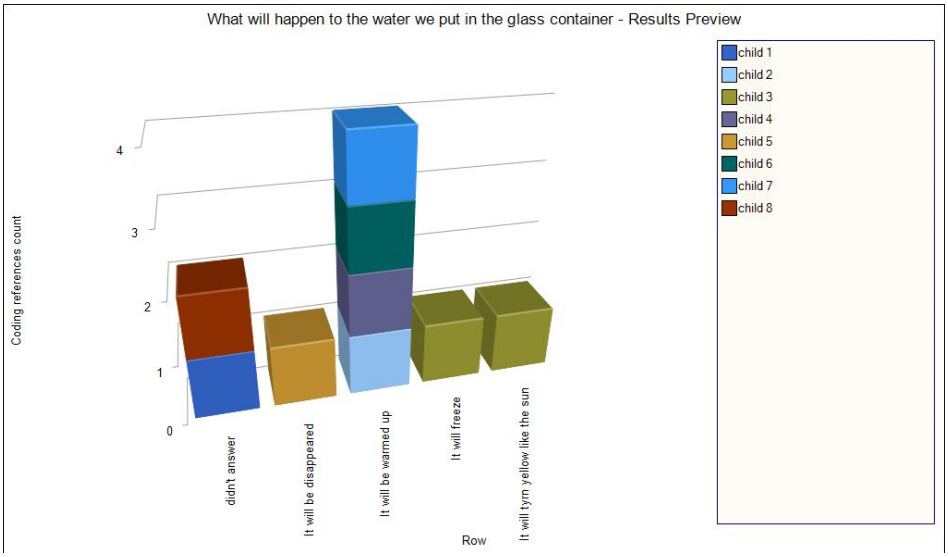

Figure 5. 'What will happen to the water we put in the glass container?' (Before teaching)

Children after the experiment with the solar collector, where they observed the level of the alcohol thermometer rising, when asked "What happened to the water? Why?", they replied that "the water was warmed up by the sun".

4.3. Activity 3: The natural phenomenon of the greenhouse: Experiment with paper and magnifying lens.

Children having been asked what would happen to the paper with the magnifying lens, if we put it inclined to the sun, the majority of them answered that the paper "will be warmed

up". One child replied that the paper "will turn yellow because the sun is yellow", one child replied that "it will be illuminated by the sun" and 4 children gave no answer (Figure 6).

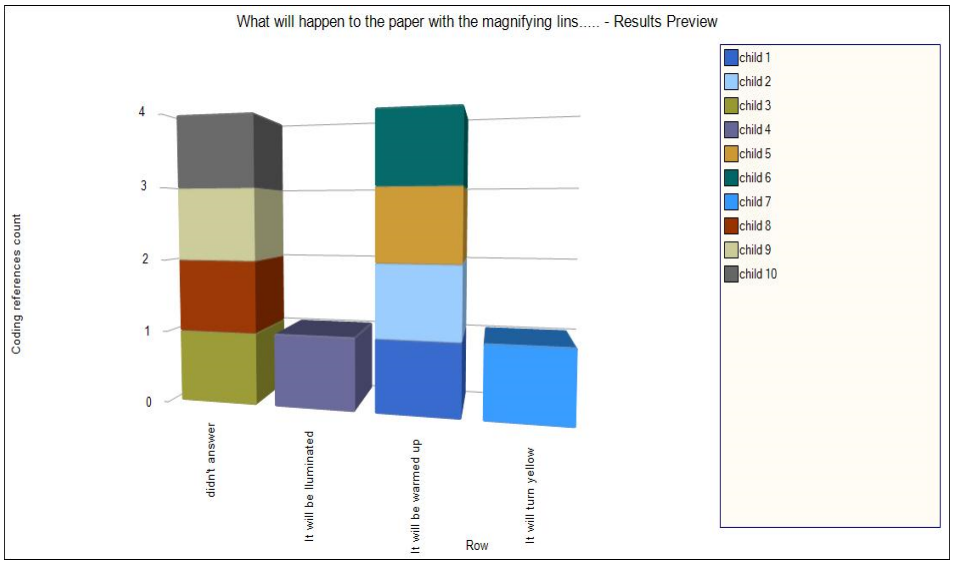

Figure 6. 'What will happen to the paper with the magnifying lens?' (Before teaching)

After experimenting with paper and magnifying lens, four children replied that the paper got burned by the sun; one child replied that the paper got burned by itself; this child replied that the paper got burned by the wind, while another child replied that the paper got burned by the magnifying lens (Figure 7).

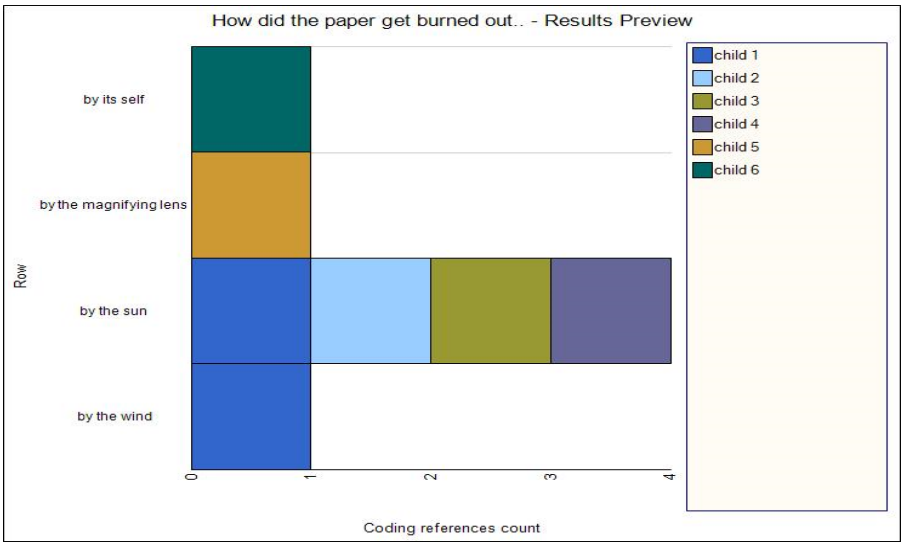

Figure 7. After the experiment with paper and magnifying lens

In the question "How can we have our sun friend? What can the sun give energy to? Draw it", the majority of children answered that the sun gives energy to animals and plants. Fewer children responded to humans, soil, animals and sunlight. Children's' answers are given below, in Figure 8.

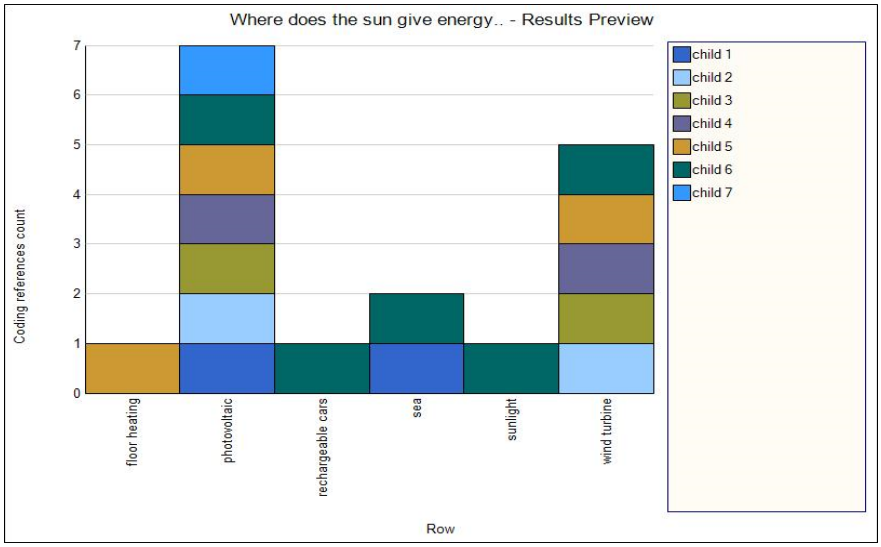

Figure 8. 'Where does the sun give energy?' (Before teaching)

After teaching, children drew where the sun gives energy, but, also, in what other ways we can get energy in our daily life from nature (alternative forms of energy). They first painted "photovoltaic", followed by "wind turbines". One child referred to the sunlight as "the light I have on the lawn in my house", which "absorbs the sun energy during the day and lights up at night". The same child also painted "cars, which you charge with electricity", a response that was coded as "rechargeable cars" and the sea "that the sun warms up". One child also painted "tubes that take energy from the ground and they heat up our house, the water and we can have a bathe", answers that were coded as "floor heating" (Figure 9).

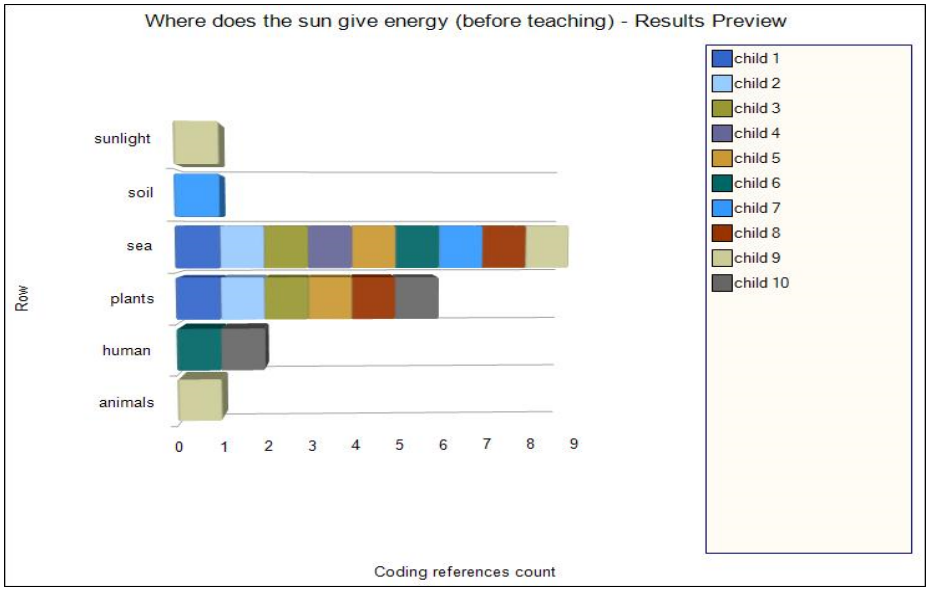

Figure 9. 'Where does the sun give energy?' (After teaching)

4.4. Activity 4: Ozone

The questions the kindergarten teacher asked children were the following:

- "Is ozone important for life on Earth? If yes, why?",
- "What can we do to prevent damage to the ozone?",
- "What would happen if there was no ozone or if it was too low?",
- "What are the consequences of the ozone hole in humans?"

Children's answers were recorded, inserted into the Nvino 11 software, and a word cloud for the concept of ozone was created, which gives the central concepts of the children's answers (Figure 10).

Figure 10. Word cloud for the concept of ozone

From the size of the words that determine their frequency of use and therefore the most central concepts, it seems that preschoolers, after watching a relevant video about the ozone hole, understood, mainly, the consequences of the problem (live, neither, animals, children, person -meaning human-, as well as the way of its creation (sun, sky, hole, ray) and its causes (spray, sky).

Discussion

Children were able to understand key aspects of the concepts of the greenhouse effect, such as the phenomenon of ozone's hole, after appropriate teaching intervention, in terms of their role in nature.

Some of the pre-existing perceptions of children were differentiated from the final ones after the experiments were performed, but some of them remained stable due to the resilience of the young children's previous perceptions (Psyllos et al, 1993).

Preschoolers have had difficulty answering questions about ozone due to their age, a result that agrees with the research hypothesis (Plunkett & Skamp, 1994). Some children, however, referred to the term "ultraviolet radiation". In general, preschoolers were able to understand the role of ozone in nature and to express it in tangible ways through the use of age-appropriate and enjoyable activities.

After teaching, children enriched their pre-existing perceptions with the new ones or replaced some of them with new ones (Kariotoglou, 2006).

In recent years, many efforts have been made to successful teaching of science in kindergarten, both in Greece and abroad. However, some science subjects are not easily approached by kindergarten teachers, either because they do not have the appropriate theoretical background to teach them to infants, or because they are considered difficult and inappropriate for them.

The present study was an attempt to be approached physics issues that present difficulties for preschoolers. Constructivism with the use of varied and attractive activities for preschoolers, e.g. mythology, painting, experiments with simple materials, stories and educational videos seem to contribute to the effective understanding of even difficult concepts of Natural Sciences.

Much research can still be done on exploring the way some physics themes taught in higher classes could be taught as well as in kindergarten, giving importance not to their scientific terminology, but to the understanding by children of their usefulness in the life of the planet earth.

Research limitations

The sample examined was small, so the results of the research are indicative and cannot be generalized.

The research also relied mainly on semi-structured interviews and exploratory questions, which made it easier for most infants to express themselves verbally, as the skill of written language has not yet been mastered, making it difficult for infants who have not developed oral speech. The fact that there is a sample of foreign children (Bulgaria), as well as children from a low socio-economic background (Roma), who did not know and / or did not understand the greek language well, made the process of data collection and processing more difficult.

In addition, because it is a qualitative research, there is always the risk of error during the research process, which is due to the "subjectivity" factor of the researcher. To reduce this risk methodological triangulation - the collection of data using different data collection methods such as data retrieval through children's' drawings, student observation in the classroom and interviews with selected sample of students (Altrichter et al, 2001) - had been implemented.

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