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PRESCHOOL CHILDREN'S MENTAL REPRESENTATIONS OF CLOUDS

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Abstract. *Children construct representations of concepts and physical phenomena and these representations are critical to education. The natural phenomenon of clouds is perceivable and also observable by young children in everyday life. Moreover, it is a subject approached by the early childhood science education curriculums. However, in several studies it is noticed that the related children's representations are often incompatible with the scientific model, mainly because of its character, which is macroscopic and not immediately observable. In this research, clouds representations framed by children aged 4.5-6 years old are studied. The sample consisted of sixteen (16) children (7 boys and 9 girls) from one public kindergarten in an urban area of Greece. Data were collected through expanded, open type conversations between children pairs and one of the researchers. The results of the qualitative analysis of the conversations show that these children use different types of representations, the majority dominated by the nature of the substance under study. The outcome of the research results indicates the potentials of preschool children to perceive clouds as autonomous natural entities.*

Key words: *pupils' representations, clouds, preschool education, science education.*

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Introduction

The study of children's representations on the phenomena of the natural world and on natural science concepts, as well as their transformation, stands as the most important research orientation in Science Education. This has also been the subject of research in Early Childhood Education for the past twenty years, leading to a long list of related papers with 4-7 year old children subjects in various cognitive areas, such as biological phenomena (Christidou & Hatzinikita, 2006; Ergazaki & Zogza, 2013), optical phenomena (Fleer, 1996; Gallegos Cázares, Flores Camacho & Calderón Canales, 2009; Ntalakoura & Ravanis, 2014; Herakleioti & Pantidos, 2015), astronomical phenomena (Kampeza, 2006; Papandreou & Terzi, 2011; Kampeza & Ravanis, 2012), and various properties of matter (Hadzigeorgiou, 2002; Koliopoulos & Argyropoulou, 2011; Kambouri, 2015).

With the application of different research techniques and methods, these researches have accentuated, on the one hand, the difficulties young children encounter in approaching natural entities, phenomena and concepts, and on the other hand, through the use of special teaching interventions, the children's ability to surpass the initial difficulties, to systematically approach the natural world and to construct, in their thought, precursor models that are compatible with those of natural sciences that are used in school (Ravanis, Christidou & Hatzinikita, 2013). These research results are significant for the creation of preschool curricula as well as teachers' training. For example in Greece this type of research in recent years has led to the Kindergarten Curriculum reform (Pedagogic Institute, 2011). Namely, it has been acknowledged that the utilization of these results enables teachers to structure efficient didactic and learning progression and also effective educational tasks supporting the development of children's thought.

The present research paper constitutes a study of 4,5-6 year old children's representations on clouds. Clouds constitute an entity encountered in children's everyday life, but the process of their creation, their alternating characteristics without a clear cause and their properties in general, evidently form a field of questions for children's thought and thus a research subject. Clouds are thematically placed in "the water cycle in nature", namely in a unit of phenomena that are frequently regarded uniformly in education, or closely interrelated. The comprehension of this cycle, however, presupposes its connection with the phenomena of liquidation and vaporization. The review of the limited bibliography on the phenomenon of clouds and of the changes of state of water in small children's thought designates the related difficulties.

Concerning the comprehension of the change of the state of matter, a number of difficulties are encountered in children's thought (Piaget, 1973; Russel, Harlen & Watt, 1989; Ravanis, 2014). The most fundamental of these difficulties are:

- The inability to establish a relation of causality between the observed phenomenon, the change of state and heat.
- The ensnarement of thought in everyday experience phenomena, i.e., the water "will blow up", "will burn", "will change position", "will be absorbed".
- The attribution of the phenomenon to human or other physical action.
- Difficulty in correlating produced steam with the initial liquid element.
- Centering in isolated characteristics of the phenomena i.e. in the remaining water, independently of the reduction of its quantity.
- The inability of detachment from the observed phenomenon in certain experimentation conditions and of utilizing this experience in other similar conditions.
- The inability to use associations and analogies macroscopically, in order to interpret the cycle of water in nature.

Specifically, concerning the natural phenomenon of the water cycle, Piaget (1930, 1973) describes three developmental stages, referring to children's reasoning on the origin of clouds. In the first stage (5-6 years old), children seem to associate the phenomenon with solid materials and human or divine action. In the second stage (6-9 years old), they primarily seem to perceive clouds as masses of smoke, and in the third stage (10 years and older), children associate he phenomenon with its natural origin.

Based on the Piagetian framework of developmental stages, Bar (1989), by studying Israeli children's representations concerning the water cycle natural phenomenon, distinguishes three levels of comprehension of the phenomenon. In the first level (5-7 years old), children's representations are based on either "primitive" or culturally predetermined ideas/beliefs. The children's perception of clouds as "bags of water" that "open up so that rain can fall" is typical of this level. In the second level (7-9 years old), children express "pseudoscientific" representations. Typical of this level is the reasoning based on which the creation of clouds is associated with the sun as a heat source, and the creation of rain with the movement of clouds by the wind. In the third level (9-15), the biggest percentage of children appears to be approaching the phenomenon with reasonings that are compatible to the scientific ones.

Taiwo et al. (1999), studying 10-14 year old Botswana children's representations on the water cycle, greatly emphasized the cultural influence on students' answers, during the descriptive analysis of the results. In this research, slightly more than half of the children use representations compatible with the scientific model. However, by systematically studying the answers of the rest of the subjects, it was discovered that they are based in either "pseudoscientific" or "culturally predetermined" representations. Hence, the cultural influences that are recorded, especially about clouds, are indeed correlated with religion (i.e. "heaven", "god"), but they are mainly associated with everyday life (i.e. "smoke from fire", "steam from household activities").

In a short but concentrated review of the bibliography concerning children's representations according to certain physical-climatological phenomena, Hansen (2009) presents a series of data that result from investigative tracing procedures on clouds, from 1883 to 2009. More specifically, he reports that, in 1833, Hall carried out a representation survey on 4-8 year old children concerning clouds, among other subjects. This particular study showed that children express a wide spectrum of representations in relation to the location, the movement and the creation/origin of clouds. Furthermore, in a 1900 research by Olsen on 6-7 year old children's representations concerning "moving clouds", he discovered that, while the majority of girls use a relatively sufficient model of interpretation of the phenomenon, less than half of the boys approach the same explanations. Finally, discussing

the results of one of his own researches, he records a combination of "unsatisfactory" and "satisfactory" representations, concerning the comprehension/explanation of the phenomenon, even among 13 year old children after a special teaching intervention.

Therefore, drawing on these research literatures as well as the extremely limited number of researches on the subject, it appears that there exists an important field of study. The main aim of this research was to investigate and categorize the representations of 4,5-6 year old children on clouds. The complexity of the phenomenon, in conjunction with the age of our subjects, led to the exploration of the characteristics of their thought in 5 levels (Nagy, 1953; Ergazaki, Saltapida & Zogza, 2010):

1. What associations do children make, when they discuss clouds?
2. How do they describe the form of clouds?
3. In what place do they recognize the existence of clouds?
4. What are their thoughts on the creation and/or the origin of clouds?
5. Where do they position them in the "living"-"non-living" scale and under what criteria do they make their choice?

Methodology of Research

This study is part of a research trend which recognizes the need for a more holistic approach of young children's scientific learning and thinking. Sociocultural, historical perspective (Fleer, 2002; Robbins, 2009; Sikder & Fleer, 2015) is placed in the relevant research foreground due to this trend. According to that approach, the investigating and tracing procedures are decentralized from a stable and established bipolar system leading to a more open- type and expanded communication system. A qualitative discourse microanalysis of preschoolers' conversations was used so as to define the children's representations of clouds.

Procedure

The survey of the children's representations was carried out through open-type conversations between pairs of the children sampled and one of the researchers. Each conversation lasted approximately 30 minutes. Through open type questions, children were encouraged to make associations with their everyday lives (i.e. "where have you seen this?") and to refer to their sources (i.e. "who do you know that?", "how did you think of that?").

Both the accumulation and the documentation of the data was carried out with the use of recordings and field notes, during, and right after the conduct of the survey.

Sample of Research

The research consisted of sixteen (16) 4.5-6 year old participants (7 boys and 9 girls) from one public kindergarten in an urban area of Greece, with a population of mixed socio-economic status. The children of the sample had not worked in their school with either the water cycle and heat phenomena, or with change in the state of matter. Furthermore, the parents lacked any form of specific education related to natural sciences. The children were randomly sampled among those who had agreed to "play" with the researcher.

Data analysis

Data analysis was based upon the video-taped discussions between the children and the researcher and individual observation protocols. The analysis of the accumulated data from all eight interviews was facilitated through the use of the qualitative data analysis software called "NVivo". In order for them to be analyzed, the data were transcribed and were prepared to be encoded; subsequently, they were encoded and organized into "categories".

Research Results

The questions, the representation categories, examples of children's answers, as well as tables documenting the frequency of references to each category are presented below. More than one references can apply to a single

subject, as it is not uncommon to encounter, in the children's discourse, representations that fall into more than one categories.

Question 1. Each pair of children was posed with the question: "What comes to mind, when you see clouds?" By asking this question, we attempt to discover which associations children make concerning clouds. In this case, we classified the children's answers into four categories:

a) Answers in which clouds are associated with weather phenomena, and especially with rain. For example, "it's raining heavily and we're getting wet", "it'll rain".
b) Answers in which clouds are associated with other physical entities. For example, "they're made of water", "they're made of smoke".
c) Answers that refer to various morphological features of the clouds, like size or plasticity. For example, "some are small, some are big", "they shape this letter".
d) Answers that point to the children's imagination. For example, "take them out, make shapes like puzzles", "will drive a rocket… to catch them".

Table 1 presents the frequency of children's references concerning the associations they make.

Table 1. Frequencies of children's references regarding clouds.

Representations	f
a. Clouds are associated with weather phenomena, especially with rain	4
b. Clouds are associated with physical entities	4
c. References to morphological features of clouds	3
d. References that point to the children's imagination	5

Question 2. Searching for children's representations concerning the form of clouds, the subjects were posed with the following question: "What do the clouds look/seem like?" In this case, the children's answers were classified into five categories:

a) Answers in which children refer to perception-based facts and properties of clouds, such as size, shape, color, structure etc. For example, "they're a little thick", "they look like curves", "they're grey when it rains and white when the sun comes out", "they're made of rain".
b) Answers in which clouds are associated with physical entities. For example, "like air", "like snow".
c) Answers in which children attempt to approach the form of clouds, using analogies. For example, "it takes lots of shapes and transforms into a big blanket", "like the moon", "like a painting", "like paper", "…dragon".
d) Answer that connects clouds with an emotion: "the cloud in the sky is love".

Table 2 presents the frequency of children's references concerning the form of clouds.

Table 2. Frequencies of children's references regarding the form of clouds

Representations	F
a. References to perception-based facts and properties of clouds	20
b. Clouds are associated with physical entities	2
c. Use of analogies	10
d. Expression of emotions	1

Question 3. In order to approach children's representations regarding the location of clouds, we asked them to tell us "where are clouds -where can clouds be found". In this case, the answers were classified into three categories.

a) Answers in which clouds are recognized to be at a distance from earth, as their position is located in

the sky, in space, in the fog. For example, "they are on the sky", "they are also in space", "fog is a cloud that comes down to earth".

b) Answers in which various places are specified, but without clear reference to locations that are recognized to exist at a distance from the surface of the earth. For example, "wherever you want… in Turkey… they're wherever you want", "where we go out and play", "everywhere".

c) A subject refers solely to a type of symbolic representation, thus only recognizing clouds in "paintings".

Table 3 presents the frequency of children's references concerning the location of the clouds.

Table 3. Frequencies of children's references regarding the location of the clouds

Representations	f
a. Clouds are at a distance from the surface of the earth	14
b. In various places without clear reference to their typical location	9
c. In paintings	1

Question 4. Attempting to comprehend the things children associate the formation of clouds with, they were asked to answer the following question: "How are clouds formed?" In the conversations that followed, a series of pre-causal forms of thinking were prevalent, as they were categorized by Laurandeau and Pinard (1972). Thus, the children's answers were classified into six categories.

a) A subject gave an answer that was compatible with scientific knowledge in schools: "the cloud is water in gas form".

b) Answers in which "phenomenism" is prevalent, namely the causal association of separate physical entities in order to form clouds, are classified in the second category. For example, "the wind afterwards turns into a small ball and then turns into a cloud… mixes with the cold".

c) Answers that are characterized as "artificialistic", as they attribute the creation of clouds to technical factors, are classified in the third category. For example, "well… first we add a little sugar… and then some water, we mix them and try to climb a big ladder and go like this (nods as if shaping the typical cloud form)…", "in the factory… only clouds come out".

d) Answers in which "animism" is prevalent, namely the ascription of properties of living beings to clouds or related physical entities, are classified in the fourth category. For example, "they are hidden in the back (by the sky), behind his back and then he throws them… on his own… holds a council on his own and paints them…"

e) "Teleological" answers, which recognize human consciousness and activity as the cause for the creation of clouds, are classified in the fifth category. For example, "there's the man that makes clouds", "he can let them go and help them stay in the sky".

f) Answers in which the subjects adopt a "metaphysical causality", as the creation of clouds is attributed to divine intervention, are classified in the sixth category. For example, "God made it… then he lowered it a bit, he blew a little air in it, the material that it needs, and after that.... the cloud was ready and it stayed in the sky for many days."

Table 4 presents the frequency of children's references concerning the formation of clouds.

Table 4. Frequencies of children's references regarding the formation of clouds

Representations	f
a. Description that is compatible with scientific knowledge	1
b. Answers based on "phenomenism"	8
c. Answers based on "artificialism"	6
d. Answers based on "animism"	2

Representations	f
e. Answers based on "teleologism"	4
f. Answers based on "metaphysical causality"	4

Question 5. Asking the fifth question ("Are clouds, in your opinion, living or non-living?"), an attempt is made to research where, according to the children, clouds should be positioned on the "living"-"non-living" scale, and what criteria they use to make that choice.

In this case, a great majority (14 children) believes that clouds are non-living. The instance in which two subjects appear to classify clouds appropriately as both living and non-living, is particularly interesting. Their measure for this classification is whether it rains or not, something that helps them conclude as to whether clouds are living or not. On the contrary, the children that perceive clouds as non-living use the absence of human features, such as movement or speech, as their measure.

Discussion

In the research presented in this article, we attempted to compare and contrast 4,5-6 year old children's representations concerning clouds. Firstly, by trying to survey the associations they make as well as their descriptions of them, we observed that they mainly focus on both the clouds' relations to weather phenomena and on their morphological features. While their references to weather phenomena are mainly associated with rain, the ones relating to the clouds' morphological features are not limited to typical properties such as color, shape, size etc., but very often lead children's thinking to analogies or narratives that are based on the activation of the imagination and their creative thinking. These results are compatible with Bar's research findings (1989) where clouds' material nature is highlighted as well as the cultural references that children make while they are conceptualizing clouds.

When asked to place clouds in a certain location, the subjects situate them somewhere above the ground, without, naturally, being able to accurately specify their exact position. Nevertheless, the level of description of this representation is compatible with school scientific knowledge.

However, moving from the issue of description to the issue of explaining the clouds' creation, all of the pre-causal thinking forms, as presented in classical theoretical approaches (Piaget, 1930, 1973; Laurandeau & Pinard, 1972), are discovered. Even though these reasonings are expected to be found in 4,5-6 year old children's thinking, this finding illuminates the great difficulties in approaching the phenomenon in this age, as they highlight an important cognitive obstacle. The designation of those thinking aspects, leads to a different direction than the one proposed in Bar's (1989) and Hansen's (2009) research, since in this paper's approach the logical difficulties, that children have in order to approach school scientific knowledge are tracked down. If these difficulties are combined with misconceptions about evaporation and liquefaction as those are mentioned in Russel's, Harlen's & Watt's (1989) and Ravanis' (2014) studies, the focus points towards a successful didactic and learning approach of clouds creation phenomenon can be specified.

Nonetheless, the perception of clouds as non-living entities allows children to construct a framework of discussion, within which they take the first steps towards the distinction between real and imaginary elements.

Conclusions

Even though, from a cognitive perspective, clouds are generally complex entities, we can recognize that preschool-age children begin to form descriptions that, regardless of the influence exerted by pre-causal forms of thinking and by the world of children's imagination, are based in properties and features that allow the clouds' recognition as autonomous natural entities. Furthermore, although children's spontaneous and experiential representations do not constitute a sufficient description and explanation model for the natural phenomenon, it seems that the majority of the study's children holds and also treats mental representations not individually and inconsistently but as a representation network regarding clouds. More specifically, children seem to possess a broad range of ideas and explanatory mechanisms regarding the natural phenomenon and they are able to reason about them. Those conclusions are made possible under a sociocultural framework, like the one used in the proposed research, where the interaction between children and teachers is promoted, the spontaneous children

expression is amplified and the complexity of children thinking as well as the influence of cultural parameters at their thought is highlighted.

From a teaching perspective, it appears that an initial approach of the subject in kindergarten could support the comprehension of the creation of clouds at a later stage, namely when children are integrated in formal education and in environments that are specially organized towards the teaching of Natural Sciences. Thus, the study of various aspects of kindergarten activities concerning clouds proves to be of particular interest, along with the communication between children, and the teachers' interventions (Fragkiadaki & Ravanis, 2014). Therefore, this present day, our research is headed towards that direction.

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