Clouds as natural entities in preschool children's thought

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ABSTRACT

This research paper seeks to determine pre- schoolers' representations about the general characteristics of the natural phenomenon of clouds, their reasoning about the consisting elements and the formation procedures of clouds and finally, their ideas about the existence of clouds through time. The sample consisted of 22 children (12 boys and 10 girls) aged 5.5-6 years from one public kindergarten in an urban area in Greece. Data were collected through semi-structured individual interviews. The analysis of the qualitative data showed that although the preschoolers had fruitful representations, the majority of them encountered difficulties on approaching several aspects of the phenomenon. Children's reasoning about the phenomenon also seemed to be without a stable and coherent structure. The need for a categorization of pre-schoolers' representations based on the use of a system of concrete criteria and the prospect of a didactic approach leading to the creation of a precursor model is designated.

KEYWORDS

Children's representations, preschool education, clouds, early childhood science education

RÉSUMÉ

Cet article de recherche vise à déterminer les représentations des enfants d'âge préscolaire sur les caractéristiques générales du phénomène des nuages, leur raisonnement sur les procédures de formation de nuages et les éléments qui les forment et enfin, leurs idées sur l'existence de nuages à travers le temps. L'échantillon de l'étude est composée de 22 enfants d'âge préscolaire (âgés de 5.5 à 6 ans) d'une école maternelle en Grèce. Les données ont été recueillies dans le cadre des entretiens semi-structurés individuels. L'analyse des données qualitatives a montré que bien que les enfants d'âge préscolaire ont des représentations fructueuses, la majorité d'entre eux ont rencontré des difficultés à l'approche de plusieurs aspects du phénomène. Les raisonnements des enfants sur le phénomène semblent aussi être sans structure stable et cohérente. La nécessité d'une catégorisation des représentations des enfants d'âge préscolaire basé sur l'utilisation d'un système de critères concrets et la perspective d'une approche didactique conduisent au besoin de la création d'un modèle précurseur.

MOTS-CLÉS
Représentations des enfants, éducation préscolaire, nuages, éducation scientifique pour l'enseignement préscolaire

THEORETICAL FRAMEWORK

Introduction

In Early Childhood Science Education Research field and the branch of Developmental Psychology that deals with learning, a great part of this research is focused on the study of children's representations about the concepts of Natural Sciences and the phenomena of the physical world. Although early childhood children have not yet developed their scientific thinking and understanding they do have initial representations of the concepts and the phenomena of physical world and they are also able to articulate composed reasoning in order to express their ideas about the natural environment (Piaget, 1975; Rayna, Sinclair & Stambak, 1982; Karmiloff-Smith, 1992; Fleer, 1997; Ravanis, 1998; Baillargeon, 2000; Dumas Carré, Weil-Barais, Ravanis & Shourcheh, 2003; Kampeza, 2006; Resta-Schweitzer & Weil-Barais, 2007; Koliopoulos, Christidou, Symidala & Koutsoumba, 2009; Hadzigeorgiou, 2015; Kambouri, 2015; Malleus, Kikas & Marken, 2016; Saçkes, McCormick Smith & Cabe Trundle, 2016). The way that children of that age conceptualize the physical world and the natural environment is a result of their relevant experiences and their interactions with the social, cultural and material world (Vygotsky, 1987; Lemke, 2001; Robbins, 2005, 2009). That means that according to the personal and the situational characteristics, children construct their own representations that are unique and also express the complexity of their thinking (Fleer & Pramling, 2014). However, children's representations are often in contradiction to the models and the explanations given by Physics, Chemistry or Biology. Consequently, in order to designate, interpret and understand these representations, a thorough and multidimensional study is needed. Categorizing children's representations constitute a concrete and also tantalizing problem throughout this study. The aim of this research paper is to explore 5 to 6 years old children's representations about clouds through the analysis of children's discourses and drawings. Moreover, a categorization of these representations according to the scientific model of knowledge about clouds used in Early Childhood Science Education is designated.

Generally, the matter of the 5 to 7 year old children's conceptual approach on clouds, on which this study is focused on, is posed in the research bibliography within two basic frameworks. In the first framework, the cloud phenomenon is conceptualized as part of a broader process of the water cycle in nature. In the second framework, the comprehension of clouds is conceptualized as an autonomous phenomenon.

More extensively, the research of Piaget (1930, 1973) and Bar (1989) was very important in the first framework. From a developmental perspective, using a qualitative methodology, they designated that children during pre-school age understand clouds mainly as a solid material, and they also associate them with divine action, cultural beliefs and human activity, such as the use of boilers. The student' s representation of clouds as "bags of water" that "open up so that rain can fall" is typical at this age. Within this framework, young children's comprehension of phenomena of change in the form of water, such as liquidation and vaporization, which are associated with clouds, is also approached. Studying the issue of comprehension of changes in the form of water, Bar (1989) observed insurmountable difficulties for young children associated with the absence of the concept of conservation of matter in children's thought. In a research by Bar and Galili

(1994) conducted on children from a broad range of ages, it was also observed that although preschool-aged children are not familiarized with water vaporization phenomenon, they frequently refer to water disappearance or absorption.

In the second framework, where children's thought on clouds is an autonomous object of research, Hansen (2009) attempted to organize the findings of a long series of researches on children's thought concerning various meteorological phenomena. Recording the representations of 4-7 years old children on clouds, he detected multilayered difficulties in relation to the creation, the origin and the location of clouds. Only on the issue of cloud movement, it appears that the children are able to provide answers compatible with scientific knowledge from the age of six. Fragkiadaki and Ravanis (2014, 2015), based on a cultural-historical perspective, studied 4.5 to 6 years old children's thought on how clouds are formed, what they resemble, where they can be encountered, and whether they constitute a living or non-living entity, discussing with pairs of children. Thus, they recorded that children encounter considerable difficulties in the way clouds are formed; however, they associate the notion of the cloud with weather phenomena, especially rain, they situate clouds somewhere above the surface of the earth, and recognize that they are non-living entities. Concerning their morphological characteristics, children engage their imagination and creativity in order to respond and refer to more than color or size.

Research Questions

The above literature review is focused on research findings concerning 5 to7 year old children. As it can be remarked, the bibliography on the issue of young children's comprehension of the process of formation of clouds is limited, and there are multiple aspects that demand a systematic research approach. In the research presented here, the recording of children's representations, as expressed individually, was undertaken trying to elaborate on questions that attempt to trace the possibility of the formation of a concrete model of thought among preschool-aged children.

The research questions were posed as follows:

1. What are the representations of preschool-age children on the general characteristics of natural phenomenon of clouds?
2. What kind of reasoning do children of that age form about clouds' composition and clouds' formation procedure?
3. Do they consider clouds to be entities that appeared in the sky at a certain point in time, remaining the same even today? Or do they regard that clouds are constantly created in nature, as they are products of a self-perpetuating process?

METHODOLOGICAL FRAMEWORK

Sample

The research sample included 22 children (12 boys and 10 girls), aged 5.5 to 6 years old, from 1 class of a public kindergarten in an urban area of Greece. Children were randomly sampled among those willing to cooperate. The children that took part in the research had not previously attended any organized teaching activity on the phenomenon of clouds.

The Research Procedure

In order to collect the data structured individual interviews were carried out, which took place in the children's school during free activities at times when clouds were clearly formed in the

atmosphere. The listing of the data was carried out through sound recordings of the interviews, and based on drawings-pictures requested of the children.

The Interview

The interview developed into three units of questions. Each unit was corresponding to one of the research questions. Starting the discussion, in order to construct a functional framework of communication that guides their thought into the study of cloud that follows, children were initially asked: "What do we see in the sky?" Consequently, they were asked to draw the clouds.

1. For the first research question, namely the detection of representations on clouds, it was suggested to observe the sky, and then the following questions were posed: 1.1. What are the clouds like? Can you describe them? 1.2. Where do you think they are?
2. For the second research question, namely the examination of the reasoning that is formed by children of that age about clouds' composition and their formation procedure, the following questions were posed: 2.1. What are clouds made of? 2.2. How do you think clouds are formed/ made? Before asking to answer this question, children were encouraged to draw a story for the process of formation of clouds.
3. Finally, for the third research question, concerning children's representations on the clouds as beings in time, the following questions were posed: 3.1. Are the clouds that people used to see the same as those that we see now? 3.2. Do you think that new clouds are created constantly, or that those that we see now in the sky were created in the past, and remain the same to this day?

RESULTS

Analyzing the data that emerged from the interviews, children's representations were classified in different stages-categories for each research question. These stages are connected to the answers' deviation from the model on clouds used in education. Consequently, typical answers from each answer category, as well as tables that reference the answers' frequency are presented.

Introductory Questions Concerning Clouds

Beginning our discussion the children were asked: "What do we see in the sky?" Afterwards, they were asked to draw clouds. All the children of the sample recognized the clouds in the sky and also wanted to depict them in their drawing as requested. Studying their drawings, it was observed that 17/22 children depicted clouds on the top part of the piece of paper that was provided, while 5/22 children drew clouds in the center of the piece of paper. In regard to the colors they used, 18 pupils drew the clouds using the color grey, two pupils using light blue, and one pupil used the color brown. One pupil, when he was asked to draw clouds mentioned that *"They are white and cannot be seen. We cannot draw them"* (Subject 8), and, after a recommendation, he decided to draw the clouds with his favorite color, black.

The first research question

With the first research question, it was attempted to approach the children's representations on the characteristics and location of clouds *(1.1. "What are the clouds like? Can you describe them?" 1.2. "Where do you think they are?")* (Table 1).

TABLE 1

Categories and frequency of answers on the clouds' morphological characteristics and location

Representations	Categories	Subjects	Frequency
Morphological characteristics	External morphological characteristics & weather phenomena	6, 7, 12, 15, 16, 17, 18, 20, 21	9
	External morphological characteristics	1, 2, 3, 4, 5, 8, 9, 10, 11, 13, 14, 19, 22	13
Location	Location of clouds in the sky & geographical references	2, 8, 11	3
	Location of clouds in the sky	1, 3, 4, 5, 6, 7, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22	19

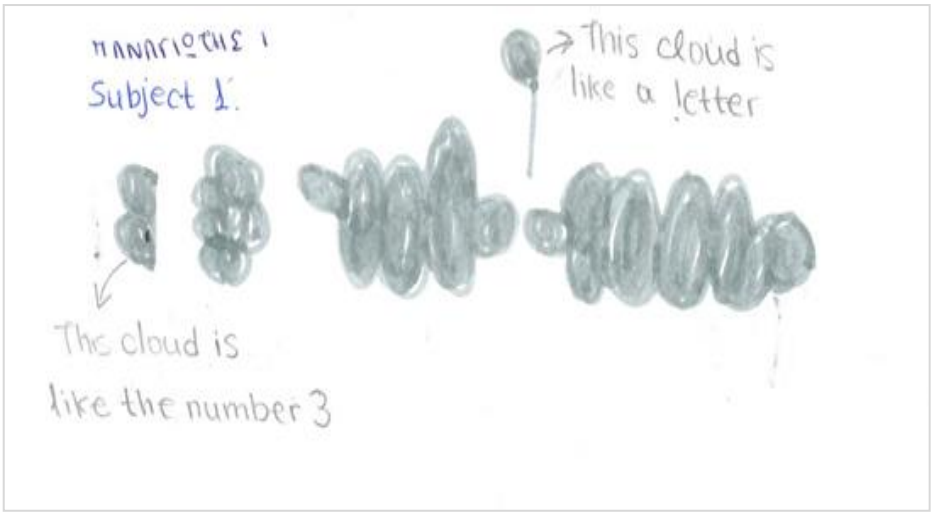
1.1. Children's answers on the descriptive traits of clouds were classified into two categories.

a) In the first category, answers of nine children that were able to describe essential external morphological characteristics of clouds, associating their differentiations with changing weather phenomena, and to recognize clouds as natural entities in the outer atmosphere were classified. For example, *"They are of the color grey, white, black… they are both small and big. When it rains they are of the color black"* (Subject 6), *"Sometimes they look like something else, like a thing. Others are small, others are big. They are grey, but normally they have a white color. I've seen darker ones, that when it rains have also dark colors"* (S. 7), *"They are white and then they also turn grey because there is a storm. They big and small"* (S. 17).

b) In the second category, the answers of the remaining thirteen children were classified. In this case, they described their essential external morphological characteristics without attributing their differentiations to changing weather phenomena. More concretely, five pupils mentioned that clouds are white; two pupils mentioned that they are white and blue, and three pupils that they are grey. Individual pupils mentioned that clouds are grey-black, white-grey, and white-grey-black respectively. Furthermore, it is noted that some children, referring to the shape of clouds, made small comparisons with familiar elements in the environment. For example, *"Some clouds also make a shape"* (S. 1), *"Sometimes they look like turtles, something with various things"* (S. 10). They highlighted that clouds take various forms, make various shapes, something that is reflected in their pictures, drawing clouds that look like a letter or a number (Figure 1), like a whale, like a turtle (Figure 2).

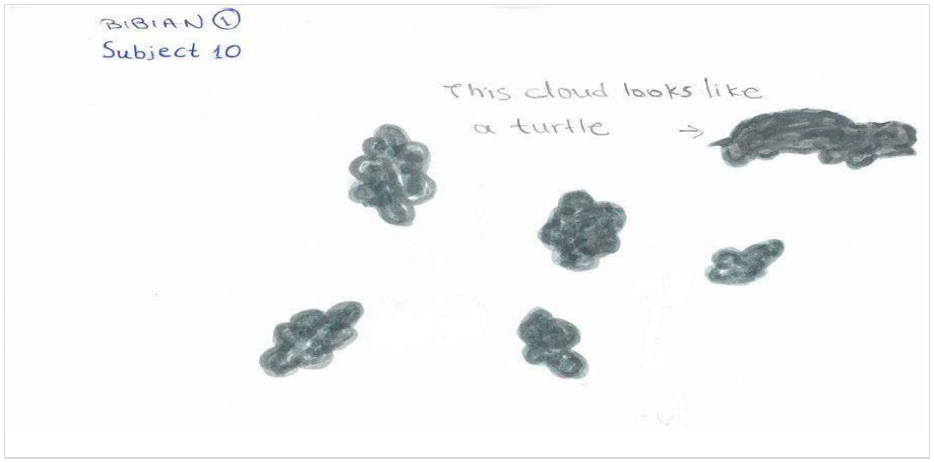
What is more, all of the children in the sample mentioned big and small clouds, concerning the clouds' size.

FIGURE 1



The cloud is like a symbolic representation

FIGURE 2



Cloud represented as an animal

1.2. All of the children in the sample answered the questions on the clouds' location in a satisfactory manner, as they recognized them as entities that can be found in the sky. However, the answers of three children in the sample were of particular interest, because they made geographical references: *"In Greece and in other countries"* (S. 2), *"Everywhere. Apart from space. Here in Greece, in Africa, in Germany"* (S. 8), *"They are in all countries"* (S. 11).

The second research question

With the second research question the children's representations on the clouds' composition and formation procedure were explored (2.1. *"What are clouds made of?"* 2.2. *"How do you think that clouds are formed- made*?") (Table 2).

TABLE 2

Categories and frequency of answers on the composition and the process of formation of clouds

Representations	Categories	Subjects	Frequency
Composition	Association with water	5, 14, 15, 21	4
	Association with other natural entities	6, 7, 8	3
	Association with entities that are morphologically related to clouds	2, 3, 9, 10, 11, 12, 13, 17, 20, 22	10
	Association with metaphysical entities	1, 4, 16, 18, 19	5
Formation procedures	Association with water	21	1
	Association with other natural entities	7, 14, 15	3
	Association with human artificial construction	6, 9, 11, 13	4
	Association with metaphysical entities	1, 2, 3, 4, 5, 8,10, 12,16, 17, 18, 19, 20, 22	14

2.1. Concerning clouds' composition, children's representations were organized into four categories.

a) In the first category, the answers that associated clouds with water were classified. The answer of a pupil which mentioned that the cloud is *"made by drops"* (S. 21) is of particular interest. When he was asked *"Which drops?"* the child pointed to his drawing of the sea. Three other children also associated the clouds' composition with the natural phenomenon of rain: *"Of rain"* (S. 15), *"Of drops of rain"* (S. 14), *"Clouds are made of air, water and rain"* (S. 5).

b) In the second category, answers of three children that referred only to natural entities associated with the clouds' location, like air and dust were classified: *"Of air…? I don't know. They might be made of air…"* (S. 7), *"Of air"* (S. 8), *"Of dust? I don't know, they might be, yes. With dust"* (S. 6).

c) In the third category, were included answers that referred to entities that are morphologically related to clouds, i.e. cotton, feathers, paint, wool. For example, *"Of cotton, I think"* (S. 9), *"I think that clouds are made of something like wool… like the wool we get from sheep"* (S. 12), *"It was made by a lot of real paint and a lot of paper"* (S. 11), *"Of water… and flour"* (S. 17).

d) In the fourth category, the answers of children that hesitantly referred to metaphysical factors and especially to divine intervention were classified. For example, *"God made them… how would I know?"* (S. 1), *"God made them with his hands. He told it: 'be a cloud' and it said 'yes'… I don't know what he made them with"* (S. 16). In some cases, references to metaphysics are associated with natural entities as well. For example, *"I think that God made them of water and soil"* (S. 18). *"God made them with his hands. I think he took some cotton and made them"* (S. 19).

2.2. On the matter of the process of formation of clouds, children's answers were classified into four categories.

a) In the first category, was integrated the answer of a child that associated clouds with rain and the sea: *"The drops make the cloud (when asked about the drops, they said they came from the sea), the drops come this way and make the cloud, they fall and go to the river. Here in the mountain, the snow drops, it goes here (in the sea) and turns into water"* (S. 21) (Figure 3).

FIGURE 3

Clouds associated with water

b) In the second category, three answers that mentioned relevant natural entities like air, or lightning, as cause for the clouds' process of formation were included. For example, *"The clouds must have been made of air"* (S. 7), *"It turned into lightning and then came the clouds"* (S. 15).

c) In the third category, we classified answers of four children that attributed the process of formation of clouds to a human-artificial construction were classified. For example,

"From a house… that's where the clouds showed up from. A person made them with dust and took them up in the sky" (S. 6), *"People made them in a laboratory. These people are experts, they have paint and they made them. They took cotton… they put alcohol, fluffed it up with some more cotton and left it in order for the wind to come and take it up in the sky"* (S. 9), *"In a factory, outside the factory there's a chimney. There they have a machine and on the machine they move the feathers on another machine, that machine mixes them… takes them away… it also mixes them here and it turns them into clouds. And they come out of the chimney. The machine makes them, some gentlemen help this machine, they take the clouds into the chimney, it also mixes them up a bit, it has a mixer inside of it, and then they go to the sky… The also mix them here in the pot and they go up"* (S. 13) (Figure 4).

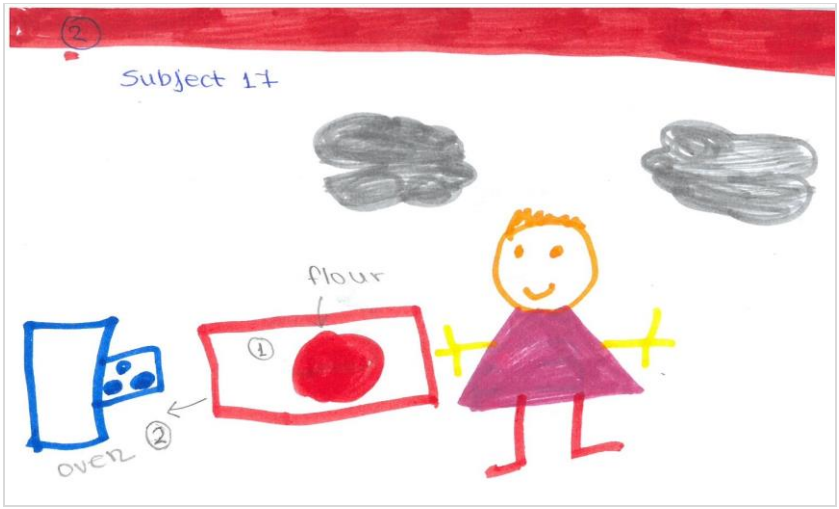
FIGURE 4

The clouds are human construction

d) In the fourth category, answers of multiple stages, the basic element of which was the attribution of the formation procedure of clouds to metaphysical entities were classified. Four children referred to both natural and metaphysical entities at the same time. For example, *"The ghost made a cloud and threw it to the sky with a stone. The other clouds were made on their own with the wind"* (S. 8), *"Once upon a time, there was a fairy named 'Fantasy', and she took wool from sheep and made the clouds. In much, much older times the fairy made clouds. Much older, back when there was nothing, only the night… She went underneath the sheep and took some wool and made the cloud. At a time a long, long time ago… when it was dark, the fairy made the clouds and told the wind to cut them like that, so that they will come in another way…"* (S. 12). Two pupils described the process of formation of clouds as an artificial procedure, carried out by metaphysical entities. For example, *"There is a little girl that kneads them with flour, makes a little cloud and will put it high up in the sky. She puts inside the flour, then she bakes it and puts it in the sky. She does them with the rolling pin, she does them with something white, and she puts them in the oven… God helps her, the little girl is God's assistant"* (S. 17) (Figure 5), *"That person made it in the factory that he works in. They put here (in the*

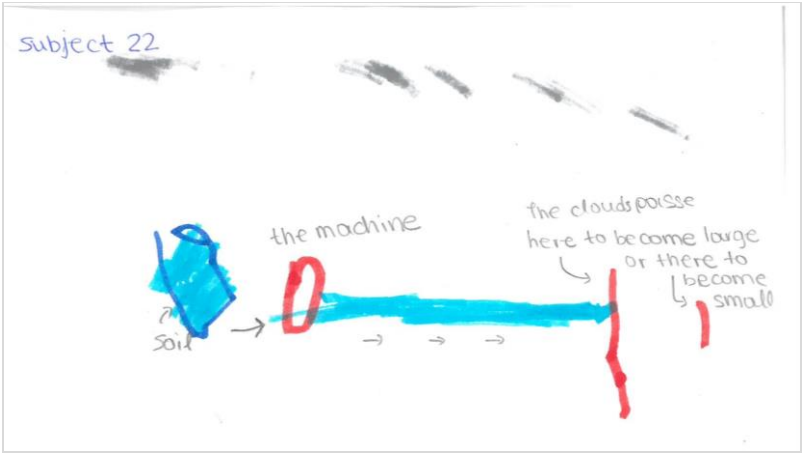
machine) color that they have carried, it goes through here and it becomes big or small… They make the cloud, and then comes a little angel that takes it to the sky. He only made those people, He didn't create us. They made them (the clouds) and now these people don't exist, God unmade them" (S. 22) (Figure 6). Furthermore, in some answers, only metaphysical causes were recognized. For example, *"The cloud was made by God…"* (S. 3), *"A lady made the clouds, she's a little angel, this lady in the sky, she makes clouds"* (S. 10), *"God made them with His hands. He told him: 'be a cloud', and it said: 'yes…'"* (S. 16).

FIGURE 5



The clouds are simultaneously human and divine construction

FIGURE 6



The clouds are simultaneously human and divine construction

The third research question

With the third research question, it was attempted to approach the children's representations on the cloud phenomenon through time; namely, whether children believed that clouds are entities fixed in time, or constantly created (3.1. *"Are the clouds that people used to see the same as those that we see now?"* 3.2. *"Do you think that new clouds are created constantly, or that those that we see now in the sky were created in the past, and remain the same to this day?"*) (Table 3).

TABLE 3

Categories and frequency of answers on clouds through time

Representations	**Categories**	**Subjects**	**Frequency**
Clouds through time	Continuous creation	4, 8, 9, 10, 15, 17, 20, 21	8
	Contradictory reasoning	3	1
	Creation in the past	1, 2, 5, 6, 7, 11, 12, 13, 14, 16, 18, 19, 22	13

3. Based on the analysis of the data that resulted from the discussions which was carried out with the children, representations were classified into three categories.

a) In the first category, eight children who regarded that clouds are products of a perpetual process that takes place in nature, and not immutable entities that appeared in the past and exist to the present day were included. For example, *"They are not the same clouds as in the past, they change, new ones are created all the time"* (S. 4), *"The clouds that people saw in the past are different. In the past, there were other clouds. New clouds are being made"* (S. 10), *"She makes new clouds, she makes them with the rolling pin, she makes them with something white, she puts them in the oven and God helps her so they can put them in the sky"* (S. 17).

b) In the second category, answers of a child who appeared to express contradictory reasoning were included. While, on the subject of clouds, they answer *"In the past there were other clouds…… and today there are new"* (S. 3), when asked whether new clouds are created, they answered that they are not.

c) In the third category, 13 children answered that clouds were created in the past, they remain the same to this day, and no new clouds are created. For example, *"We see the same clouds as in the past. They change sometimes… When it rains… They change colors. They were created in the past and they are the same today. No new clouds are created,* (S. 6), *"They are the same because it's not possible for different ones to have been created, they stay like that. No new clouds are created. The same clouds exist"* (S. 1), *"They were the same in the past, the same goes with the rest of the clouds, and in the past, and now until today…… when it rains, they just change colors. No new ones are*

created" (S. 7), *"Yes they are the same, no new clouds are created… They were made once, before humans were born, no one was born. First God made the clouds, then he made Adam and Eve"* (S. 18), *"Once, in the past, way back… when there was darkness the fairy made the clouds and told the wind to cut them like this so they can come like that, they make shapes, like a heart, each day the shapes may change. It is the same cloud, it just changes. In the past, there was the fairy that made the clouds, she left and the clouds exist since then, they just change shapes with the wind"* (S. 12).

DISCUSSION

In this paper, the representations of preschool children, concerning basic aspects of the cloud phenomenon, such as form, location, composition, formation procedure, as well as their existence in time were recorded. The research results showed that, even though preschool children have experiences with this phenomenon, they encounter significant obstacles during the approach of several of its traits.

In the first research question, which was associated with the clouds' morphological characteristics and location in the sky, it was observed that the children referred to basic perceptional data, such as color, shape and location. Indeed, reference to the clouds' shape was often persistent, and was usually associated with forms which the children are familiar with, such as objects or animals. However, a few of the children related the morphological characteristics with relevant meteorological phenomena, such as rain. Thus, children's pertinent representations remain fixed.

In the second research question, children's representations in relation to the composition and the process of formation of clouds were discussed. Concerning the subject of the clouds composition, 7/22 children referred to various natural entities, such as rain or air; what is more, one of them referred to the drops which originate from the sea. The rest of the children were either confined to metaphysical explanations, or related the clouds to objects with which they share morphological similarities, sometimes in conjunction with water. In this case, however, it is rather significant that some children approached clouds as natural entities, regardless of whether they associated them with the proper elements. Concerning the subject of cloud formation procedure, four children referred to natural entities, such as air, rain and lightning, and one of them referred to its formation from drops which originate from the sea. This child formulated a relatively satisfactory reasoning which was documented in the drawing in detail, albeit it was somewhat insufficient in relation to the model on clouds used in education. The rest of the children recognized artificial procedures, caused by either human activity or metaphysical entities, or attributed the process of formation of clouds to the intervention of metaphysical elements, or even to their coexistence with natural ones. In this case, however, specific forms of children's causal thought were encountered, through which similar reasoning can be interpreted.

In the third research question, it was attempted to be observed whether the children understood clouds as products of continuous natural procedure, or of an instant creation. 8/22, children referred to a continuous creation of clouds, but their conceptualization not always associated with encountering a natural phenomenon, since several of these children expressed metaphysical views on their creation.

In general, it appears that although the reasoning that the children of the sample formulated was complexed and fruitful, it seemed to be unstable and without a coherent structure. In parallel, the recorded children's representations were more frequently based on fixed

morphological characteristics, and less frequently on the creation of relationships between certain entities (Fragkiadaki & Ravanis, 2015). What is more, the metaphysical views that were traced referred to the influence of cultural elements which had been recorded in past researches (Bar, 1989; Fragkiadaki & Ravanis, 2014).

The above results highlight a substantial distance between children's conceptualization about the natural phenomenon of clouds and the scientific model that is used in kindergarten educational reality. For example, according to the curriculum in force for preschool education in Greece, the phenomenon of clouds is related, mainly, to the broader process of the water cycle in nature or to the thermal phenomena and other relevant topics such as evaporation, melting, solidification and the phenomena of changes of matter, in general (The Ministry of National Education and Religious Affairs – The Pedagogical Institute, 2002). Consequently, teaching activities are usually focused on the approach of clouds as part of a broader natural of physical process rather than as an autonomous phenomenon. However, according to the results of the present and relevant researches (Fragkiadaki & Ravanis, 2015), children of that age conceptualize clouds as concrete natural entities and they face difficulties on interrelating the phenomenon with other physical processes and natural procedures into the broader environment.

Moreover, according to the above results children's conceptualization of the phenomenon is oriented towards social and cultural aspects of thinking (Fleer & Pramling, 2014). Namely, children are basically using their everyday multilayer experience to understand the phenomenon and face difficulties in correlating them with macro-systemic aspects of nature that is not visible and touchable in everyday reality. However, as Vygotsky argued (1987), concept formation presupposes the formation complexes and complex connections. This element also underscores the distance between children's conceptualization about the phenomenon and the scientific model that is used in kindergarten educational reality which is disconnected with children's everyday knowledge and understanding.

In conclusion, what appears as essential is a more systematic approach of the children's representations about clouds, based on two necessities. The first necessity is the use of a system of criteria for the better comprehension of the reasoning articulated by the children, such as the framework proposed by Laurandeau and Pinard (1972) concerning causal thought. The second necessity is associated with the elaboration of a teaching and learning sequence of tasks for kindergarten referring to the phenomenon of clouds. In succession, this perspective leads to the necessity of constructing a precursor model appropriate for preschool children. Namely, an educational construction attuned to the multiple capacities and experiences of young children is needed. At the same time, it is highlighted that such an educational construction should also include a number of characteristic elements of the scientific model (Lemeigman & Weil-Barais, 1993; Ravanis, Papandreou, Kampeza & Vellopoulou, 2013; Delserieys, Jégou & Givry, 2014). Our research now moves towards this direction.

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