

Exploring children’s ideas about natural phenomena in kindergarten classes: designing and evaluating ‘eliciting activities’

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ABSTRACT

Young children’s ideas about a number of science topics have been steadily studied in recent years and the respective research findings have considerably supported the development of early childhood science education so far. However, according to the sociocultural perspective on young children’s ideas in science, children adopt a variety of theories, since they are based on their everyday cultural experiences, which makes classification quite difficult. It is therefore suggested that any teaching intervention should take seriously into account the ideas of the children it addresses. But such thing presupposes that the teacher’s educational design involves ‘eliciting processes’ of his/her students’ ideas. The present study aims to investigate methodological issues on the implementation in Kindergarten classes of such processes concerning natural phenomena, as an essential stage of designing the respective teaching interventions. Particular emphasis is put on the “educational context” of these processes, while at the same time the function of the different kinds of activities exploring the ideas of Kindergarten children about the Earth’s shape and the day/night cycle is studied with a view to formulating concrete proposals on learning and teaching in early childhood science classes.

KEY WORDS

Early childhood science education, children’s ideas, communication, drawing activity, group discussion, research methods, Earth’s shape, day/night cycle

RÉSUMÉ

Les idées des petits enfants, par rapport à un certain nombre de concepts et phénomènes des sciences physiques, ont été solidement étudiées ces dernières années et les résultats respectifs de recherche ont considérablement soutenu le développement de l'éducation scientifique à l'école maternelle jusqu'ici. Les enfants adoptent une variété de théories pour expliquer des phénomènes naturels. Mais, selon la perspective socioculturelle, ces théories sont basées sur leurs expériences culturelles quotidiennes, qui rendent leur classification tout à fait difficile. Il est suggéré donc que n'importe quelle intervention éducative devrait tenir compte sérieusement des savoirs antérieurs des enfants aux qu'ils s'adressent. Néanmoins, un tel choix présuppose que la planification éducative du maître implique des activités d'exploration des idées de ses élèves. La présente étude vise à examiner des questions méthodologiques sur l'application de telles activités à l'école maternelle comme étape essentielle du développement des interventions didactiques par rapport aux phénomènes des sciences naturelles. L'accent est mis sur "le contexte éducatif" du processus explorant les idées des enfants de l'école maternelle sur la forme de la terre et la cause du cercle 'jour-nuit', alors qu'en même temps la fonction des différents genres d'activités utilisées est étudiée en vue de formuler des propositions concrètes concernant l'éducation scientifique à l'école maternelle.

MOTS-CLÉS

Éducation scientifique à l'école maternelle, représentations d'enfants de l'école maternelle, communication, activité de dessin, discussion en groupe, méthodes de recherche, la forme de la terre, le cercle 'jour-nuit'.

INTRODUCTION

Most pedagogical and teaching approaches generally favour the view that designing the educational process should take into account the knowledge previously acquired by the children (Driver, Guesne & Tiberghien, 1985; Katz & Chard, 2000; Moyles, 2007; Yelland, Lee, O'Rourke, & Harrisson, 2008; Robbins, 2009). However, when this theoretical view is put into teaching practice, it may be interpreted in different ways, some of which reveal its use only as a pedagogical "slogan". On several occasions, while designing teaching interventions, findings from research on children's thinking may be exploited. A prerequisite for the essential adoption of this view is the integration of 'eliciting processes' into the curriculum as the starting point of designing

learning activities (Endwards, Gandini & Forman, 1998; Katz & Chard, 2000; Moyles, 2007; Yelland, et al., 2008).

This perspective is becoming increasingly visible in some teaching proposals on early childhood science education, where activities exploring children's ideas seem to be incorporated. However, it mostly serves as a tool for evaluating teaching interventions and aims at helping the comparison between children's performance before and after the intervention (Valanides, Gritsi, Kampeza, & Ravanis, 2000; Resta-Schweitzer & Weil-Barais, 2007; Kampeza & Ravanis, 2009) and rarely as a tool for designing the following learning activities (Ergazaki, Zogza, & Grekou, 2009; Ergazaki, Saltapida & Zogza, 2010). What seems not to have been proposed so far is the exploitation of the ideas the children of each specific group expose during the educational design process. But such a pedagogical perspective brings forward several issues on designing 'eliciting processes' and implementing them at Kindergarten class as well as on evaluating, interpreting and exploiting complex data.

The present study attempts to examine methodological issues on designing and implementing such processes. The first part includes a description of the theoretical framework used while designing, implementing and evaluating a specific 'eliciting process' regarding children's ideas about the Earth's shape and the day/night cycle in a Kindergarten class. The results are presented in order that proposals on the actual integration of these processes, while investigating concepts and phenomena of the natural world, into the Kindergarten class may be formulated.

THEORETICAL FRAMEWORK

Studying children's thinking about natural phenomena

The study of children's original ideas about natural phenomena has been a special field of research for years. Research findings reveal that young children shape ideas and views on a number of science topics (Vosniadou & Brewer, 1992, 1994; Flear, 1997; Ravanis, 1999; Shepardson, 2002; Koliopoulos, Tantaros, Papandreou, & Ravanis, 2004; Christidou & Hatzinikita 2006; Kampeza, 2006; Resta-Schweitzer & Weil-Barais, 2007). However, researchers are often divided over the origins, characteristics and exploitation of children's previous knowledge, for they are based on different theoretical approaches and methodological options.

The largest part of the relevant research has adopted Constructivism as its theoretical framework. Cognitive development is faced mainly as a personal process not greatly affected by external factors. By exploring the similarities found in children's thinking about a number of scientific concepts and phenomena, researchers (e.g. Driver et al., 1985; Bar, 1989; Bliss, 1993; Shepardson, 2002) want to identify the paths through which children's thinking moves from the original ideas to a view compatible

with the scientific model for explaining phenomena. According to this approach, understanding the development of children's thinking may become the base for establishing appropriate science teaching interventions and science curricula.

As maintained by the sociocultural theory, neither knowledge construction nor the learning process is a personal matter. On the contrary, they depend on the constant participation of individuals in cultural and social activities, where they interact with other individuals, make use of, adopt and transform cultural tools, social practices, traditional activities, systems of values, etc (Rogoff, 2003). Researchers place emphasis on the differences attributed to various sociocultural factors rather than on the similarities found in children's thinking. Children develop theories about natural phenomena, based on direct experiences, tools and artefacts, such as television, books of various kinds, songs, topics taught at school, family and community stories, habits, beliefs etc. As a matter of fact, these theories vary and are usually inconsistent, which prevents their easy classification (Robbins 2005b). Children's ideas about natural phenomena are much richer and more complex than what the western constructivist approach has shown (Fleer, 1997; Schoultz, Saljo, & Wyndhamn, 2001; Nobes, Moore, Martin, Clifford, Butterworth, Panagiotaki & Siegal, 2003). It is only natural that there are consequences in educational practice.

Fleer & Robbins (2003, p. 418) support that "teaching should take account of children's present conceptions". This idea is actually different from what constructivism suggests, because the authors refer to particular children participating in a specific class, with a given sociocultural background. There are also suggestions that teachers should exploit children's rich and complex ideas so that a common meaning could be attained within the group (Robbins, 2005a), while, on the other hand, the children could reflect on these ideas more easily, particularly when these ideas are conflicting (Robbins, 2009). Nevertheless, such pedagogical perspectives have not been researched yet, and no proposals have been put forward on the exploitation of young children's ideas during the educational process according to the sociocultural view. This educational implication with no doubt lies at the heart of the constructivist movement. However, constructivists' educational implications are mainly based on predetermined children's 'mental models' derived from previous research findings.

Methodological issues concerning the study of children's thinking

Much speculation has been developed in recent years over the methods adopted for studying young children's thinking and experiences (Clark, 2005; Fleer & Robbins, 2003; Robbins, 2005a; Dockett & Perry, 2007; Fargas-Malet, McSherry, Larkin & Robinson 2010). The relevant literature denotes that new perspectives and methodological tools are being shaped, some of which will be discussed below by

identifying methodological issues considered critical by researchers and by commenting on them.

If we admit that children's abilities, knowledge, ideas and experiences reflect the social and cultural context within they live and develop, then the "research context" in which their ideas are studied must not be much different (Robbins, 2005a; Dockett & Perry, 2007). Researchers (e.g. Donaldson, 1978) who have been critical of the classic, clinical-type research methods have underlined issues they consider could obstruct the identification of children's thinking. For example, if the "research context" is far from their social experience, it is very likely that the children will not understand the researchers' questions and will respond at random or will just be uninterested in participating in the process (Fargas-Malet et al., 2010).

Another issue of concern for the researchers is the ways in which the children usually express and represent ideas and experiences in their everyday life, which the supporters of Reggio Emilia's approach call "*The hundred languages of children*" (Edwards et al., 1998). Children "talk" by gestures, movements, dancing, singing and drawing and, in this way, they try to communicate with other people. So "Malaguzzi... challenges adults to discover the hundred ways of listening" (Clark, 2005, p. 491). Barker and Weller (2003, p. 33) propose the adoption of "inclusive and participatory children-centered research methodologies", which are based on the different languages of the children, considering that in this way the authoritarian relations appearing between adults and children can be blunted. The various means of representation and communication used by the children, for example drawings, stories, songs, gestures, symbolic play, photography, etc., may become the suitable tools for exploring their thinking (Barker & Weller, 2003; Robbins, 2005a, 2009). However, each of those means may have special restrictions. For example, although drawing is one of the most popular activities with young children, there are children that are not particularly fond of it or even avoid it because they feel they are not good at drawing. As it is likely that, on several occasions, different children may respond better to different research methods, some researchers (Barker & Weller, 2003; Einarsdottir, 2005; Smith, Duncan & Marshall, 2005) propose the adoption of *multi-method research approaches*.

The methodological issues analyzed above on the methods researching young children's ideas seem to present clear pedagogical implications that could be exploited with the intention of designing and incorporating 'eliciting processes' of young children's ideas about natural phenomena into the Kindergarten class.

Children's ideas on the Earth's shape and the day/night cycle

Research on children's representations of the Earth's shape and the day/night cycle has revealed a variety of characteristics. Some researchers claim that children (aged 6-11)

construct “mental models” of the Earth’s shape as well as of the day/night cycle, which are structured according to the everyday social, cultural and scientific information to which they are exposed, thus gradually approaching the scientific model for describing and explaining the relevant phenomena (Vosniadou & Brewer 1992, 1994). Other research findings, which used classic experimental methods exploring younger (aged 5-6) children’s ideas (Valanides et al., 2000; Kampeza, 2006) or introduced innovative methods (Fleer, 1997) for probing aboriginal children’s (aged 4-8) understanding of the night/day cycle (for example storytelling, drawing, interviewing), differentiate as they display more variations in children’s thinking than those found before. Other researchers (Schoultz et al., 2001; Nobes et al., 2003) showed more systematically that children’s responses to researchers’ questions are affected by the available tools as well as by the context of communication established among the participants. Variety in children’s representations of the Earth’s shape and the day/night cycle seems to lead to the conclusion that the relevant children’s ideas do not represent consistent “mental models”, but are shaped and transformed according to the sociocultural setting, and that the research communication context based on the use of suitable alternative methodological tools helps the wealth of children’s ideas to emerge.

The aim of the study

Since young children’s ideas about natural phenomena result mainly from their everyday sociocultural experiences, the children’s ideas of a Kindergarten class which are described by similarities and differences constitute the unique profile of this specific group of children. This means that in order for the design of science learning activities to meet the needs of the children it addresses, it should be based on this unique profile and, consequently, put emphasis not only on the similarities but also on the differences in their thinking, on the contradictions they express and on issues that seem to really interest them.

Therefore, the possibility of an actual implementation of this perspective in the Kindergarten should be studied. The present paper places emphasis on the ways in which this unique profile is explored, their design and implementation. Our aim was to study the function of different types of activities exploring Kindergarten children’s ideas about the Earth’s shape and the day/night cycle.

METHOD

Procedure and participants

The educational program (exploration, learning activities and evaluation) was implemented in a central Kindergarten of a small town of Western Macedonia in Greece, between the late March and the mid-May 2010. Sixteen children aged 4-6 (11

children aged 5-6 and 5 children aged 4-5) participated, including 9 girls and 7 boys. No similar educational program had been previously realized in this Kindergarten. The first phase of the program namely the exploration of children's ideas lasted three days and included a variety of activities.

The 'eliciting process'

A multi-method approach (Einarsdottir, 2005; Smith et al., 2005) was adopted for eliciting children's thinking, including six different activities, whose type and order in which they were carried out appear in Table 1. The activities were thematically connected with each other, as they were based on a common scenario introduced in the first activity of narration. A "*communication trick*" activated children's involvement in the following activities and encouraged them to express their ideas: the hero (doll) of the story asks for help from the children in order to learn some things about the Earth. The children are originally urged to talk to the hero about their ideas (Activity 1) and then to draw the Earth as well as the Earth in the day and the Earth at night (Activity 2) so that they can help the hero. As soon as they completed the drawing activity, every child describes his or her drawing to the teacher-researcher (Activity 3). In the ensuing group discussions the children are asked to "read" their peers' drawings in order to find out whether the hero of the story will be able to understand, with the help of the drawings, what the Earth looks like (Activity 4) and what happens in the Earth in the day and at night (Activity 6). In Activity 5 the children at first are asked to choose a geometrical shape that reminds them of the Earth in order to further help the hero of the story. The activity is completed with a group discussion (see Table 1, activity 5).

TABLE 1

<i>Activities exploring children's ideas</i>	
Days	Activities
Day 1	<ol style="list-style-type: none"> 1. Narration of a short story with the use of a doll and challenge of questions about the Earth (group discussion) 2. Two drawing activities on "the Earth" & "the Earth in the day and the Earth at night". 3. Personal interview about the drawings. Every child describes his or her drawing to the teacher-researcher, who asks relevant questions.
Day 2	<ol style="list-style-type: none"> 4. Group discussion on certain drawings about "the Earth", selected according to the different characteristics they depict (e.g. drawings with or without geophysical details, people outside or within the drawing limits, etc.). 5. A game in which a geometrical shape is selected prior to a group discussion: at first, every child is asked to secretly choose the shape the children think resembles the shape of the Earth from a table depicting different vertically arranged geometrical bodies; then the different choices are measured at group level, children's drawings are reexamined and compared with the results of the measurements, and finally the children are asked to show where the people live in the Earth, with the use of the shapes that seem to prevail in their choices.
Day 3	<ol style="list-style-type: none"> 6. Group discussion on certain drawings about "the Earth in the day and the Earth at night", selected according to the different characteristics they depict (the same process is followed in activities 4 and 5).

The multi-method approach with the variety of activities aimed to provide the children with more opportunities to express their ideas. Although oral speech is the prevailing mode of communication, the children are differentiated regarding the modes of communication they prefer when they want to express themselves (Yelland et al., 2008). In order to improve the context of communication between the researcher and the children, several researchers have used a variety of techniques for exploring children's ideas. On several occasions the dolls prove helpful in "listening" to the children (Clark, 2005). The narration of stories and the existence of a specific scenario may arouse children's interest and make them get involved in the process and, therefore, they can recall previous experiences more easily (Fleer, 1997). The drawing activity, in combination with observation and the transcribed oral speech (Clark, 2005) or with the personal interviews conducted during (Robbins, 2009) or after its completion (Dockett & Perry, 2007; Einarsdottir, Dockett & Perry, 2009), provides the children with time to think and recall knowledge and experiences as well as to focus on them. As for group discussions, researchers support that the children are much more relaxed when they are with their friends, are helped by the others to express themselves (Einarsdottir, 2005), share their ideas and refer to aspects of the "subject" of the discussion, to which they might not have referred during personal interviews (Fleer & Robbins, 2003; Dockett & Perry, 2007). In this study the first group discussion (activity 1) is conducted as an unstructured 'brainstorming' process, while the other three group discussions (activities 4, 5 & 6) are constructed in a way that the teacher helps children to clearly express their ideas and state their explanations in order to 'help the hero of the story'.

Data collection and analysis

The overall research process was tape-recorded and the teacher-researcher was taking notes. Research data included children's drawings, personal interviews and transcribed group discussions. The first study on the drawings, in combination with children's responses during the interviews, resulted in eight categories of 'symbols' (Table 2). In order to illustrate the unique profile of this specific group of children regarding their ideas about Earth's shape and the day/night cycle we used these categories to code the data collected throughout the 'eliciting process'. The present article is concerned with a part of the results obtained from this process in an attempt to reveal the specific characteristics of the different activities and the way they functioned at either personal or group level.

RESULTS

A. Drawing activity and personal interviews

A1. Variety of symbols

The two drawings activities revealed the great variety of symbols the children invented in order to represent their ideas about the Earth (Table 2). It should be noted that all the children depict the Earth as a circular shape and talk about the “round” Earth or a “circle” in their interviews. Only one child differs: “*I drew the Earth, which looks like my ball*”. Most of the children of this class include representations of some geophysical features of the Earth (sea, water, mountains, soil) and invent various symbols to depict them, while they also talk about them (see figures 1a, 1b, 2a, 3b & 3c). Furthermore, several children depict people and houses at different points of the circle: peripherally, in the lower part or only in the upper segment of the circle (figures 1a, 1b & 3c). They draw various heavenly bodies, like the sun, the moon and the stars as well as the “sky” or the clouds (figure 1b). Only on few occasions do they appear inside the drawing of the Earth (figure 1b), or are drawn twice, for example a double sun or double clouds, within and outside the Earth (figures 1a & 3b). In order to depict “the Earth in the day” and “the Earth at night” they use bright and dark colours (figures 3a) as well as the respective heavenly bodies, namely the sun, the moon and the stars (figures 3b & 3c). Only one child tried to depict some kind of Earth movement by inventing a symbol –the “helical lines”. The child used the symbol in both drawings (figures 2b & 3a)

TABLE 2

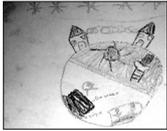
Categories of 'symbols'

1.	Earth's shape: round
2.	Geophysical features: sea, water, mountains, soil
3.	Heavenly bodies: sun, moon, stars (mainly outside but also within the Earth or both)
4.	Clouds, “sky” (mainly outside but also within the Earth or both)
5.	People, houses (various positions)
6.	Day: bright colours, sun
7.	Night: dark colours, moon, stars, ‘the sun is sleeping’, ‘children are sleeping’
8.	Movement of Earth: helical lines

Their graphic representations of the Earth are possibly influenced by “pictures” of the Earth, either realistic or less realistic, with which they became familiar on other occasions in their everyday life. In some cases, their graphic representations are closer to realistic models, such as the globe or pictures of the Earth included in reference books (figures 2a & 3c left). In other cases, their representations are closer to unrealistic models, like UNICEF pictures, which children in Greece frequently see in

their surroundings (figures 1a, 3b & 3c right). There are cases where both tendencies are present (figure 3c). However, there are drawings and symbols not reminiscent of familiar “pictures”, which seem to be children’s attempts to communicate their complex mental representations of the Earth, as it happened with Christina, who made a drawing (figure 1b) dividing the Earth into 4 segments and, in combination with her oral description, she revealed a set of ideas: the Earth contains water and soil (“upper” part of the circle), the houses are in the “lower” part, the sky and the clouds are inside the circular shape, whereas more clouds appear outside and along the periphery of the circle. According to her comments accompanying her drawing (figure 1b), Christina consciously selected to draw clouds within and outside the Earth, without realizing any inconsistency in her drawing.

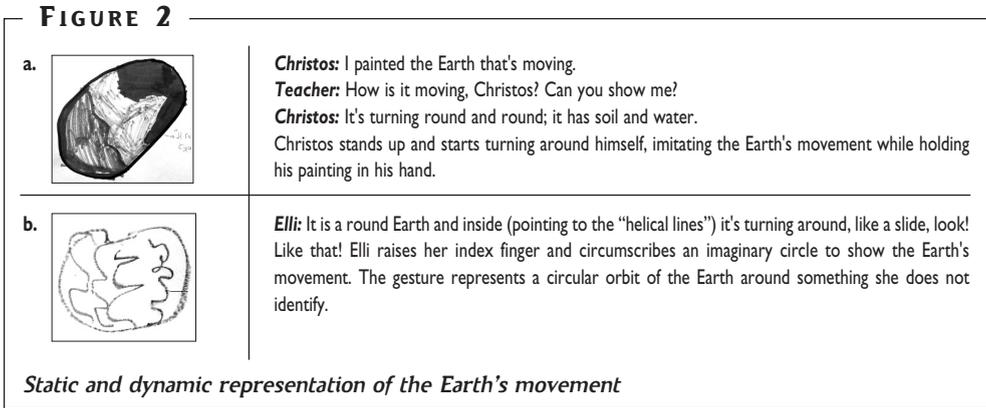
FIGURE 1

<p>a.</p> 	<p>Katerina: I drew a round Earth; some people live in the one half and some others in the other half. And the Earth has sea and soil.</p>
<p>b.</p> 	<p>Christina: I drew a round Earth and I put some houses underneath because the houses are on the Earth. There is soil and a lot of water and the clouds are all around Teacher: And what are these? (showing the clouds within the circle) Christina: they are the clouds we see from our house</p>

Representations of the Earth and respective descriptions

A2. “...the talk feeds into the drawing... the drawing feeds into talk...” (Cox, 2005 p. 123)
 It is interesting to highlight the way in which the idea of the Earth’s movement emerges from the drawing activity of two children. Christos (figure 2a) draws a round Earth and fills it with brown and blue colours in order to indicate the “soil” and the “water” of the Earth, although he has not found any symbol indicating the Earth’s movement. However, the oral presentation of his drawing shows that he considers the movement as a primary characteristic of the Earth and, as a result, he completes with words what he would really like to “say” through his drawing. On the other hand, Elli (figure 2b) has invented a graphic symbol of her own, the “helical lines”, in order to declare the Earth’s movement, though she does not seem to describe it very well in words. These two children display different representations of the Earth’s circular movement, since they present it in different ways. Christos refers to the Earth’s rotation around itself and Elli to the Earth’s revolution around the sun (without directly referring to the sun). While Christos creates an incomplete static iconographic representation, which he completes verbally by describing the Earth’s

rotation, Elli creates a 'dynamic representation' of the movement, which helps her talk about the Earth's rotation.



However, both children complete their drawings and oral descriptions with body movements and gestures; Christos uses his entire body, while Elli her finger. It is only then that what they want to say becomes clear (figures 2a & 2b).

According to some researchers (Kress, 1997; Cox, 2005; Wright, 2007; Robbins, 2009), several children use lots of different ways at the same time, which support one another, in order to represent their thinking. This example showed that the specific children used simultaneously three different contexts of communication, namely oral speech, drawing and gestures –particularly popular at this age– so as to express their definitive ideas about the Earth.

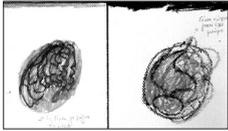
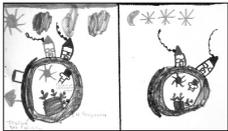
A3. Drawing opposite situations

In the second drawing activity the children were asked to depict their ideas about "the Earth in the day and the Earth at night" on a piece of paper divided in two parts. Such tasks inviting children to draw opposite situations are reported (Maxwell, 2006 in Einarsdottir et al., 2009) to provide the children with additional opportunities for expressing and clarifying their ideas about the subject of the activity.

Two main tendencies prevailed in the specific class. Most of the children drew two, almost identical, pictures of the Earth, adding to each of them the symbols (Table 2) they considered that differentiated the night from the day (figures 3a, 3b). In her drawing, Katerina (figure 3b) included two identical earths, while the only differences between the two drawings were the sun in the one drawing and the moon and the stars in the second. On the other hand, other children produced two completely different representations, as it happened with Theocharis (figure 3c). He depicts the Earth at night (right) with lots of children around the Earth "...who are going to sleep"

and a moon (the semicircle above the Earth to the left), while the Earth in the day is depicted in a more realistic way, including “water” and “countries”, the “sun” and “clouds” all around.

FIGURE 3

<p>a.</p> 	<p>Elli uses blue and black colours in order to represent the sky in the day and at night, respectively. The 'helical lines' indicate the rotation of the Earth, as in her first drawing (figure 2b). “The Earth is blue in the day” (left); “it is night because it is black” (showing the sky to the right)</p>
<p>b.</p> 	<p>Katerina: In the day I drew the sun and houses around, and the night the moon and the stars. Some people live in the one half and others live in the other half ... and when the sun is out, it is day.... Teacher: What about the other half, Katerina? Katerina: It is night.</p>
<p>c.</p> 	<p>Theocharis: The Earth is round and has a lot of things inside, I made it large with the water and the countries; the Earth has a lot of countries. On Earth in the day there is sun and clouds; when it ends it is night and little children all around go to sleep.</p>

Different representations of the Earth in the day and the Earth at night

During the description of their drawings, two tendencies were noted again. At first, there were several children simply describing characteristics of the day and the night. Elli is one of them (figure 3a). This activity must not have been particularly challenging for her. On the other hand, the activity made some of the children think and talk in their own way, spontaneously, about the phenomenon of the day/night cycle (figures 3b and 3c). Katerina (figure 3b) followed an indirect way. When she talks, she describes a single Earth in half of which it is day and in the other half it is night at the same time, while in her drawing she seems to represent these two sides of the Earth. In his comments, Theocharis presents different interpretations. He provides a phenomenological explanation: “*During the day the Earth has the sun and the clouds...*”, then he talks about the sun that is leaving: “*...when it leaves, it is night...*”, and he finally refers to everyday human activities: “*...and the children all around go to sleep*”.

B. The context of group discussion

Some typical excerpts from activities including group discussions will be presented below, while the way in which these activities affected the emergence of children’s ideas will be highlighted.

B1. The children provide the narrator of the story with information about the Earth

In the first activity, immediately after the narration, the hero (doll) of the story asks for information from the children about the Earth. In this discussion the children talked mainly about a round Earth and referred to geophysical features and to various astronomical elements (sun, moon, planet, star, space). The following excerpt is the last part of this discussion, in which additional dimensions of some children's thinking and experiences emerge.

Athanassia: I'll tell you that! The Earth is round.

Fani: It is like a ball.

Elli: Yes, it is a ball and it goes round.

Christos: Yes, it is like that, the documentary says so too, and when it turns around, people don't get dizzy.

Heracles: Look there, it is like that (showing the Globe in a corner of the classroom).

Maria: I see it's round in my brother's books.

Katerina: I watch the television, which shows about the Earth.

Elli: We have the Earth in the computer, teacher!

Theocharis: Yes, we can see it and it's round.

While the children had been continuously talking about the round shape, Fani's comment, which compared the Earth with a "ball", probably helped Elli and Christos to recall some ideas about the Earth's movement. Indeed, when Christos referred to the documentary (where he had found the information about the Earth's movement), the other children on impulse also referred to the sources they had obtained the relevant knowledge from. Thus, already from the first activity it was revealed that some ideas several children of the group had, came from different sources, such as books, documentaries, computer, television and the globe.

The way in which the context of the group discussion could help the children recall previous knowledge and experiences becomes quite clear, since a child's comment can provide the discussion with new material and act as a stimulus or as a reminder, thus leading to the formulation of more views (Einarsdottir, 2005; Dockett & Perry, 2007).

B2. The children show where the people live on the wooden sphere

In the fifth activity all the children selected the globe as the representative shape of the Earth, without naming it. The ensuing long discussion showed that they confuse the terms "round", "circle" and "sphere". Shortly later, holding the sphere (the wooden geometrical body) in her hand, the teacher invited the children to show her where the people live on Earth. Table 3 depicts some children's responses during this group discussion as well as children's drawings (Activity 2) of the previous day. It should be

noted that only a few children had drawn people or houses in the drawing depicting the Earth.

TABLE 3

<i>Children's responses to the question "Where do you think the people live on Earth?" and respective representations in their drawings</i>	
Responses (Activity 5)	Drawings (Activity 2)
Theocharis: Down and in the middle.	People sleeping on the boundaries of the Earth, directing to the centre (figure 3c).
Katerina: Everywhere and up and down and to the right.	Almost the same representation (figures 1a, 3b).
Elpida: Not to the top because it's cold, it is the North Pole; nor in the lower part because it's hot.	No people are drawn.
Christina: There are no people in the sea.	Houses in the lower segment of the circle (figure 1b).
Christos: People live inside the Earth and there is gravity and we do not fall off.	No people are drawn (figure 2a).
Savvina: The Earth is also a round sphere turning slowly and we cannot understand it and we do not fall off.	No people are drawn.

Table 3 presents three tendencies: the children that remained consistent with the ideas expressed in their drawings (Activity 2), like Katerina, the children that formulated contradictory ideas, like Theocharis, and the children that formulated complementary ideas because they had not drawn any people or houses before, like Christos, Savvina and Elpida. Of particular interest is the case of Savvina, who had never referred to the spherical shape and the movement of the Earth in her previous activities. Here, Christos' preceding comment (Table 3) made her recall ideas about the Earth' shape and movement she already had but had not formulated until then. Another interesting remark emerging from the above conversation is that the children do not express their views independently, but are based on the comment of the previous speaker, either completing them (Katerina) and analyzing their view (Savvina) or disagreeing with them (Elpida). This example shows once again the dynamic of group discussion as a means for exploring children's ideas.

It could be said that the activity with the solid geometric shapes and the ensuing group discussion provided some children with the opportunity to express additional ideas –either contradictory or complementary– about the Earth, which had not been revealed in previous activities.

B3. The children are talking about the sun

In Activity 6, the discussion at some point was focused on the sun, for it was the

prevalent symbol in their drawings and their explanations about the day/night cycle. An excerpt from this discussion is given below.

Teacher: Where is the sun?

Christos: The sun is in the sky. What do you think, teacher, in the Earth?

Elli: Up in the sky.

Dimitris: Teacher, the sun is in the East.

Athanassia: In the East, behind the mountains.

Theocharis: It turns around, everybody around the Earth.

Christos: No, Theocharis, the Earth turns around itself and around the sun.

Teacher: Does anybody else agree with Christos?

Christina: No, teacher, the sun just turns around.

Christos: And the Earth turns a little bit.

Teacher: Where do you think the sun is in the day or at night?

Elpida: The sun is high up in the sky and keeps turning.

Fani: Sometimes it hides behind the clouds.

Dimitris: Look, now there is no sun. The clouds have hidden it.

Apostolis: It is behind the trees.

Teacher: You say that the sun is somewhere and that's why we cannot see it?

Dimitris: Yes, it's moving and that's why it has hidden in the clouds.

Thodoris: It also hides in the mountain.

Christos: What are you talking about? The sun does not move – the clouds move.

Teacher: And where is the sun at night?

Maria: At night it hides and goes to sleep.

Fani: When it is not day, it is sunset.

Heracles: At night the sun goes and the moon comes.

Niki: Children should sleep at night. There are stars as well.

Theocharis: Teacher, when it is day here, in Africa it is night.

Christos: It is night in Canada, too.

Teacher: Why do you think this is so? I mean, why when we have day, other countries have night?

Savvina: Because the sun may not be able to light Africa and they have darkness.

Dimitris: Because the clouds hide it.

Niki: Because it can't be always day. Little children should go to sleep and wake up to go to school.

Christos: Because, I told you teacher, the sun does not turn. The Earth turns. I'm bored of saying the same thing.

The discussion is particularly interesting. To be more specific, almost all the children of the class participated. Seven children, which had not managed to express themselves

on the phenomenon of the day/night cycle in the personal interview (Activity 3), formulated their opinions in this group discussion (e.g. Fani, Niki, Apostolis). Several children expressed additional ideas about the sun and the day/night cycle. In general, the view that the sun hides somewhere (in the “clouds”, in the “trees”, in the “East”, etc.) prevailed. Some children for the first time referred to a movement of the sun (e.g. “goes”, “moves”, “turns”). Three children (Theocharis, Savvina and Christos) seemed to adopt the view that at the same time in one place it is day while in another place it is night—a view expressed only by Katerina in the personal interview (figure 3b). Finally, only one child continued insisting throughout the discussion that the Earth keeps turning—a view he had expressed in a previous activity as well (Christos, figure 2a).

DISCUSSION AND PERSPECTIVES

The present research paper studied the “context” of the ‘eliciting process’ regarding children’s ideas about natural phenomena in the Kindergarten. The ways in which different types of activities exploring children’s ideas on the Earth’s shape and the day/night cycle functioned were presented as they were exactly implemented in a specific class. The most important findings of the research will be summarized below, focusing on the special characteristics of the two types of activities (drawings and group discussions) and the overall process, which functioned in a rather positive direction regarding the emergence of children’s ideas. Finally, proposals and perspectives on investigating natural phenomena in the Kindergarten will be formulated.

Communication trick

The six activities functioned in a complementary way and acquired a specific meaning, as there was a certain reason for their implementation, that is, the children to communicate all the things they knew about the Earth to the hero of the story. This communication trick, which accompanied all the activities, seemed to have acted positively, since the children participated actively in all activities. A typical example is the discussion held about the sun (Activity 6), in which all the children of the class participated and expressed their views.

Drawing activity

The major research tool was the drawing activity (Activity 2), which was exploited in all the following activities as well.

The first drawing of “the Earth” and the variety of the resulting symbols helped the collection of a considerable amount of data concerning children’s ideas and the initiation of discussions that provided additional data. In some cases, their graphic

representations of the Earth revealed influences from realistic or less realistic “pictures” of the Earth, which the children are faced with in their everyday life, while in other cases they revealed children’s efforts to express more complex thinking.

The second drawing, “the Earth in the day and the Earth at night”, did not produce lots of “graphical” responses concerning children’s thinking on the phenomenon of the day/night cycle. In fact, this activity was not particularly successful in revealing the ideas of all the children of the group about the specific phenomenon. However, it was clear that the illustration of the two opposite situations served as a challenge for some children who they managed to think and spontaneously express their ideas on the phenomenon of the day/night cycle.

On the whole, the drawing activity seemed to help lots of children in expressing their ideas (spontaneously or following a challenge) in words or, in certain cases, through gestures (Kress, 1997; Wright, 2007, Robbins, 2009). When the children talk to others about their drawings, they do not always refer only to what they have drawn, but they frequently expand the discussion to contents not graphically represented (Kress, 1997), as it happened in the cases of Christos (figure 2b) and Katerina (figure 3b).

The evidence confirms that drawing is a valuable tool for exploring children’s ideas, as already supported by several researchers (Docket & Perry, 2007; Einarsdottir et al., 2009; Robbins, 2009). In their attempt to draw, the children start recalling knowledge, ideas and previous experiences, while at the same time they construct graphic “symbols” in order to communicate their thinking. The pictures they create are helpful for the assessment of their thinking, always in combination with their oral comments or even their gestures, with which they try to complete the messages they want to convey.

Group discussions

Group discussions must have created a common context of communication, thus gradually improving communication between the children. On several occasions, they helped children recall additional ideas and experiences that they had not expressed in previous activities. Quite a lot of times a child’s comment served as a challenge for the continuation of the discussion and the exposure of their ideas about other aspects of the subject, like the sources of some of their ideas about the Earth (Activity 1), or for the formulation of additional ideas, like their views on where the people live on Earth (Activity 5).

Moreover, group discussions provided extra opportunities to some children, which had not managed to effectively express themselves through drawing, in order to reveal their thinking, as it happened during the discussion about the sun (Activity 6). The findings of this study bring out the dynamic of group discussions regarding the exploration of children’s ideas, and support some other researchers’ opinion that in

this way a better and more substantial access to children's thinking becomes possible (Fleer & Robbins, 2003; Robbins, 2005a; Einarsdottir, 2005; Dockett & Perry, 2007).

A variety of activities and a wide range of children's ideas

The findings showed that the children of this class had a wide range of ideas –sometimes contradictory– about the Earth and the day/night cycle, which were expressed in a number of ways. Previous research, conducted through personal interviews in a narrower context (Valanides et al., 2000; Kampeza, 2006), had not revealed such a variety in children's thinking. Traditional methods usually record children's initial responses to the researchers' questions, while in some cases they do not ascertain the way they think (Fleer & Robbins, 2003). In the present study, it seems that the variety of activities allowed the children to express their ideas with the help of different means and at different phases of the process. Fleer (1997) also used alternative research tools and revealed a wide range of children's ideas about the day/night cycle, but, as she mentions, the research process did not achieve to depict the sociocultural dimensions of children's thinking. Besides, in that case the research method was not implemented in a Kindergarten class but once again involved personal interviews.

Another interesting finding, connected with the variety of ideas in this class, resulted from the present study. Some children's ideas, as expressed in different activities, were contradictory. Other researchers (Schoultz et al., 2001; Nobes et al., 2003) attribute these contradictions in children's thinking to the fact that their representations are a mixture of experiences and information from various sources (adults, pictures, books, beliefs, etc.) accessed by the children.

Implications for research and practice

Interesting pedagogical perspectives result from the present study on teaching natural phenomena in the Kindergarten.

First, the integration of the 'eliciting process' into the science teaching program design appears to be indispensable as part of the sociocultural approach to learning and teaching. As shown by the present study, according to its composition, a group of children displays some certain characteristics, which should be taken into account in any educational intervention design.

Second, the design of an in-depth exploration of children's ideas may be based on the relevant literature, which analyzes methodological aspects concerning research on children's thinking (e.g. Fargas-Malet et al., 2010). One of the aspects that seems to be of particular importance for designing the relevant process and activities is the perspective on providing the children with a variety of means of expression and communication (Barker & Weller, 2003; Fleer & Robbins, 2003; Einarsdottir, 2005;

Smith et al., 2005; Robbins, 2005a). In the present study it became clear that the drawing activity and the group discussions served as alternative perspectives on children's expression. It is also really important that the design of the process and the activities be based on the sociocultural characteristics and habits of the children it addresses, so that the activities can have some meaning for the children, be close to their experiences and trigger their interest as well as help them represent and communicate their thinking.

The particular features of the concept or the phenomenon seem to also play a crucial role in the selection of activities. In the present study, the activity with the solid geometric shapes (Activity 5) was necessary, as already shown by previous studies (Vosniadou & Brewer, 1992; Valanides et al. 2000; Kampeza, 2006), because the drawings did not allow the children to fully present their views on the Earth's shape (flat or solid), while, on the other hand, the children appeared to confuse the terms "round" and "sphere".

Third, exploring children's ideas in a Kindergarten class, under the conditions already described, does not only provide the teacher with the ideas of a specific group about a natural phenomenon, but also, as revealed in the present study, with additional useful information about the children and the group, such as the ways of expression and communication preferred by certain children, the aspects of the subject that probably interest them more, the sources of their ideas or of some of them, juxtapositions and conflicts between the children, etc. The teacher can exploit the additional information together with the children's ideas when designing the following learning activities for the investigation of the phenomenon.

Finally, it is considered of great interest that the different aspects of this educational perspective on teaching natural phenomena in Kindergarten classes be studied in the future using structured educational designs (exploring children's ideas, learning activities, implementation, evaluation) regarding other natural phenomena or concepts as well as a variety of kindergarten classes comprising students of different socio-cultural backgrounds.

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