

Is the Earth Flat or Round? Primary School Children's Understandings of the Planet Earth: The Case of Turkish Children

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Abstract

The purpose of this study is to explore primary school children's understandings about the shape of the Earth. The sample is consisted of 124 first-graders from five primary schools located in an urban city of Turkey. The data of the study were collected through children's drawings and semi-structured interviews. Results obtained from the drawings showed that only one third of the participants have drawn scientifically acceptable images of the earth. However, the subsequent semi-structured interviews revealed that more children have scientific knowledge about the shape of the Earth. The results also revealed that cartoons, story books and daily life experiences are the reasons for children's misconceptions.

Keywords: Drawings of earth, children's drawings, children's conceptions of planet Earth

Introduction

Over the past four decades, children's understanding of natural phenomena has become one of the major issues in science education. Research has revealed that children experience difficulties when learning scientific concepts (Abrams 1997; Posner et al., 1982) and they possess scientifically inaccurate or incomplete conceptions about the world (Clement, 1982; Henriques, 2002; Osborne & Wittrock, 1983; Posner et al., 1982). Different terms have been used to refer this type of knowledge- such as preconceptions (Ausbel, 1968), misconceptions (Novak, 1987); alternative framework (Driver & Easley, 1978), children's science (Gilbert, Osborne & Fensham, 1982), naïve beliefs, (Caramazza, McCloskey & Green, 1981) mental models (Collins & Gentner, 1987; White & Fderiksen, 1986), folk theories (Kempton, 1987), and intuitive theories (McCloskey & Kargon, 1988). Although different kinds of terms have been used to define unscientific theories, there is a general agreement that this intuitive

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knowledge provides explanations of natural phenomena which are frequently different from the currently accepted scientific definitions. Children's conceptions are formed by daily life experiences, perceptions, cultural influences and language use long before they begin formal education (Duit & Treagust, 1998; Vosniadou & Brewer, 1994). Children's misconceptions are pervasive, stable and resistant to change (Haslam & Treagust, 1987; Osborne, 1983). Moreover, they may block understanding of scientific concepts and hinder further learning (Hewson & Hewson, 1983; Shuell, 1987). For meaningful learning to occur, children should relate new knowledge with previously learned ones (Duit & Treagust, 1998). Thus, misconceptions should be taken into consideration in all stages of formal education to eliminate the old ones and to prevent the development of similar ones.

Astronomy is one of the oldest and the most popular science field that involves many concepts that can be incorrectly interpreted and learned by children. Astronomy takes an important place in science education because it has a relation with the Earth, space and nature. Conceptual understanding about the shape of the Earth, including alternative conceptions has been studied with educational researchers for many times. Children's drawings have been frequently used as a methodological means for their understanding of the concept Earth (Nussbaum & Novak, 1976; Sneider & Pulos, 1983; Vosniadou & Brewer, 1992). Research in this area revealed consistent results across different countries and cultures. However, this knowledge was also inconsistent with the scientific ones. In their study, Vosniadou and Brewer (1992) determined five types of unscientific models of the Earth. Researchers defended that flat Earth, rectangular Earth and the disc Earth are the initial models that children use before they receive information about the planet Earth. When children obtain some information about the shape of the Earth, they usually try to assimilate new information with their preexisting schema and they develop synthetic models such as the dual Earth and the hollow Earth. In the hollow Earth model, children represent the Earth spherical with a flat surface with people inside it whereas in the dual Earth children draw two earths; one being a flat surface on which people live and the other round and located in the sky. These findings are consistent with the findings from different cultures (Brewer et al., 1987; Samarapungavan, Vosniadou & Brewer, 1996; Sneider & Pulos, 1983; Vosniadou & Brewer, 1990; 1992). Although there exist some cultural variations, research demonstrates a universal tendency for young children to believe that the world is flat or flattened.

A number of recent studies have raised doubts about the mental models obtained from the previous research studies. Schoultz, Saljö, and Wyndhamn (2001) used interviews to explore children's conceptions about the shape of the Earth. In their study, researchers reported that even young children have scientific conceptions about the Earth's shape. Additionally in various studies researchers asked children, to select the plastic model representing the Earth's shape (Nobes et al., 2003; Panagiotaki, Nobes & Banerjee, 2006) and to select pictures that represented their view of the Earth (Straatemeier, van der Maas, & Jansen, 2008). In all these studies, researchers have reported that they have found little or no evidence of naïve mental models. Thus, they concluded that children have more knowledge about the Earth than the mental theorists indicated. Obtaining different results directed researchers to think about the instruments used to determine children's conceptions about the shape of the Earth. Siegal, Butterworth and Newcombe (2004) argued that using children's drawings might lead to overrepresentation of a flat Earth concept among children due to the difficulties in drawing a sphere. Moreover they also questioned whether a drawing of a person standing on a flat surface indicated that children believe that the Earth is flat.

Children's cognitive development can be studied by many approaches such as open-ended questions, two-tier diagnostic tests, concept maps, word association tests etc. Children usually experience difficulties in expressing their thoughts and their explanations are easily

affected by the types of questions asked and researcher's attitudes. For these reasons, using these data collection methods bring some deficiencies together. Additional to these tools, using children's drawings to probe their understandings can provide fruitful information about their representational world (White & Gunstone, 2000). Children's drawings have been a focus of research for many decades. Drawings are usually used for cognitive, personality and diagnostic assessment (Knoff & Prout, 1985; Naglieri, 1988). Previous research studies proved that drawings can be used to provide rich data on children's understandings of various science concepts; such as water cycle, groundwater, rivers, mountains, and their alternative conceptions (Bar, 1989; Coates, 2002; Cuthbert, 2000; Edens & Potter, 2003; Golomb, 1992; Hayes, Symington & Martin, 1994; Moline, 1995; Rennie & Jarvis, 1995; Sneider & Pulos, 1983; Stromment, 1995; van Meter, 2001; Vosniadou & Brewer, 1992). Reith (1997) explains that "drawings are believed to reflect the subject's mental representations and conceptual knowledge about the objects they draw. Drawings become more accurate and detailed as children's mental models of the world become more extensive and differentiated." (p. 61). Previous research studies also revealed that using drawings to elicit children's understanding would have some limitations. Children's drawing abilities limit what they produce in their drawings. Understanding a concept, or having a scientific knowledge about it, does not necessarily mean children can and they will draw it accurately (Arnold, Sarge & Worrall, 1995). In his study, which is focusing on biodiversity, Strommen (1995) found that children tended to draw multiples of a single type of animal or plant rather than different species, although they knew names of different kinds of animals and plants. Additionally, especially in the early childhood, children's drawings may be misinterpreted by the researchers due to the lack of clarity in the images. Because of these limitations researcher prefer to use interviews in conjunction with drawings. This combined methodology have been used successfully to explore children's ideas about concepts such as technology (Rennie & Jarvis, 1995), water cycle (Dove, Everett & Preece, 1999) and evaporation (Schilling, McGuigan & Qualter, 1993). In the current study, researcher preferred to use this data collection method to overcome the deficiencies that may come up with using either methods alone.

Aim of the Study

Astronomy is an important component of the Turkish science and technology curricula throughout different grade levels. The current curricula include concepts about solar system, movements of the sun, earth and moon, formation of a day and seasons, shape and size of the planet Earth. Understanding the shape of the Earth is a part of the 4th grade Turkish science curriculum. As a part of the science curriculum, students are expected to define the shape of the Earth, give some daily life examples supporting the spherical shape of the Earth and realize that in the history, people have naïve theories about the shape of the world. Turkish children faced with the formal instruction about the shape of the earth for the first time in the fourth grade. Thus, for an effective instruction to occur, it is important to determine children's (pre-) conceptions about the shape of the Earth.

With this respect, the purpose of this paper is to investigate Turkish first grade children's conceptual knowledge about the Earth's shape. The purpose was to understand the nature of children's initial knowledge about the shape of the Earth. The study reported in this paper sought to specifically examine the data gathered from the primary school children with the following research question in mind: How do first-graders conceptualize the shape of the Earth?

Method

Sample

The research was carried out in the fall semester of 2011-2012 academic year. A total of 124 first-graders at five primary schools in an urban area of Turkey have attended the study. The children were between 6 to 8 years old with a mean age 7.4. (sd= 5 months).

Procedure

The data of the study were collected by children's drawings. Drawing is a powerful qualitative tool to determine how children explain and construct ideas and concepts. Not to cause any confusion whether they were required to draw the Earth from the global perspective or the local perspective, the researcher invited children to draw the Earth as if they were watching it from the space and write what is happening. As some of the earlier mentioned literature have revealed, when children are asked to include people and the sky in their drawings, they experience confusion about the perspective in their drawings. For this reason, the researcher only focused on children's conceptions about the shape of the Earth. The drawings were completed within a regular lesson which lasted in 40 minutes. Children were asked to work individually and not to perceive the task as a test with right or wrong answers. Children were provided a drawing sheet to work on it and allowed to use any colours of crayons. Since children at these ages may lack adequate writing skills, additional information was gathered by interviewing the children while they were drawing the Earth. This method was preferred as data collection technique to prevent the probability of losing children's considerations during the drawing process. Drawing tasks in combination with an interview provided an opportunity to utilize two methods of determining students' understanding about the shape of the Earth. While they were drawing, children were interviewed in a semi-structured way and the discussions were typed. For the interview, questions are designed according to the child's own interest, but they also focused on the children's understanding of the Earth and their choice of pictorial convention. Sometimes, it was difficult to determine the images children drew on their working sheet. Interview questions were also used to clarify these ambiguous images. Additionally, children were also asked the source of their knowledge. Initial questions in the interviews aimed at understanding what images the children have drawn in their drawings. Follow up questions were used to clarify the responses which are difficult to understand. To elicit further information the children were given the opportunity to tell more about their drawings.

Analyses

Visual and verbal data were analyzed by content analysis techniques (Ball & Smith, 1992; Banks, 2001). Before coding, the researcher overviewed all the drawings and read the transcriptions of interviews to get general ideas and to determine meaningful data units. Then, a list of codes was created by noting all the features included in the drawings and interviews. Throughout the analysis this list was revised as new features were identified. After coding the data, categories were emerged. The codes were compiled into categories; i.e. codes were organized under related categories. The researcher overviewed all the transcripts again to validate the appropriateness of codes and categories emerged. The data obtained from drawings and interviews were read and coded by another researcher; a specialist in primary school education. Inter-rater reliability was calculated as 89%.

Findings

Drawings of Spherical Earth: The largest group of participants ($n = 51$, 41.13%) drew this version of the Earth. In their drawings they usually included a spaceship coming closer to the Earth, some other planets and stars (see Figure 1). They usually included an astronaut inside or sometimes outside the spaceship. Children drew the spherical Earth and coloured the surface of it with brown and blue. When children were asked why they have used these colours for the surface, they replied that from the space, the surface of the Earth seems mostly blue, and this colour represents oceans and seas. However, there are also brown areas representing the land where people live on it. Children drawing spherical Earth did not include people in their drawings. When they were asked why they did not draw any people, they replied *"It's not possible to see people living on the Earth from the space"*. In their drawings, although children drew the shape of the Earth as a circle to represent its spherical shape, they drew the stars with a star polygon with five corners. Additionally, some of them drew the Moon in their drawings however in its waxing crescent phase. When the researcher asked the reason of drawing the Moon in that way, children replied that Moon has several phases and it is possible to observe the phases of the moon from the space. Children were also asked about the real shapes of the stars. All of the children including stars in their drawings replied that they don't know the exact shape of the stars. They also replied that in their story books, stars are drawn with a star polygon. And when they look up the sky at night, they can see the sparkling stars. Based on these information they concluded that probably stars do not have a regular shape like the planets have.

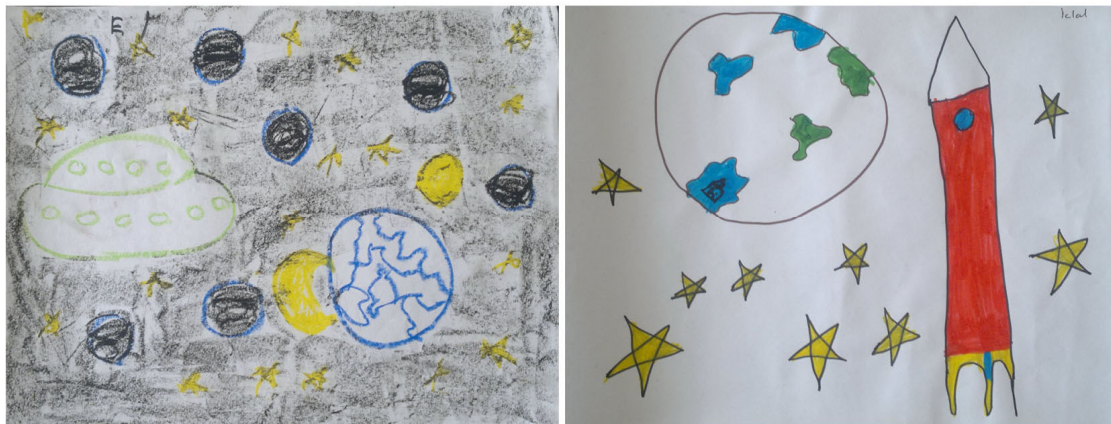


Figure 1. Example Drawings of Spherical Earth

Drawings of Flat Earth: Nearly 21% of children; that is 26 of them, drew a flat Earth. They showed one or more people, usually with buildings, mountains or trees. In all of the drawings people stood on a straight line representing that children believe that the Earth's shape is a plane or a disk. All of these pictures were similar to the children's drawings that Vosniadou & Brewer (1990, 1992) have interpreted as indication for flat Earth mental models. All children drawing flat Earth showed evidences of spherical earth during the interviews. First, they were asked about the shape of the earth. All the children replied: *"The earth is round"*. When they were asked why they did not draw a circular shape, children replied that in this way: *"It is not possible to see the people living on the Earth"*. They made comments that in order to show the people, mostly themselves or their families, they had to draw the Earth in this way. Some of the children (11 of them, 8. 87%) commented that although the Earth is round in shape the lands in which people live on are flat. The tendency among this subgroup of participants with regard to their conception of Earth is this: The Earth looks straight and flat when we look

at our surroundings. They also expressed that we can see the Earth's roundness in downhill slopes. This finding is consistent with what Nussbaum (1985:179) found in his studies: Children who said that the Earth was round, but who believed that we lived on a flat Earth, explained the Earth's roundness by saying "The Earth's roundness is just the roads' curves' or 'The Earth's roundness is just the mountains' shapes". These findings shows that children cannot differentiate the astronomical conceptual framework of the planet Earth from the common sense framework of the Earth as nearby surroundings.



Figure 2. Example Drawings of Flat Earth

Drawings of Dual Earth: These pictures were drawn by 47 (37.90%) of the participants. In their drawings they drew both the scientific and the flat versions of the Earth. The subsequent interviews revealed that none of them believes in the existence of two Earths; one which we live on and the other which is a planet in the sky. Children were asked the reason for drawing two earths, instead of one. They replied that although they knew that the Earth is round, and there is only one Earth we live on, they also wanted to draw their home places with an Earth representation. The dual Earth pictures show separate views of the same earth, from the two different perspectives.



Figure 3. Example Drawings of Dual Earth

Discussion and Conclusion

This paper has presented data and discussed the the views of 124 Turkish first-graders about the planet Earth. Based on the results obtained from the children's drawings, it was able to

identify two alternative models of the earth: the flattened Earth and the dual Earth. Nearly 60% of the participants drew the unconventional scientific version of the Earth. The drawings show some variety among them however, they can easily be grouped into the alternative models of the Earth defended by the mental theorists. These findings are consistent with the results of prior research claiming that children have difficulty in understanding that the Earth is spherical and form various misconceptions regarding its shape (Nussbaum, 1979; Nussbaum & Novak, 1976).

By considering the results obtained from the interviews, however, it can be reported that children have some scientific knowledge about the shape of the Earth. The findings from this study seems to indicate that drawings provide a powerful tool to explore the children's conception of the Earth, but the information one can get from the drawings and the subsequent conversations about the drawings should be interpreted and used very carefully. Moreover, when the children were given the opportunity to give an account for the source of their knowledge about the Earth, Moon and the stars, almost all of the children said that they have seen how the earth is seen from the space on TV - mostly from cartoons and in their story books. Those of the children who represented the stars with a star polygon also replied that in their daily lifes they observe the stars as tiny and shiny dots in the sky. Thus, one may say that cartoons, the story books and the daily life experiences are the reasons for their misconceptions.

Exploring children's misconceptions about the nature and natural phonemenons and the sources of their knowledge may strengthen the teachers' efforts to improve their teaching practices with regard to science concepts. For meaningful learning to take place, teachers should consider what knowledge the learner already possesses (Gunstone, 1990). Knowing children's (pre-) conceptions will provide the teachers information about the children's mental models that they have constructed before the instruction. By this way it will be possible to create instructional methods, strategies and aids that may help the students to change the wrong mental models and construct meaningful and useful ones. To understand the natural world, children should be provided conditions for developing positive experiences, imagination, increased sense of wonder, creativity and observation skills. Science educators, should create such learning environments in which the children meet challenges that can encourage them to activate and evaluate what they already know in the light of scientific knowledge that they encounter in the school. By this way it will be possible to promote a conceptual development which is consistent with our existing scientific knowledge about the nature.

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