

## Drawings as representations of children's conceptions

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### Drawings as representations of children's conceptions

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## Drawings as representations of children's conceptions

### Introduction

Drawings are often used when our primary research interest is children's conceptions (e.g., Arnold, Sarge & Worall, 1995; Dove, Everett & Preece, 1999; Halldén et al, 2002; Klein, 1982; Sneider & Pulos, 1983; Vosniadou & Brewer, 1992). This tradition has recently received methodological and theoretical criticism. Dove, Everett and Preece (1999) discussed their own results in a study of children's understanding of a river basin, a concept linked to the water cycle. Drawings of snow-covered mountains with sharp peaks were common. Dove and colleagues questioned whether the children really believed that mountains were as they drew them, or if they were using a clichéd representation. They pointed to the fact that stereotypical images are not always incorrect representations, but there is a danger that this kind of picture prevents children from recognizing the rich variety in the real world. Siegal, Butterworth and Newcombe (2004) focused on a methodological problem in studies of children's conceptions of the Earth. They maintained that the use of drawings might lead to overrepresentation of a flat-Earth concept among children. They argued that children's difficulties in drawing a sphere could lead them to produce something that appears to be a flat Earth. They also questioned whether a drawing of a person standing on a flat surface indicates that children believe that the Earth is flat; rather, it may simply reflect the children's ambition to orient figures to baselines. From a socio-cultural standpoint, Ivarsson, Schoultz and Säljö (2001) have objected to drawings being regarded as mirroring underlying conceptions. Instead they argue that drawings should be looked upon as cultural tools, which contribute to answers. Vosniadou, Skopeliti and Ikospentaki (2005) responded to the criticisms of Siegal et al (2004)

1  
2  
3 and Ivarsson et al (2001) by pointing to the question of how drawings are used to get an idea  
4  
5 of children's conceptions. Studies by Vosniadou and colleagues analysed drawings together  
6  
7 with children's comments.  
8  
9

### 10 11 12 13 14 15 **Drawings as representation**

16  
17 **If drawings are to be used for learning about children's conceptions, we must know how**  
18  
19 **children represent their conceptions in drawings.** Piaget and Inhelder (1966/1969) described  
20  
21 children's representation as the semiotic function, which is the capacity to represent a  
22  
23 signified entity with the help of a signifier. They distinguished between symbols (i.e.,  
24  
25 signifiers that have some link to what they represent) and signs (i.e., signifiers that are  
26  
27 arbitrary and have a conventional relation to what they represent). Symbols can be creations  
28  
29 of the individual child, whereas signs are conventional and collective.  
30  
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32

33  
34 Luquet (1927/2001) argued that there are different methods of representation in  
35  
36 children's drawings. What he calls a *visually realistic* picture is like a photo, where what is  
37  
38 rendered is seen from one perspective. In *intellectually realistic* pictures children show what  
39  
40 they hold as the most important characteristics, and different techniques can be used for this.  
41  
42 To show parts of an object that cannot be seen from only one perspective, the child can use  
43  
44 transparency, plan view, folding out or mixed viewpoints. These techniques are illustrated by  
45  
46 the findings of Dove et al (1999) concerning the concept of a river basin. In their study, a  
47  
48 majority of the 306 children, aged 9 to 11 years, used mixed viewpoints in their drawings.  
49  
50 Mountains, trees, houses, fish and boats were depicted in side view; the river was either in  
51  
52 side view or seen from above, in plan view; the sea, the river's outlet and the roads were  
53  
54 shown in plan view. Although Luquet identified the techniques of intellectual realism in  
55  
56 children's drawings, they also appear in adults' pictures. Examples are architectural or  
57  
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60

1  
2  
3 technical drawings, whose producer shows the inside of an object or the same object from  
4  
5 more than one viewpoint. Therefore, Luquet questioned whether the different methods were  
6  
7 not better described as conventions from which the child chooses, than as steps in intellectual  
8  
9 development.  
10

11  
12 Investigating the role of conventions in art, Gombrich (1960/1977) argued that artists  
13  
14 describe the world with the help of a system of schemata. "[T]he starting point of a visual  
15  
16 record is not knowledge but a guess conditioned by habit and tradition" (Gombrich, 1977, p.  
17  
18 77). According to Gombrich, artists apply different schemata through corrections to their  
19  
20 initial picture. He argues that it is impossible to make a picture without having learned how to  
21  
22 do so from other pictures. Likewise, Thomas (1995) suggested that children's drawings  
23  
24 translate neither internal representations nor visual impressions. He cites studies showing that  
25  
26 better visual knowledge of an object to be represented does not improve children's drawing.  
27  
28 Rather, in order to make a good drawing the child apparently needs instructions on how to  
29  
30 draw that particular object. Presenting an absolute idea of pictures as conventions, Goodman  
31  
32 (1976) argued that pictorial representation is a conventional system of symbols to the same  
33  
34 degree as verbal descriptions are. According to him, resemblance is neither a necessary nor a  
35  
36 sufficient condition for depiction: the only criterion for representation is reference to an  
37  
38 object.  
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45  
46 Because a photographic or visually realistic picture is also a consequence of the choice  
47  
48 of a mode of depiction, this study views visual realism as one convention among other  
49  
50 pictorial conventions and genres. This implies that how children represent their conceptions is  
51  
52 a question of what convention they choose for depiction. In order to study how children  
53  
54 choose among drawing conventions to express their conceptions, a theory that includes both  
55  
56 cultural and cognitive aspects will be used. Halldén (1999) distinguished between different  
57  
58 contexts in children's learning of concepts. In a cognitive context, concepts are contextualized  
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3 in conceptual frameworks. Possible frameworks for the concept Earth are for example the  
4  
5 astronomical framework of the planet Earth and the common sense framework of the Earth as  
6  
7 nearby surroundings. In any situation, it is the acting person's judgement of different  
8  
9 explanations' relevance that leads to the actualization of a certain conception. In a cultural  
10  
11 context, verbal descriptions are contextualized in different speech genres or ways of talking.  
12  
13 In the same way, visual descriptions are contextualized in different pictorial genres, in which  
14  
15 different modes of depiction may be used. A biological drawing of a cell may be in a  
16  
17 transparent mode of depiction, in Luquet's terminology; intellectually realistic, while a  
18  
19 zoological bird drawing may be in a photographic mode of depiction, in Luquet's  
20  
21 terminology; visually realistic.  
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### 32 **Aim of the study**

33  
34 The aim of this study is to investigate how children represent their conceptions in drawings.  
35  
36 This means that different contexts will be considered. Children's drawings will be seen as  
37  
38 contextualized in pictorial conventions, and children's conceptions will be seen as  
39  
40 contextualized in conceptual frameworks. To become aware of how children represent their  
41  
42 conceptions in drawings, we will study how children choose pictorial conventions to represent  
43  
44 their conceptions in a given situation.  
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### 53 **Children's conceptions of the Earth**

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55 One area where children's conceptions are well researched and where drawings have been  
56  
57 used as a methodological means for such research is the understanding of the concept of  
58  
59 Earth. Studies in a constructivist tradition have shown that children may have trouble  
60

1  
2  
3 understanding a scientific astronomical concept of the Earth (e.g., Mali & Howe, 1979;  
4  
5 Nussbaum, 1979; Nussbaum, 1985; Nussbaum & Novak, 1976; Sneider & Pulos, 1983;  
6  
7 Vosniadou, 1994; Vosniadou & Brewer 1992). Children are said to often use alternative  
8  
9 models based on interpretations of their own experiences. Vosniadou and Brewer (1992)  
10  
11 described five such models of the Earth. The rectangular Earth and the disc Earth are initial  
12  
13 models that children use before they receive information about the planet Earth. When  
14  
15 children are informed about the planet, they may combine this information with suppositions  
16  
17 based on their earlier experiences. In this process, according to the research by Vosniadou and  
18  
19 Brewer, synthetic models (i.e., the dual Earth, the hollow Earth and the flattened sphere) may  
20  
21 appear.  
22  
23  
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26  
27 Halldén and colleagues (2002) introduced a model for conceptual differentiation through  
28  
29 contextualization. They propose that the problem for children is finding the appropriate  
30  
31 conceptual framework for different pieces of information about the Earth. During the process  
32  
33 of differentiation, children gradually realize that we can talk about the Earth in different  
34  
35 conceptual contexts e.g., in a common sense framework and in an astronomical framework.  
36  
37  
38 Contrary to the model of Vosniadou and Brewer, Halldén and colleagues maintain that the  
39  
40 process of differentiation does not involve the child's abandoning the concept of a flat Earth  
41  
42 in favour of a scientific concept. Rather, children use the conception of a flat Earth in their  
43  
44 everyday surroundings; but at school (e.g., in science classes) they might use the concept of a  
45  
46 spherical planet. In addition to the differentiation between a theoretical framework and a  
47  
48 common sense framework for some concepts there may be a need to differentiate between  
49  
50 different theoretical frameworks. For example concepts related to natural resources are often  
51  
52 contextualized in either a biological framework or an economical framework. This description  
53  
54 of concept formation is in line with constructivism, as it attributes conceptions to the  
55  
56 individual. However, like socio-cultural researchers' view, this model acknowledges the  
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1  
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3 decisive role of physical and cultural surroundings, as the individual applies a conception in  
4  
5 line with her or his own understanding of the situation.  
6  
7

8 When the aim of this study is described in a theory of contextualization, with children's  
9  
10 understanding of the Earth as empirical example, the following research questions are formed:  
11

- 12 1. How do children contextualize their conceptions of the Earth in conceptual frameworks?
- 13 2. How do children contextualize their drawings of the Earth in pictorial conventions?
- 14 3. How do they relate the contextualization of their conceptions of the Earth to their  
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contextualization of their drawings in pictorial conventions?

## Method

Data to describe children's contextualization of their conceptions in conceptual frameworks,  
and to contextualize their drawings in pictorial conventions, were obtained by interviewing  
children in Sweden while they were drawing the Earth. This method was preferred to a  
technique that would have interviewed children about their drawings after they were finished,  
because it was presumed that the children's considerations during the drawing process might  
otherwise be lost. Eighteen children with varied social backgrounds from urban, but not inner  
city, surroundings were interviewed. The children were from six to nine years old. All  
participating children volunteered, with their parents' consent, to take part in the study after  
they and their parents had been informed of the study. While they were drawing, the children  
were interviewed in a semi-structured way. The interviews were intended to follow the child's  
own interest more than a predetermined set of questions, but nevertheless they focused on the  
children's understanding of the Earth and their choice of pictorial convention. The chosen  
method does not imply that the children's conceptual frameworks have to be stable during the  
entire interview (cf. Welzel & Roth, 1998). Rather, the theory of contextualization



1  
2  
3 presupposes that conceptions may be contextualized in different frameworks during the same  
4  
5 conversation.  
6

7  
8 Initially the children were asked if they knew what the Earth was, and if they could draw  
9  
10 it. A few children needed more conversation about the subject than just this direct question  
11  
12 before they had an idea of something to draw. The children had access to paper in A3 format  
13  
14 and crayons of different colours. They made one, two or three drawings of the Earth. Those  
15  
16 who drew more than one picture usually did so after the interviewer had encouraged them  
17  
18 with such questions as, "Can you draw the Earth in another way?" or "Can you draw what it  
19  
20 looks like where people are?" One child drew a straight line depicting the Earth as the ground  
21  
22 in two pictures. Seventeen of the children drew a form similar to a circle. Most of these forms  
23  
24 contained green and blue areas, and the children explained that the blue represented sea or  
25  
26 water, and the green denoted land, country or grass. Nine of the children who drew a round  
27  
28 Earth on one paper also drew a flat ground, seen in a side view, on another paper.  
29  
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33

34 The interviews were audio-recorded and transcribed. Short notes about what had  
35  
36 happened were written down, mainly immediately after the interviews. Often occurrences  
37  
38 could also be deduced from the dialogue and the drawings. With this material it was possible  
39  
40 to describe the children's acting in the given situation. Acting is distinguished from other  
41  
42 behaviour in that an intention behind the action is acknowledged. "Given the action, we 'look  
43  
44 back' on the grounds and reasons which make it intelligible." (von Wright, 1989, pp. 804,  
45  
46 805) This means that an intentional model of analysis can be used (Halldén, 1999; Halldén,  
47  
48 Haglund & Strömdahl, 2007; Ryve, 2006). Considering the children's actions in the situation  
49  
50 made it possible to consider not only the children's cognitive ideas, but also their views of the  
51  
52 physical and cultural constraints of the interview situation. The utterances and the drawings  
53  
54 were made in a situation in which certain rules for talking, drawing and behaving interacted;  
55  
56 and what the children said and drew resulted from their interpretation of this, together with  
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1  
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3 their knowledge of the Earth, drawing conventions and anything else they found relevant in  
4  
5 the situation. What the children said about the Earth was related to conceptual frameworks,  
6  
7 and was compared to earlier research (e.g., Nussbaum, 1985; Vosniadou & Brewer, 1992).  
8  
9  
10 Indications of reasons for the children's choice of mode of depiction were scrutinized. The  
11  
12 children's contextualization of the mode of depiction in pictorial genres was compared to their  
13  
14 contextualization of conceptions in cognitive contexts.  
15  
16  
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21

## 22 Results

23  
24 For presentation in this section are chosen the eight children, from whom it was possible to  
25  
26 give the clearest descriptions of different ways of relating contextualizing of conceptions in  
27  
28 conceptual frameworks to contextualizing drawings in pictorial conventions. Thus the criteria  
29  
30 for choice of examples were clearness and variation.  
31  
32

33  
34 When describing the conceptual contextualization, the astronomical framework of the  
35  
36 planet and the common sense framework of the Earth nearby are considered. In addition to  
37  
38 this the material made it urgent to reflect on the differentiation of the concepts country, earth  
39  
40 and planet. Findings in earlier research on the children's development of the concept earth are  
41  
42 given as comparison when appropriate.  
43  
44

45  
46 When describing the contextualization of drawings in pictorial conventions Luquet's  
47  
48 concepts visual and intellectual realism are used. The intellectual realism is specified as for  
49  
50 example mixed view-points or transparency. Pictorial conventions are also regarded as  
51  
52 broader genres, like an astronomical scientific genre compared to a science fiction genre.  
53  
54

55 The children are presented under pseudonyms.  
56  
57  
58  
59

60 *Differentiated conceptual frameworks and a visually realistic mode of depiction*

1  
2  
3 Two children explained the difference between the Earth nearby and the Earth as a planet as a  
4 difference in distance. Elin (age 7) drew a girl on a hillock in her second drawing. When  
5  
6 difference in distance. Elin (age 7) drew a girl on a hillock in her second drawing. When  
7  
8 asked why the Earth was round in her first drawing but only a bit bent in her second drawing,  
9  
10 she said (about her first drawing), "This is from a great distance. Then you don't see the  
11  
12 hillock." (Nevertheless, after this question she added the girl and the hillock to her first  
13  
14 drawing.) When asked if there were any people in his picture of a round Earth, Erik (age 9)  
15  
16 said, "They can't be seen in this little picture." After that, he drew people covered by a  
17  
18 magnifying glass in his picture of the round Earth — a "close-up," he called it. These  
19  
20 children's explanations indicate that their conception of the Earth was of one object, which  
21  
22 can be depicted as round from a great distance, and with details as people visible from a short  
23  
24 distance. Their descriptions of the their drawings shows that they had differentiated the  
25  
26 astronomical conceptual framework of the planet Earth from the common sense framework of  
27  
28 the Earth as nearby surroundings, and that they also understood the relation between these  
29  
30 frameworks. Before the interviewer's suggestions they drew the planet Earth in a visually  
31  
32 realistic mode of depiction, and only after reservations or specified explanations did they add  
33  
34 people to their drawings of the planet Earth. The additions of people in the drawings of the  
35  
36 planet changed the mode of depiction in the drawings to an intellectually realistic mode of  
37  
38 depiction. This was because the people and the planet were depicted from different  
39  
40 viewpoints and distances. These children appeared to have differentiated and related the  
41  
42 conceptual frameworks of the Earth, and they preferred to represent it in a visually realistic  
43  
44 mode of depiction.

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54  
55 *Undifferentiated conceptual frameworks and visually realistic depiction*

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59  
60 [Insert figure 1 about here]

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5  
6 Gunnar (age 7) made a round Earth with green and blue areas in his first drawing. He said that  
7  
8 the green areas depicted grass. A round Earth is a convention for the planet, but "grass" does  
9  
10 not belong to the astronomical framework of the planet Earth. Instead, it belongs to the  
11  
12 framework of the Earth as nearby surroundings. When asked if there were any people, he said  
13  
14 that they were "on the grass." He did not, however, draw any person on this round Earth. This  
15  
16 means that his drawing of the Earth was from one perspective, that is, in a visually realistic  
17  
18 mode of depiction. The interviewer asked him about the roundness.  
19  
20

21  
22 I: How can it be that this one looks round, but that it looks straight and flat where we  
23  
24 are?  
25

26  
27 Gunnar: There are sides on the Earth that may look straight.  
28

29  
30 I: The sides of the Earth look straight?  
31

32  
33 Gunnar: If there is a downhill slope, you can see that there is a bend on the Earth.  
34

35  
36 Gunnar explained the interviewer's proposition that the Earth looks straight and flat where we  
37  
38 are by saying that "sides on the Earth may look straight." But he also stated that we can see  
39  
40 the Earth's roundness in "downhill slopes." These comments indicate that he did not associate  
41  
42 roundness with the planet as distinguished from the flatness of the Earth nearby. His  
43  
44 explanation can be compared to what Nussbaum (1985, p. 179) found in his studies: children  
45  
46 who said that the Earth was round, but who believed that we live on a flat Earth, explained the  
47  
48 Earth's roundness by saying, "The Earth's roundness is just the roads' curves," or, "The  
49  
50 Earth's roundness is just the mountains' shapes." Gunnar appeared not to have differentiated  
51  
52 the astronomical framework of the planet from the common sense framework of the Earth  
53  
54 nearby. His drawing of the Earth, however, was in a realistic mode of depiction, and could be  
55  
56 connected to conventions for drawing the planet.  
57  
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1  
2  
3 Indra (age 6) drew a round Earth in her first picture, the interviewer asked her about  
4  
5  
6 people. She responded that there might be people in space.

7  
8 I: Yes, but there are no people in your picture.

9  
10 Indra: No.

11  
12 I: There are none. So where are the people? Those who are not in space? Like you and  
13  
14 me, where are we?

15  
16  
17 Indra: Here, inside the Earth.

18  
19 Thus, she appeared to have meant that people were inside the round Earth that she had drawn.  
20  
21 She did not add people to her drawing of the round Earth, when the interviewer asked her  
22  
23 about people. She developed her ideas in connection with her second drawing, in which she  
24  
25 drew a picture of a woman, who she said depicted the interviewer; then the interviewer asked  
26  
27 her:  
28  
29

30  
31 I: This one that you drew before, the big one with grass and water...

32  
33 Indra: Yes, that one.

34  
35 I: Can I not see that one?

36  
37 Indra: No, because you are inside it.

38  
39 In her second picture, which showed the interviewer, she also drew a sun. When the  
40  
41 interviewer asked her if the sun was inside the Earth, she answered, "Yes, because you can  
42  
43 see it." This comment indicates that she meant that everything that could be seen in her  
44  
45 second drawing -- the interviewer standing on the ground and the sun in the sky -- was inside  
46  
47 the Earth that she had drawn in her first picture. This can be compared to the model of the  
48  
49 hollow sphere in Vosniadou's and Brewer's (1992) research on children's conceptions of the  
50  
51 earth. Indra's comments about the sun and the interviewer as being inside the Earth indicate  
52  
53 that she had not differentiated the astronomical framework of the Earth from the common  
54  
55 sense framework of the earth nearby. Her drawings, however, can be related to different  
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3 conceptual frameworks of the Earth; the first picture to an astronomical framework and the  
4  
5 second to a common sense framework of the Earth nearby (cf. Halldén et al., 2002). Because  
6  
7 of this, she can be described as having contextualized her conceptions of the Earth in  
8  
9  
10 undifferentiated frameworks and her drawings of the Earth in visually realistic conventions  
11  
12  
13 for depicting the Earth.

14  
15 Albert (age 8) drew a round Earth. Explaining how the Earth rotated, he said that people  
16  
17 did not go under the Earth even though it rotated. Then the interviewer went on to ask him  
18  
19 where people were. Albert said that they were "on the Earth, here inside." He did not draw  
20  
21 any people on his picture of a round Earth. Because he had used the word "inside," the  
22  
23 interviewer asked him what was outside, and he said, "This is," indicating his drawing of a  
24  
25 round Earth. When the interviewer asked him what the Earth was when he looked around  
26  
27 himself, he said it was the sky and the air; and when she was asked in what direction he  
28  
29 should look to see the Earth, he first said, "up," but then changed his mind to "ahead." Also  
30  
31  
32  
33  
34 Albert appeared to have a conception of the Earth similar to the descriptions of a hollow  
35  
36 sphere by Nussbaum and Vosniadou & Brewer and he seemed not to have differentiated the  
37  
38 conceptual framework of the planet from that of the Earth as nearby surroundings. It was,  
39  
40 however, not until he told the interviewer that what could be seen in his drawing was the  
41  
42 outside of what he meant was the Earth, that this became apparent. This was because his  
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44  
45 drawing of the Earth was in line with visually realistic depictions of the planet.

46  
47  
48 Halldén et al (2002) described the development of the concept of Earth as a process,  
49  
50 wherein the intuitive conception of a flat Earth is not abandoned in favour of the scientific  
51  
52 concept of the planet Earth. All information about the Earth is assimilated into an all-  
53  
54 embracing model. The development of the concept of the Earth involves a process of  
55  
56 differentiation, by which the child starts to realize how the Earth can be contextualized in both  
57  
58 the common sense framework of the Earth nearby and the astronomical framework of the  
59  
60

1  
2  
3 Earth as a planet. What Gunnar, Indra and Albert said about the Earth can be taken as an  
4  
5 illustration of this process. These children may not yet understand what qualities of their  
6  
7 conception of the Earth belong to the Earth nearby, and what qualities belong to the planet  
8  
9 Earth in an astronomical framework. That this process of differentiating and relating the  
10  
11 different conceptual frameworks of the Earth is only at an early stage is **not possible** to  
12  
13 conclude from their drawings.  
14  
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23

24 *Undifferentiated conceptions of Earth, country and planet and visually realistic depiction*  
25  
26  
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28  
29 [Insert figure 2 about here]  
30  
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33

34 When Annika (age 7) was asked if she knew what the Earth was and if she could draw it, she  
35  
36 started her drawing with one big circle and said, "There is the sun." After that she said, "Then  
37  
38 one makes the planets around," and she made 10 smaller circles around the first big circle.  
39  
40 She wrote the Swedish word for "sun" inside the big circle and when the interviewer asked  
41  
42 her which was the Earth, she wrote "joden," which is a misspelling of the Swedish word for  
43  
44 Earth, near one of the smaller circles. She coloured this circle (Figure 2) and told the  
45  
46 interviewer what could be found on the Earth: grass, earth (soil), trees, flowers, plants, fir  
47  
48 trees, Christmas, water, a forest called the rain forest and a store of sweets or a country of  
49  
50 sweets. Then she talked about Spain, and going there by aeroplane. When her picture and  
51  
52 verbal description of the Earth seemed to be finished, the interviewer asked her:  
53  
54  
55  
56

57 I: On this one [indicating the coloured circle], are there all the things you told me about?  
58

59 What was it, the country of sweets, the rain forest?  
60

1  
2  
3 Annika: Yes.  
4

5 I: And Spain.  
6

7  
8 Annika: Maybe not exactly on this Earth, maybe on the next Earth. Which is situated up  
9  
10 here [indicating the circle just above the coloured one].  
11

12 I: Is that an Earth, too?  
13

14  
15 Annika: Yes, all these small ones are Earths (Swedish: jordar).  
16

17 I: Well, why did you draw so many Earths then?  
18

19  
20 Annika: There are pretty many around the sun.  
21

22 This means that she changed her earlier explanation, now saying that the smaller circles  
23  
24 depicted Earths, rather than planets. Because she had said that Spain perhaps was not on the  
25  
26 Earth that she had coloured, the interviewer asked her if one could travel between the Earths.  
27

28  
29 I: But can you go from one Earth (Swedish: jord) to another?  
30

31  
32 Annika: Yes, you can.  
33

34 I: How do you do it, then?  
35

36  
37 Annika: Go by aeroplane.  
38

39 I: And then you go by air... You can show it on this one that you have drawn... If you,  
40  
41 for example, go to Spain, can you draw how you go by air then... from... Which Earth do  
42  
43 you live on?  
44

45  
46 Annika: Here.  
47

48 I: Make a cross where you live.  
49

50  
51 Annika: Yes. [She makes a cross on the coloured Earth.]  
52

53 I: You live there.  
54

55  
56 Annika: Yes.  
57

58 I: And then you will go by air to Spain.  
59  
60



1  
2  
3 Annika: Then the plane goes there over to the Earth. [She draws a plane, which looks  
4 like it is leaving the coloured Earth in the direction of the circle just above, where she  
5 has said that Spain is situated.]  
6  
7  
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9

10 What Annika early in the interview had called planets around the sun she later explained to be  
11 Earths, and she placed countries on different planets/Earths. Although she gave a new  
12 explanation of what the smaller circles represented, they were represented by the same  
13 drawing. This indicates that she did not differentiate her conception of planet from her  
14 conception of Earth, something which could not be concluded from her drawing without her  
15 own explanation.  
16  
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23

24 Jakob (age 7) began by drawing a rather round Earth with blue, green and brown areas,  
25 explaining that they represented water, grass and Earth (Swedish "jord" may be translated into  
26 either "Earth" or "soil" in English). When the interviewer asked him if the Earth could be  
27 drawn in another way, he responded that it was possible without brown, and drew a second  
28 round Earth with blue and green areas, explaining that they represented water, grass and trees.  
29 This indicates that the brown areas in his first drawing represented earth/soil. He also talked  
30 about the earth where the ants lived. Later he spoke about going by boat or aeroplane to  
31 different countries. He had pointed out Sweden and Tunisia in one of his pictures of the Earth.  
32 Because he had drawn two different pictures of the Earth and talked about the earth where the  
33 ants lived, the interviewer wanted a clarification about which Earth the travelling could be  
34 related to.  
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50 I: But if you go by air from Sweden to Tunisia, then you travel above the Earth?

51 Jakob: Yes.

52 I: Then which Earth is it that you travel above?

53 Jakob: The Earth of Sweden.

54 I: Well, and the Earth of Sweden, what does it look like?  
55  
56  
57  
58  
59  
60

1  
2  
3 Jakob: Round.  
4

5 I: It is round too?  
6

7  
8 Jakob: Yes. All planets are round.  
9

10 I: Yes, but are there two then? There is the Earth of Sweden, is it the same as the Earth  
11  
12 of Tunisia?  
13

14  
15 Jakob: No, because in Tunisia it is warmer and in Tunisia there is never snow.  
16

17 After a while, he told the interviewer that he had gone by boat to Finland, and the interviewer  
18  
19 asked him to explain.  
20

21  
22 I: But if you go to Finland, then you travel over water?  
23

24  
25 Jakob: Yes.  
26

27 I: Is it the same Earth in Finland as in Sweden?  
28

29  
30 Jakob: Yes, because Sweden and Finland are near each other.  
31

32 Jakob explained that Tunisia and Sweden were not the same Earth, while Sweden and Finland  
33  
34 were. According to Jakob this was because in Tunisia it was warmer and never snowed, and  
35  
36 because Finland and Sweden were situated near each other. These explanations indicate that  
37  
38 Jakob did not differentiate between the concepts of country, Earth and planet. Moreover,  
39  
40 Jakob did not seem to differentiate between different meanings of the word "Earth," as he  
41  
42 made drawings of the Earth with and without brown areas representing earth (soil) and talked  
43  
44 about the earth where the ants lived. Although Jakob had pointed out Sweden and Tunisia in  
45  
46 the same round object in his drawing, he said these countries were not [on] the same Earth. It  
47  
48 was not until Jakob verbally explained his understanding of the concept Earth that it became  
49  
50 evident that his drawings represented undifferentiated conceptions of country, Earth and  
51  
52 planet.  
53  
54  
55

56  
57 Jahoda (1963) studied children's understanding of geographical concepts in relation to  
58  
59 where the children were situated. Young children in Glasgow had a vague idea of Glasgow as  
60

1  
2  
3 something nearby, but usually not including their own immediate surroundings. Some  
4  
5 children believed that Scotland was outside Glasgow. Jahoda also found examples of children  
6  
7 describing countries or streets as towns and towns as countries. Jahoda perceived these  
8  
9 children's organization of geographical concepts as minimal. He argued that children cannot  
10  
11 be expected to understand the relationships between the concepts if they do not differentiate  
12  
13 between them. In a wider context, in which children are situated in relation to country, Earth  
14  
15 and planets in the solar system, similar problems may arise. In this study, Annika and Jakob  
16  
17 appeared not to differentiate between their conception of Earth and their conception of  
18  
19 country and planet. This could be concluded from their dialogue with the interviewer, but was  
20  
21 not evident in their drawings, which appeared to adhere to conventional depictions of the  
22  
23 Earth as a planet, alone or in the solar system.  
24  
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32 *Undifferentiated conceptual frameworks and an intellectually realistic depiction in a science*  
33 *fiction genre*  
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39 [Insert figure 3 about here]  
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41  
42

43 Alexandra (age 7) drew a round Earth with green and blue areas, one person and three boats.  
44  
45 Then she made, in the same drawing, what she called "outer space" (Figure 3). She drew  
46  
47 something that the researcher associates with the planet Saturn, because it is a round object  
48  
49 with some kind of circles. The interviewer asked her about that.  
50  
51

52  
53 I: [...] What is it that you have drawn?

54  
55 Alexandra: It is one such...I don't know what it is called.

56  
57 I: Anyway, it is somewhere around, near the Earth.

58  
59 Alexandra: There is the sun, isn't there?  
60

1  
2  
3 I: Yes, you may decide what you think there should be.  
4

5 Alexandra: It should be near, because then the sun goes into the globe.  
6  
7

8 I: Does the sun go into the globe?  
9

10 Alexandra: Yes, so it can be seen.  
11

12 I: So it can be seen. By whom can it be seen?  
13

14 Alexandra: Maybe by the people down here.  
15

16  
17 What did she mean by her expression, "Then the sun goes into the globe"? After she had  
18  
19 made a second picture, the interviewer went back to talk about this again.  
20  
21

22 I: [...] You said before that the sun, that we talked about before, when it was about outer  
23  
24 space.  
25

26 Alexandra: Yes.  
27

28 I: And then you said that if we should see it, what should it do then?  
29  
30

31 Alexandra: It must be outside or it comes down, you know.  
32  
33

34 I: Outside...  
35

36 Alexandra: Outside or comes down.  
37

38 I: What is it outside?  
39  
40

41 Alexandra: Outside the globe.  
42

43 Alexandra's picking up of the expression "outer space" may have strengthened her view of an  
44  
45 "outside" in relation to the Earth. Her reference to an "outside" may be related to Nussbaum's,  
46  
47 and Vosniadou's and Brewer's, research on children's understanding of the Earth. Nussbaum  
48  
49 (1985) asserted that children may think of the Earth as a ball made up of two hemispheres,  
50  
51 where people live on the flat surface of the lower solid part. Vosniadou and Brewer (1992)  
52  
53 found that some children believe we live on a flat surface inside a hollow sphere. Alexandra  
54  
55 drew something, which she called a flying saucer, referring to what she had seen in a  
56  
57 computer game. The flying saucer indicated that the computer game she referred to was in the  
58  
59  
60

1  
2  
3 science fiction genre. Her second drawing showed the ground as seen from above. It can be  
4  
5 compared to Erik's drawing, which had a magnifying glass over part of the Earth, to show  
6  
7 people. The similarity is that people on the ground were shown from the same angle as the  
8  
9 planet. The difference is that Alexandra also drew people and boats in her picture of the Earth  
10  
11 in space. This indicates that she did not intend to differentiate, especially between distances,  
12  
13 in her drawings.  
14

15  
16  
17 Alexandra's reference to the sun as outside, going into and coming down in relation to  
18  
19 the Earth indicate that she had not differentiated an astronomical framework of the Earth from  
20  
21 a common sense framework. Her first drawing (Figure 3) was in an intellectually realistic  
22  
23 mode of depiction, because of the different viewpoints from which the planets and the people  
24  
25 were depicted. It was in a science fiction genre because of the flying saucer.  
26  
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### 34 Summary

35  
36 The explanations that Gunnar, Albert, Indra and Alexandra gave of their drawings of the  
37  
38 Earth were in line with alternative conceptions of the Earth found in earlier research  
39  
40 (Nussbaum, 1985; Vosniadou & Brewer, 1992). The interviews with Annika and Jakob  
41  
42 indicated that these children did not differentiate between their conception of Earth and their  
43  
44 conceptions of country and planet. This problem was related to the research findings on  
45  
46 children's understanding of geographical concepts (Jahoda, 1963). There were many  
47  
48 indications of that these children had not differentiated the astronomical framework of the  
49  
50 planet Earth from the common sense framework of the Earth as nearby surroundings. Despite  
51  
52 that the interviews with these children indicated that their drawings represented conceptions  
53  
54 of the Earth that belonged to undifferentiated or unrelated frameworks; their drawings of the  
55  
56 Earth could be connected to cultural conventions depicting the Earth as a globe and the  
57  
58  
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1  
2  
3 ground (Gunnar, Indra), as a globe (Albert, Jakob), as the solar system (Annika), and as a sci-  
4  
5  
6 fi computer game (Alexandra).

7  
8 When the interviewer asked if there were any people on the Earth, or where people  
9  
10 were, some children added people to their drawing of a round Earth (Elin, Erik, Alexandra,  
11  
12 and three others). This indicates that intellectually realistic drawings with more than one  
13  
14 viewpoint were a possible mode of depiction to them.  
15  
16

## 17 18 19 20 Discussion

21  
22 The assertion of Ivarsson, Schoultz and Säljö (2001), that drawings cannot be regarded as  
23  
24 mirroring underlying conceptions, is in line with a socio-cultural theory that does not  
25  
26 acknowledge personal conceptions. Because this study sought to understand how children  
27  
28 represented their conceptions in drawing, it was a premise that children hold conceptions.  
29  
30 Conceptions were regarded as contextualized **in conceptual frameworks** in cognitive contexts,  
31  
32 and drawings were regarded as contextualized **pictorial conventions** in cultural contexts. This  
33  
34 study indicated that children might contextualize their conceptions of the Earth in  
35  
36 undifferentiated or unrelated frameworks and, at the same time, contextualize their drawings  
37  
38 of the Earth in conventional modes of depicting the Earth. Thus, drawings cannot be  
39  
40 anticipated to "mirror" conceptions that children hold; in this respect, this study agrees with  
41  
42 the opinion of Ivarsson and colleagues. On the other hand, **following** Goodman (1976) **in** that  
43  
44 the only criterion for pictorial representation is reference to an object, pictures can never be  
45  
46 looked upon as "mirroring" what they represent. In this study, the "object" that the drawings  
47  
48 referred to, i.e., the children's conceptions, were more diversified than what could have been  
49  
50 expected before the children gave their explanations.  
51  
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57  
58 The drawings by the children in this study did not support the assumption of Siegal and  
59  
60 colleagues (2004) that drawings as a means of grasping children's conception of the Earth

1  
2  
3 would lead to an overrepresentation of a flat-Earth concept, because of children's difficulties  
4 in drawing spheres or their tendency to orient figures to a baseline. Many of the children drew  
5 people situated on a round Earth. In doing so they used an intellectually realistic mode of  
6 depiction with two different viewpoints in the same drawing (cf. Luquet, 1927/2001); the  
7 people were drawn in side view and from a shorter distance compared to the Earth on which  
8 they were situated. There was, however, probably reluctance in some children, to place people  
9 in their drawings of a round Earth, which may be explained by their choice a visual realistic  
10 mode of depiction.  
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22 **The remarks** by Dove and colleagues (1999) on children's clichéd images of mountains  
23 in their own study **can be compared** to drawings of the planet Earth. If children's drawings  
24 normally are connected to conventions (cf. Thomas, 1995), **the drawings** could also be  
25 described as clichés. In this study the children can be **understood** to have made clichéd  
26 drawings of the Earth. Some of their conceptions of the Earth and related phenomena were  
27 not conventional, and consequently were not shown in **these clichéd** drawings.  
28  
29  
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36 The results indicate that children seek a convention for depicting the Earth among  
37 existing conventions in their culture, and if they hold an alternative conception of the Earth, a  
38 suitable convention may not exist. At the beginning of the interview, Annika talked about the  
39 smaller circles around the sun as planets, and then expressed herself as if she was trying to  
40 conform to a convention. Her drawing also appeared to have been influenced by pictures of  
41 the solar system. Later in the interview, when the discussion went deeper into the character of  
42 the Earth, she referred to the smaller circles around the sun as different Earths. This change  
43 may have indicated that she had left the process of finding a pictorial convention in a cultural  
44 context and moved on to the process of contextualizing the concept of Earth **in a conceptual**  
45 **framework** in a cognitive context. This second process of contextualizing her conception of  
46 the Earth in a cognitive context may exemplify Jahoda's (1963) description of children's  
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3 problems in relating concepts if they have not differentiated those concepts. Annika might not  
4  
5 have differentiated the concept of planet from the concept of Earth. However, this case may  
6  
7 also exemplify what Halldén (1999) called "error of application." It is probable that Annika  
8  
9 may have chosen an explanation in which her drawing became relevant. Therefore, we must  
10  
11 take a third kind of context, the situation, into account. Halldén (1999) argued that to  
12  
13 contextualize a problem involves not only finding a relevant speech genre (in this study,  
14  
15 understood as mode of depiction) in a cultural context and finding the appropriate conceptual  
16  
17 framework in a cognitive context; it also involves finding an appropriate explanation in the  
18  
19 present situation. The child's understanding of the situation determines the conception the  
20  
21 child chooses from his or her repertoire of conceptions (Carvita & Halldén, 1994).  
22  
23  
24  
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26

27 This study indicates an unclear relationship between children's choice of convention for  
28  
29 depicting an object and their conception of the object. Also, that similar pictures may  
30  
31 represent different conceptions. Elin and Erik explained that there were no people in their  
32  
33 picture of a round Earth, because they could not be seen from that distance. Indra and Albert,  
34  
35 on the other hand, explained that people were inside the round Earth that they had drawn. An  
36  
37 implication from this would be that drawings themselves are not an appropriate means for  
38  
39 drawing conclusions about children's conceptions in research or in school situations. This  
40  
41 concerns methods which collect and analyse drawings without children's own comments.  
42  
43 When the drawings are used together with children's descriptions of their conceptions (e.g.,  
44  
45 Vosniadou & Brewer, 1992) they may have a complementary function or serve a purpose as  
46  
47 something concrete to talk about.  
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## References

- Arnold, P., Sarge, A. & Worall, L. (1995). Children's knowledge of the Earth's shape and its gravitational field. *International Journal of Science Education*, 17 (5), 635--641.
- Caravita, S. & Halldén, O. (1994). Re-framing the problem of conceptual change. *Learning and Instruction*, 4, 89--111.
- Dove, J.E., Everett, L.A. & Preece, P.F.W. (1999). Exploring a hydrological concept through children's drawings. *International Journal of Science Education*, 21 (5), 485--497.
- Gombrich, E.H. (1960/1977). *Art and Illusion. A study in the psychology of pictorial representation*. London: Phaidon.
- Goodman, N. (1976). *Languages of Art. An Approach to a Theory of Symbols*. Indianapolis/Cambridge: Hackett Publishing Company.
- Halldén, O. (1999). Conceptual change and contextualization. In W. Schnotz, M. Carratero & S. Vosniadou (Eds.), *New perspectives on conceptual change* (pp. 53—65). Amsterdam: Pergamon, Elsevier.
- Halldén, O., Haglund, L. & Strömdahl, H. (2007). Conceptions and contexts. On the interpretation of interview and observational data. *Educational Psychologist* 42 (1).
- Halldén, O., Petersson, G., Scheja, M., Ehrlén, K., Haglund, L., Österlind, K. & Stenlund, A. (2002). Situating the question of conceptual change. In M. Limón & L. Mason (Eds.), *Reconsidering conceptual change: Issues in theory and practice* (pp. 137—148). Dordrecht, the Netherlands: Kluwer Academic Publishers.
- Jahoda, G. (1963). The development of children's ideas about country and nationality. *The British Journal of Educational Psychology*, 33, 47--60.

- 1  
2  
3 Klein, C.A. (1982). Children's concept of the Earth and the Sun: A cross cultural study.  
4  
5 *Science Education* 65 (1), 95--107.  
6  
7  
8 Luquet, G.H. (1927/2001). *Children's drawings (Le dessin enfantin)*. Translated with an  
9  
10 *introduction and notes by Alan Costall*. London: Free Association Books.  
11  
12  
13 Mali, G.B. & Howe, A. (1979). Development of Earth and gravity concepts among Nepali  
14  
15 children. *Science Education* 63, 685--691.  
16  
17  
18 Nussbaum, J. (1979). Children's conceptions of the Earth as a cosmic body: A cross age  
19  
20 study. *Science Education*, 63, 83--93.  
21  
22  
23 Nussbaum, J. (1985). The Earth as a cosmic body. In R. Driver, E. Guesne & A. Tiberghien  
24  
25 (Eds.), *Children's ideas in science*. Milton Keynes and Philadelphia: Open University  
26  
27 Press, 170--192.  
28  
29  
30 Nussbaum, J. & Novak, J.D. (1976). An assessment of children's concepts of the Earth  
31  
32 utilizing structured interviews. *Science Education*, 60 (4), 535--550.  
33  
34  
35 Piaget, J. & Inhelder, B. (1966/1969). *The Psychology of the Child*. London: Routledge &  
36  
37 Kegan Paul.  
38  
39  
40 Ryve, A. (2006). Making explicit the analysis of students' mathematical discourses –  
41  
42 Revisiting a newly developed methodological framework. *Educational Studies in*  
43  
44 *Mathematics*, 62 (2), 191—209.  
45  
46  
47 Schoultz, J., Säljö, R. & Wyndhamn, J. (2001). Heavenly Talk: Discourse, artefacts, and  
48  
49 children's understanding of elementary astronomy. *Human Development*, 44, 103--118.  
50  
51  
52 Sneider, C. & Pulos, S. (1983). Children's cosmographies: Understanding the Earth's shape  
53  
54 and gravity. *Science Education*, 67 (2), 205--221.  
55  
56  
57 Siegal, M., Butterworth, G. & Newcombe, P.A. (2004). Culture and children's cosmology,  
58  
59  
60 *Developmental Science*, 7:3, 308--324.

- 1  
2  
3 Thomas, G.V. (1995). The role of drawing strategies and skills. In C. Lange-Kuttner & G.V.  
4  
5 Thomas (Eds.), *Drawing and Looking. Theoretical approaches to pictorial*  
6  
7 *representation in children* (pp. 107—122). New York, London, etc.: Harvester  
8  
9 Wheatsheaf.  
10  
11  
12  
13 Welzel, M. & Roth, W-M. (1998). Do interviews really assess students' knowledge?  
14  
15 *International Journal of Science Education*, 20 (1), 25—44.  
16  
17  
18 Vosniadou, S. (1994). Capturing and modeling the process of conceptual change. *Learning*  
19  
20 *and Instruction*, 4 (1), 45-69.  
21  
22  
23 Vosniadou, S. & Brewer, W. (1992). Mental models of the Earth: A study of conceptual  
24  
25 change in childhood, *Cognitive Psychology*, 24, 535--585.  
26  
27  
28 Vosniadou, S., Skopeliti, I. & Ikospentaki, K. (2004). Modes of knowing and ways of  
29  
30 reasoning in elementary astronomy, *Cognitive Development*, 19, 203--222.  
31  
32  
33 Vosniadou, S., Skopeliti, I. & Ikospentaki, K. (2005). Reconsidering the role of artefacts in  
34  
35 reasoning: Children's understanding of the globe as a model of the Earth, *Learning and*  
36  
37 *Instruction*, 15, 333-351.  
38  
39 von Wright, G. H. (1989). *The philosophy of Georg Henrik von Wright*. La Salle, Illinois: The  
40  
41 *Library of Living Philosophers*.  
42  
43  
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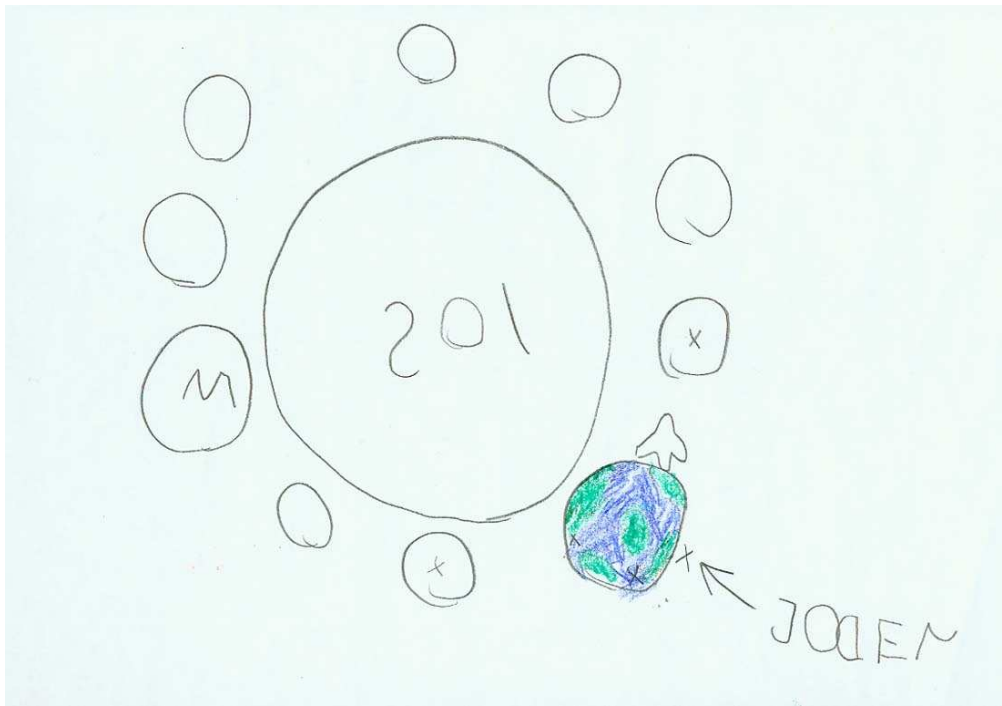


Figure 2. Annika's drawing.  
289x203mm (96 x 96 DPI)

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Figure 3. Alexandra's first drawing.