“If It Lived Here, It Would Die.” Children’s Use of Materials as Semiotic Resources in Group Discussions About Evolution

Johanna Frejd

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“If It Lived Here, It Would Die.” Children’s Use of Materials as Semiotic Resources in Group Discussions About Evolution

Johanna Frejd

Linköping University, Norrköping, Sweden

ABSTRACT
With the aim of exploring how children discuss underlying reasons for evolution and how materials function in children’s meaning making processes, this article provides insight into how evolution theory can be introduced in preschool and in the early years of primary school. Video data from eight group discussions (N = 27) were analyzed using a multimodal perspective. Despite not having had any formal instruction about evolution theory, the 6-year-old children in this study made use of their previous experiences and the materials to make meaning and argue for different reasons for animal diversity. The results show that the children’s discussions concerned four conceptual themes: animals are different because of kinship and heredity, environmental effects, the need for adaptation, and the need for geographic separation. The children used the provided materials, comprising photographs, figurines, and a topographic world map, as resources for providing meaning, as argumentative tools, and as tools for communication. By making observations in a logical and scientific way, the children spontaneously discussed similarities and differences in traits, which implies that variation might be a fruitful way to introduce evolution theory to preschool children.

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Early childhood; group discussion; materials; meaning making; science

Evolution theory is one of the foundations of modern science and biology education. Traditionally, evolution theory has been introduced in the latter years of primary school or in high school. Researchers and teachers are now probing the potential benefits of teaching evolution theory to even younger children, in primary school and at preschool level. Providing young children with experiences and activities that reflect scientific explanations of evolution might facilitate students’ meaning making and provide them with a foundation of ideas to build upon as they progress in their education (Nadelson et al., 2009). In arguing for the teaching of evolution theory from kindergarten to 5th grade, Wagler (2012) proposes that:

If we are to fully understand anything about any species, we must first know how it was produced (i.e., via biological evolution), how it has changed (i.e., via biological evolution), and how it is currently being changed (i.e., via biological evolution). This fact applies to all of biology education, whether it is a primary student learning about a spider in a deciduous forest, a middle school student learning about amphibian genes, or a high school student learning about human DNA polymerase. (p. 275)

Evolution theory has been included in curricula at primary level in many countries in the past decades, including Sweden. However, research has shown that primary students have difficulties understanding evolution theory (Berti, Barbetta, & Toneatti, 2017; Berti, Toneatti, & Rosati, 2010; Evans, 2000; Samarapungavan & Wiers, 1997). Concurrently, primary teachers seem to have difficulties teaching the theory of evolution (e.g. Prinou, Halkia, & Skordoulis, 2011).
Introducing evolution theory for primary students and preschool children calls for new ways of teaching and talking about a complicated subject. In Sweden, the context of the current study, children begin primary school at age 7. The children in this study are age 6 years and attend preschool class. This article aims to explore how children discuss reasons for animal diversity when they have access to different teaching materials, namely, a three-dimensional map of the world, figurines of four different big cats (lion, tiger, jaguar, and snow leopard), and photographs of the same big cats in their natural environment. In addition, the study explores how these materials are used in the discussions about animal diversity.

Theoretical framework
The following sections outline the theoretical perspectives of the study. From a sociocultural perspective, meaning making and learning are seen as collaborative processes that take place in situated practices where interaction and materials play a crucial role.

Meaning making
While children learn, they are processing ideas, thoughts, and concepts, individually and in interaction with others (Jewitt, Kress, Ogborn, & Tsatsarelis, 2001). Meaning making is a continual process (Jewitt, 2011; Leijon & Lindstrand, 2012; Selander & Kress, 2010), which is complex, dynamic, collaborative, and contextualized (Robbins, 2007).

Meaning can be understood as the synthesis of what a person communicates through several modes (Jewitt, 2011; Jewitt et al., 2001; Streeck, 2009). Meanings in any mode are always intertwined with meanings made with other modes in an interaction within a particular context (Goodwin, 2000; Jewitt, 2011). In a study focusing on the meaning of action in learning in science classrooms, Franks and Jewitt (2001) claim that action is not just an illustration of language. Instead, action and speech do different things. However, during interaction, action and speech can mutually elaborate each other (Goodwin, 2000). Jaipal-Jamini (2011) has developed a four-level discourse analysis framework to analyze meaning making in science contexts, where one of the four levels is conceptual aspects of meaning. In science educational discourse, this type of meaning indicates conceptual aspects of the denotative meanings (also see Jaipal, 2010). In this article, meaning is defined as an idea or a message about animal diversity, which can be represented by spoken language and/or other modalities.

Semiotic resources
In addition to human interaction, the use of semiotic resources is crucial in the meaning making process (Jewitt, 2011; Selander & Kress, 2010; Van Leeuwen, 2005). This study adopts the definition of semiotic resources as “actions and artefacts we use to communicate” (Van Leeuwen, 2005, p. 3). All semiotic resources have a “meaning potential” based on past use that is actualized in concrete social contexts. Van Leeuwen (2005) states that a semiotic resource is always a material, social, and cultural resource at the same time. However, a material or an object is not always a semiotic resource. For example, a rock lying on the ground is not a semiotic resource if not used in communication.

Providing tools for children to use while making meaning about science phenomena may not only support meaning making, but also can reveal a more complex understanding than if they do not have access to such semiotic resources (Robbins, 2007). With the purpose of critically analyzing previous findings about children’s understanding of astronomical concepts (such as gravitation and the shape of the earth), Schoultz, Säljö, and Wyndhamn (2001) allowed children to access a globe as a “tool for thinking” during interviews about gravity. In previous studies (e.g., Vosniadou & Brewer, 1992), children expressed misconceptions in response to questions such as “Is there an end or an edge to the earth? If there is, could you fall off this edge?” When the children in Schoultz et al.’s study consulted the globe in front of them while answering questions similar to the ones in
Vosniadou’s studies (e.g., Vosniadou & Brewer, 1992), none of the previously reported misconceptions was revealed. Instead, a majority of children said that gravity caused people to stay on the earth. Thus, having access to a globe influenced what the children said. Furthermore, in a study investigating preschool children’s exploration of interactive causality during play with a pair of toy sound blocks, Solis and Grotzer (2016) discovered that the children focused on perceptual aspects of the blocks. Here, the children relied on the information provided by the materials for developing their causal understanding. The results from Schoultz et al. (2001) and Solis and Grotzer (2016) highlight the notion that children’s reasoning is tool dependent and that the meaning potential of provided semiotic resources is actualized in the social context where there is a mutual understanding of the resource (Selander & Kress, 2010).

**Children’s understanding of evolution theory**

Previous studies of how primary students understand speciation and the origin of species have revealed somewhat conflicting results. In a study by Samarapungavan and Wiers (1997), 9-year-olds and 12-year-olds tended to explain speciation in essentialist terms (i.e., that animals have immutable features or essences). When Berti et al. (2010) interviewed students who had undergone formal education as well as students without formal education, there were significant differences in their explanations of the origin of species. Students without formal instruction depicted creationist conceptions, whereas those who had been taught that animals have evolved from other animals expressed a mixed conceptual framework, mentioning creation and evolution. Berti et al. (2010) concluded that their results highlighted “the role of instruction and cultural mediation in the development of children’s conceptions of the origin of species” (p. 528). In a more recent study, Berti et al. (2017) constructed an intervention for 3rd-graders (age 8 years), which taught different concepts related to evolution over 10 lessons. The same group of students were interviewed before and after the intervention, with the objective to investigate how formal instruction affected their conceptions about the origin of species. In the pretest, fewer creationist conceptions were reported than in previous studies by workers such as Berti et al. (2010) and Evans (2000). Berti et al. (2017) explain the variation in the range of creationist conceptions as a result of different levels of exposure to religious teaching. This finding reinforces that fact that understanding evolution theory has a sociocultural dimension. A great number of the students in the later study by Berti et al. (2017) showed a “no conceptions pattern,” giving “don’t know” answers to most questions during the preinterview. Creationist and “don’t know” answers decreased after the intervention; instead, most students provided evolutionary answers to the questions. However, the researchers concluded that the students had learned about evolution in a fragmented manner, which manifested naïve or primitive evolutionary answers.

Due to the fragmented understanding shown by most students even after the intervention, Berti et al. (2017) suggest that evolution should not be taught earlier than the 3rd grade. However, there are alternative ways of introducing evolution theory to young children. In this regard, formal instruction combined with modeling and drawing (Nadelson et al., 2009), narrative texts (Browning & Hohenstein, 2013), and picture books (Emmons, Smith, & Kelemen, 2016; Kelemen, Emmons, Schillaci, & Ganea, 2014) have been studied and proposed as fruitful methods. Nadelson et al. (2009) have developed standardized lessons, including instruction and hands-on activities, to teach evolutionary concepts to kindergartners and 2nd-graders. The results from their study show that children are capable of learning simplified versions of the concepts of speciation and adaptation and that the products generated during the lessons can be used as sources of evidence, which reflect children’s learning and understanding of evolution.

In an exploration of 1st-graders, 2nd-graders, and 3rd-graders (age 5–8 years) learning about evolution, Browning and Hohenstein (2013) presented children with narrative and expository texts. They concluded that narratives and imagination are tools that can be used to teach evolution. Compared to more traditional expository texts, narratives have an explicit chronology that “helps
children to link events with ease and understand causes and consequences of events more clearly, thus encouraging understanding of the more specific aspects of a story, or theory” (Browning & Hohenstein, 2013, p. 14). Their results have been supported by Emmons et al. (2016) and Kelemen et al. (2014), who conclude that picture books have been shown to be useful in introducing a simplified understanding of natural selection.

**Aim and research questions**

In contributing to previous studies on alternative ways to introduce evolution theory in preschool and in early years of primary school, the aim of the current study is to investigate how preschool students make meaning about animal diversity in interaction with other students and with access to different teaching materials. By analyzing how materials are used as semiotic resources in the meaning making process about evolution and speciation, there is an opportunity to offer new perspectives on science learning. Thus, the specific aim of the study is twofold, with the objective to examine how children explain reasons for animal diversity, but also to explore the function of the materials in the discussions.

The following research questions were posed to guide the study:

1. What are the conceptual themes when children discuss reasons for animal diversity?
2. What are the functions of different materials in children’s meaning making about animal diversity?

**Research design and methodological perspectives**

The study took place in a Swedish preschool class. The analysis is based on video data from eight group discussions conducted with three or four 6-year-old students in each group (10–25 minutes each).

**Participants and context**

Preschool class is a voluntary stage of education in the Swedish school system that is led by preschool teachers. Almost all children attend preschool class the year they turn age 6 years, the year before compulsory primary school commences. Swedish schools are nonconfessional, and preschool class combines social skills and free play with activities to stimulate children’s curiosity and interest in literacy, mathematics, and science.

In total, 27 six-year-old preschool students from two different classes in the same school participated in the study. None of the students has any formal education on evolutionary theory or speciation. This was a selection criterion, which made it possible to study a meaning making process in its early stages.

By analyzing group discussions instead of individual interviews, it is possible to investigate the use of semiotic resources in a social context similar to the everyday setting of a Swedish preschool class. According to Murphy, Murphy, and Kilfeather (2011), when given the opportunity to discuss their ideas, children can help “scaffold” one another’s ideas. Furthermore, the situated practice of group discussions prompts children to argue for their ideas, which makes it possible to capture elements of their meaning making process.

**Data collection**

Data were gathered over a period of 2 weeks. The animals used as an example of speciation were four big cats: a jaguar, a lion, a tiger, and a snow leopard. They each represent the same family (*Felidae*)
and genus (*Panthera*). All big cats diverged from the remainder of modern Felidae about 11 million years ago (Figure 1) (Davis, Li, & Murphy, 2010).

Previously, the snow leopard was not considered to be one of the big cats. However, DNA technology has provided new insights, and now we know that the snow leopard is actually a close relative of the tiger (Tseng et al., 2014). The four big cats were used as examples in the study because children recognize them and often have personal experiences of them from zoo visits, movies, television, or books. In addition, the big cats are found in different parts of the world, which enables discussions about environmental aspects, such as climate and habitat.

The children were asked to answer the question: "Lions, tigers, snow leopards, and jaguars are all 'big cats.' Several million years ago, all big cats looked alike. Why do they look so different from each other today?" Photographs of a tiger, a lion, a snow leopard, and a jaguar in their natural habitats, toy figurines of the same animals, and a topographical world map were provided to the children (Figure 2).

![Figure 1. Felidae Panthera species tree showing that all big cats diverged from the remainder of modern Felidae about 11 million years ago (based on Davis et al., 2010, p. 71).](image1)

![Figure 2. Figurines, photographs of the big cats, and a topographical world map were provided in the discussions.](image2)
To prepare for the group discussions, the students drew an individual picture showing their ideas and had an individual discussion with the interviewer. The children’s individual explanations for animal diversity informed the interviewer so she could create groups with diverse ideas.

The children discussed the question collaboratively in groups of three or four. The children were seated at a table with the materials. The figurines were placed in their natural geographical location on the world map and the photographs were placed in front of the children (two children shared a set of photographs). At the beginning of each group discussion, the children looked at the figurines and named the different animals. The interviewer repeated the question about why they are different and then asked the children to tell each other about their ideas. The interviewer encouraged them to speak their mind and to ask each other questions if they did not understand what their peer meant. The discussions were video recorded with two cameras. The video recordings made it possible to collect data on how gestures and other semiotic resources were used during the discussions.

The discussions had an open character in the sense that the interviewer did not have any more questions prepared than the opening question. The approach of using an open discussion format requires awareness of the fact that the way the students are prompted with follow-up questions might affect the discussions. The interviewer followed the students’ reasoning by asking clarification questions (e.g., “What do you mean?”) and probing for more elaborate answers (e.g., “Can you tell us more about …?”). Although the interviewer did not correct or teach the students, follow-up questions and other responses and reactions (e.g., nodding) of course might have had an impact on the meaning making.

Data analysis

A qualitative analysis of the group discussion was conducted in three steps, “moving from macro to microanalysis” (Ash, 2007, p. 209), where each step was more detailed than the previous. This was an iterative process moving between different levels, where the analysis was continuously related to the research questions.

First, a flowchart was generated to describe all video material from the group discussions in broad strokes. While viewing the recordings from each group discussion several times, notes were taken on whether materials were used often. In addition, sequences where the children expressed ideas on why the animals looked different from each other were noted.

Second, significant events (Ash, 2007) were focused on. Sequences were deemed significant when the children talked about why the animals looked different from each other. In line with the first research question, conceptual aspects of the meanings (Jaipal, 2010; Jaipal-Jamini, 2011) were linked to evolutionary concepts. For example, an expressed meaning that the animals are different because they now live in different parts of the world was linked and coded as geographic separation. In another example, the meaning communicated by a child saying that the big cats used to be siblings that were alike when they were young, but then became different as they grew up, was coded as variation and heredity. All meanings expressed were then contrasted and finally narrowed down to four conceptual themes: kinship and heredity, environmental effects, need for adaptation, and need for geographic separation.

Third, in line with the second research question, a description of materials used when the children talked about why animals look different from each other was added to the chart. For example, if a child held a figurine in her/his hand or looked at the map while talking, this was noted.

Lastly, a fine-grained analysis of the significant events was conducted. The significant events were transcribed verbatim in Swedish. All modes were given equal attention in the analysis.
(Norris, 2004). The analysis focused on the function of the materials in the children’s meaning making process through inductive coding, concentrating on what material was used and on how the material was used in the specific situation. The analysis revealed three functions of the materials. These functions were communicative tools, resources providing meaning, and argumentative tools. More elaborated descriptions of these functions are presented in the Results section.

The ambition of the Results section is to provide interesting examples and a detailed analysis of how children explain reasons for animal diversity and how different materials function in the discussions, based on transcripts of communication between the children. Verbal exchanges have been translated into English in all the described examples. Bodily actions as well as actions performed with the materials are described in parentheses.

**Ethical considerations**

In all research, but perhaps especially in research in which children participate, ethical perspectives have to be considered. This study follows the ethical guidelines stated by the Swedish Research Council (Gustafsson, Hermerén, & Petersson, 2006).

The principal of the school was contacted by phone followed by an e-mail with further information. The children’s guardians were informed about the study aims and methods by the children’s preschool teachers and by mail. Consent from the principal and the guardians was provided in writing. All participating children were informed about the study and its application. The children were also informed about their right to choose to participate or not before each activity. In addition, the researcher disseminated this information to the children when she turned the video cameras on and off. All children chose to take part in the activities. With the purpose of gaining mutual trust among the researcher and the students, the researcher spent two whole days in each class before the data collection commenced.

**Results**

In response to the first research question, four qualitatively different themes of meanings about reasons for animal diversity were revealed in the analysis. The themes were kinship and heredity, environmental effects, need for adaptation, and need for geographic separation. Table 1 provides a short description of each theme.

In response to the second research question, the analysis of the function of the materials showed that the children used the materials in three different ways, namely, as argumentative tools, communicative tools, and resources providing meaning (cf. tool for thinking Schoultz et al., 2001). Table 2 provides definitions of the three functions revealed in the discussions.

In the following text, examples from the data are presented to illustrate the results. The subsection headlines are named by the conceptual themes. In the analysis of each datum example, the function of the materials is stated in italics and is further described in relation to the context of the discussion.

<table>
<thead>
<tr>
<th>Conceptual theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinship and heredity</td>
<td>Animals are different as a result of breeding.</td>
</tr>
<tr>
<td>Environmental effects</td>
<td>Animals develop different traits because of living in habitats with different conditions, such as climate, temperature, and food range.</td>
</tr>
<tr>
<td>Need for adaptation</td>
<td>Animals live in different conditions; because of this, they need different characteristics to survive.</td>
</tr>
<tr>
<td>Need for geographic separation</td>
<td>Animals live in different environments and in different parts of the world, because of their traits.</td>
</tr>
</tbody>
</table>
Table 2. Name and descriptions of the three emergent functions of the materials.

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Communicative tool</strong></td>
<td>The material serves as a tool to communicate something to another person. For example, the children point at the tiger photo or figurine and say, &quot;That one,&quot; instead of, &quot;The tiger.&quot;</td>
</tr>
<tr>
<td><strong>Resource providing meaning</strong></td>
<td>The children observe aspects of the materials, for example, green grass, white snow, size of the cats. These observed aspects are included in the meaning making process. For example, the children look at the photo of the tiger and say that it lives in the jungle.</td>
</tr>
<tr>
<td><strong>Argumentative tool</strong></td>
<td>The children synthesize several observed aspects in the materials and use these to argue for ideas. For example, the children compare patterns of the big cats’ fur and argue for relationships.</td>
</tr>
</tbody>
</table>

**Kinship and heredity**

During the discussions, the children used the materials to make meanings that included kinship and heredity as reasons for animal diversity. The interspecies relationships were described in various ways. In the following excerpt, Rose, Bella, and Audrey are talking about kinship as a direct mother-child relationship. However, in other groups, kinship was also discussed and described in terms of cousins and second cousins. Rose, Bella, and Audrey’s conversation begins with Bella saying that one cat gave birth to a lion. When the interviewer asks her which cat it was, Bella lifts up the jaguar and says it gave birth to the lion, and that the tiger gave birth to the snow leopard. While Bella is talking, she points to the figurines in turn. Rose points at the tiger figurine and asks Bella, "But which one gave birth to that one?" Bella does not respond, and Audrey then points to the figurines saying:

Excerpt 1. Audrey, Rose, and Bella.

1  A: Maybe that one (points at the tiger figurine) gave birth to that one (points at the snow leopard) and that one (points at the snow leopard) gave birth to that one (points to the tiger).
2  R: But I’m thinking like that one (touches the lion figurine) is the biggest, and then it’s that one (touches the tiger) and then comes that one (points at the jaguar) and then comes that one (points at the snow leopard).
3  B: But I mean that those two are babies (points to the snow leopard and the jaguar).
4  R: And those two are the parents (points to the lion and the tiger).

In the excerpt above, Rose is using the size of the figurines to argue for which one of the animals might have given birth to the other. In lines 3–5, Rose touches and points to the figurines as she arranges their sizes from biggest to smallest. Her actions with the materials are communicative, and the materials function as *communicative tools*. Bella then adds that the smallest of the figurines are babies, and Rose fills in that the other two, the biggest (lines 3–4), are the parents. It seems as if Bella and Rose agree that the size of the animals portrays something about their relationship. In other words, the size of the figurines provides meaning that affect the girls’ meaning making. The students continue talking about which one of the animals “gave birth” to which for approximately two minutes, when Audrey says:

Excerpt 2. Audrey.

1  A: But those two (points at the snow leopard and the jaguar figurine) look the same, so maybe that one (points to the snow leopard) can give birth to that one (points to the jaguar) and that one (points to the jaguar) can give birth to that one (points to the snow leopard). They are alike in their pattern.
Audrey uses the resemblance in patterns on the snow leopard and the jaguar (lines 1 and 3) as an argument for the snow leopard and jaguar having a relationship as parent and child. Thus, in this example, we see that the figurines are used as argumentative tools. Two different traits, pattern and size, are used to argue for different big cat species’ inter-relationship as mother and child. The children explicitly point to the traits that are depicted in the figurines, and use them as semiotic resources in their meaning making.

**Environmental effects**

The meaning that the big cats have developed different traits or appearances because of living in habitats with different conditions, such as climate, temperature, and food range, were made in several groups. The following example presents a conversation between Martin, Moe, Lisa, and June as they take turns to tell each other their ideas about why animals are different now, when a million years ago there was only one type of big cat. When it is Martin’s turn to express his thoughts, he says that the animals have “turned out” differently due to what they have eaten:

*Excerpt 3. Martin, Moe, Lisa, and June.*

1. Ma: Ehm … I was thinking like this, that at first, they were the same tigers with sharp teeth (holds his index fingers at each side of his mouth) really sharp, like this (pulls index fingers down across his chin) that went down. So they could eat very well. And then, the snow leopard … it, it walked to the snow and started to get cold. Because it didn’t find any food and so. And then it became really snowy and became a snow leopard. And the others … they … they walked to warmer and it … like the tiger (points on the photograph of the tiger) it, it went (points at the photograph again) to the forest and eats a lot of leaves.
2. Mo: To the rainforest.
3. Ma: Yes. And the lion (points at the photograph of the lion) it went and ate this yellow stuff (points at the photograph again) and ehm …
4. L: What yellow stuff? (Leans towards the photographs and looks at the photograph of the lion.)
5. Ma: This (points to the yellow grass).
6. J: (leans forward towards to photograph)
7. Mo: (leans forward towards to photograph)
8. Ma: And this one … (points to the photograph of the jaguar). What’s it called again? This one … ate only grass, so he became this animal. (Moves his hand over all photographs.) So then all became different (moves his hand back over the photographs).

In the excerpt above, we see how the children use the photographs to discuss how different habitats might have affected the development of different species. Martin says that the animals were alike at first, with sharp teeth, and gesturing with his index fingers to mark the placement and size of the teeth. Martin then says that the snow leopard walked to the snow where it got cold (line 4). Martin’s words in lines 3 and 4 are interpreted as if the original animal, the one with sharp teeth, walked into the snow and then “became a snow leopard” when it got “snowy” and it could not find any food (lines 4 and 5). Martin then says that “the others” (the other big cats with sharp teeth) walked to places where it was warm and ate different things, such as leaves (lines 7–8), yellow stuff (lines 10–11), and grass (lines 16–17). All these things are visible on the photographs of the big cat that he couples the food with. The photograph of the lion has a background showing yellow grass, the snow leopard is in snow, the tiger is in a green forest or rainforest, and the jaguar is lying on green grass. When Martin explains the different conditions for the animals, he looks at the photographs and points at them repeatedly (lines 6–7, 11, and 16). In addition, when Martin says that the lion eats “yellow stuff” (line 10), Lisa does not understand what he means. This makes Martin explicitly point out the yellow grass on the photograph (line 12–13), using the photograph as a communicative tool. Martin’s action indicates
that his meaning making is affected by the photographs. Thus, in this situation, the photograph thus serves as a resource providing meaning.

Another theme discussed by the children was that the environment in itself was not a causal factor in the development of the big cats. Examples of this conceptual theme will be presented in the next section.

**Need for adaptation**

In the children’s discussions, the process of meaning making also led to the assumption that big cats have a greater possibility to survive and/or thrive when they are adapted to their habitat. The reason for evolution was discussed from the starting point that animals live in different conditions, and because of this, they need different characteristics.

In the following example, the need for camouflage is discussed. Just before the conversation commences, Jenna has presented the idea that all the big cats live in different places on the earth, and because of that, they have to look different. The example she gives is that the snow leopard has white fur to prevent it being seen by other animals. The interviewer then asks the other three students seated at the table what they think about Jenna’s idea:

**Excerpt 4.** Victoria, Interviewer, Mike, and Jenna.

1 V: I think it is like Jenna said. It could be that the snow leopard is white so it cannot be seen.
2 I: What do you think, Mike, is it the same for the lion?
3 M: (Looks down, shakes his hands up and down.)
4 (quiet for 22 seconds)
5 I: What do you think about the lion, Jenna? If the snow leopard is white so it cannot be seen, is it the same for the lion then?
6 J: (Nods and smiles) Mmm.
7 I: Tell me more!
8 J: It is so it cannot be seen where it lives.
9 M: (Picks up the photograph of the lion and taps it with his finger.)
10 I: You are pointing at the photograph.
11 M: They have the same color (points at the lion and then the grass behind it several times while he speaks).

The meaning made in the conversation in Excerpt 4 is that the animals have different colors of fur “so they cannot be seen.” That is, the students state that there is a reason why the snow leopard and the lion have different colors of fur: to avoid being seen. Victoria says that she agrees with Jenna’s idea (line 1). With the intention of further probing the line of thought, the interviewer then asks if the same principle applies for the lion as well (line 2). The question is directed to Mike, who has been rather reserved during the discussion, and Mike does not respond. Instead, he looks down and shakes his hands in his lap (line 3). After a period of silence in the group, Jenna receives the same question from the interviewer. Jenna is positive that the same idea applies to the lion (line 7). When Mike joins the discussion, he uses the photograph as a semiotic resource (line 12). He lifts up the photograph and points to it repeatedly, which draws the interviewee’s attention. After the interviewer assigns words to Mike’s action (line 11), Mike then says that “they have the same color.” In combining gestures and verbal language, Mike uses the photograph as a communicative tool. Mike refers to the photograph and claims that the lion looks the way it does because then it cannot be seen and that the lion’s fur has a color that matches the colors of its habitat.

In the following example, Max talks about traits other than camouflage as important for the big cats’ survival opportunities. The traits he focuses upon are fur thickness and the need for good vision. In the following excerpt, Max is elaborating on an explanation of why the snow leopard has thick fur:
In the excerpt above, it is clear that the photographs function as a resource providing meaning. In other words, Max’s meaning making is influenced by the meaning potential in the photographs. He states that the snow leopard has thick fur because it is “freezing” where it lives and explicitly refers to the photograph of the snow leopard (line 1). Max picks up the photograph of the jaguar and says that the snow leopard’s fur is much thicker (lines 2–4). He starts an utterance (line 4) but does not complete it. However, the first part of the transcribed sentence indicates that Max has an idea that something would happen “otherwise,” which can be interpreted as indicating that Max thinks that the snow leopard has a need for thick fur.

Max moves on to talk about another trait, vision, when he picks up the snow leopard figurine and begins to talk about the lion’s need to have “far off” (distance) vision to catch prey (line 8). According to Max, fur and vision are traits that have evolved as a result of a need to meet the animals’ living conditions. As did Mike in Excerpt 4, Max uses the photograph as a communicative tool when he talks about these traits. When he talks about vision, he first points to the eyes of the lion portrayed in the photograph, and then to his own eyes, combining gestures and verbal communication. The photograph represents an image of the lion where the eyes are observable (lines 7–8), making it possible to use as a semiotic resource. In addition, the photograph visualizes the environment where the lion lives. The meaning made by Max concerning the fact that big cats have different eyesight capabilities, could be an assumption based on the notion of the variation in topography in the photographs. There is a more open landscape visualized behind the lion compared to landscapes portrayed in the photographs of the tiger and the jaguar. This might have affected Max’s meaning making, where he uses the meaning potential of the photograph to claim that the lion needs to have distance vision to target prey.

The meaning making processes described in the two examples of this section describe situations where photographs are used as semiotic resources to communicate and from which to extract meaning. The children point at the environment and the conditions where the animals live as reasons for evolution. However, the materials functioned as semiotic resources when the children discussed that animals are in different environments and in different parts of the world, because of their traits. This will be described further in the next section.

**Need for geographic separation**

This section presents examples of how the materials functioned when the children discussed why the animals cannot live in a different climate than their present habitat. Note that these meanings made did not really contain any developmental aspects. On the contrary, meanings made were that animals are “fitted” to a certain environment, and a change in the living conditions would have a negative impact on the species. Thus, these meanings made are the opposite of the meanings made in the previous category.

In the following excerpt, Sarah and Max consult the map when talking about where the snow leopard could live. Note that both Antarctic and Greenland are depicted in white on the map.
In the excerpt above, the meaning made is that climate is crucial for the survival of the animals. Initially, Sarah places the snow leopard on Greenland. When the interviewer asks her why, she explains that she put the snow leopard there because the area contains a lot of snow. Greenland is depicted in white, and Sarah interprets the white color as representing a cold climate. She also relates the “snow” on the map to the name of the animal she is holding, the snow leopard (line 3). This is interpreted as Sarah making it explicit that the map and the snow leopard figurine are resources providing meaning, and that this affects her deduction on the whereabouts of the snow leopard. The map functions as a meaning provider through its communicated colors (white is snow), whereas the figurine represents a snow leopard, where the very name of the animal implies that it lives in snow.

Max interrupts Sarah, claiming that the island is called Greenland. He says this twice, while underlining the first part of its name (line 4). This observation is interpreted to mean that Max is opposing Sarah’s interpretation of the white color on the map. Perhaps the contradiction of the white color on the map and the color in the name Greenland bother him. After the interviewer confirms Sarah’s interpretation of the map, the two students start reading and interpreting the map together. Max assigns words to what he sees, but asks Sarah for her view on whether the part of the map where the Antarctic is located is land or ice. In this example, the figurines and map are used simultaneously. In line 12, Max takes the snow leopard figurine and places it on the Antarctic, claiming that the animal could also live there. This can be interpreted as showing that Max thinks that the snow leopard could live in Greenland and the Antarctic since both places are covered with ice or snow. Despite disagreeing with Sarah’s interpretation of the white color earlier, here it seems as if the social interaction with Sarah has influenced his use of the map as a semiotic resource. Hence, the social interaction seems to contribute to Max discovering other meaning potentials of the map. Max is using the lion figurine in his action of laying it down, while claiming that the lion would die (lines 13–14). When he does this he makes a guttural noise, and the sound and the way the lion is placed communicate to the other students that the lion is dead. Sarah smiles, points to Africa and says that the lion should live there. This is interpreted to indicate she thinks that Africa is a more appropriate environment for the lion.

The students move the figurines between different colored fields of the map. They also point at the map and refer to the different colored fields as “there.” Sarah’s and Max’s joint interpretation of white colors as snow and ice, as well as land or ice, shows that the map and the figurines serve as both socially shared resources providing meaning and communicative tools in their meaning making process.
Summary of results

The materials were associated with different functions during different themes of the discussions. Table 3 presents a synthesis of the conceptual themes discussed above and the respective function of the materials in each theme.

Discussion

The aim of the study was twofold, aiming to examine how children explain reasons for animal diversity, as well as how materials function in the discussions. The discussion of the results is presented as three subsections. First, the conceptual themes are discussed in relation to the first research question. Then, the functions of the materials are discussed in relation to the second research question. In conclusion, pedagogical implications of the results are provided for how teachers can introduce evolution theory in preschool and early years education.

Conceptual themes in children’s discussions about animal diversity

Four conceptual themes were identified in the children’s discussions that all related to different reasons for animal diversity.

The three conceptual themes of environmental effects, need for adaptation, and need for geographic separation have environmental features as a common aspect in relation to animal diversity. In the environmental effects theme, aspects such as food and temperature were provided as reasons for the development of new animal features. In contrast, need for adaptation indicated that animals have to adapt to the environment in order to survive, and that different environments call for specific features, such as camouflage, thick fur, or distance vision. Lastly, need for geographic separation differs from need for adaptation in that it builds on the notion that animals will perish in an environment that does not fit the animals’ features.

In the need for geographic separation and need for adaptation conceptual themes, the children include an implicit “what if” in their discussion. In need for adaptation, the unstated assertion could be, “What if animals do not adapt to the environment? Then they will die, hence they evolve.” Compared to meanings expressed about environmental effects, there is a reason that animals evolve (in order to survive). They do not just suddenly change as an effect from eating something of a certain color. In need for geographic separation, the implicit assertion could be, “What if the animals were not living in this specific environment? Then they would die.” In this conceptual theme, adaptation to the new environment does not seem to be an alternative for the children. The finding of meanings that animals are adapted to the environment from the beginning correlates with previous findings from Samarapungavan and Wiers (1997), where essentialist conceptions were common among 9-year-old and 12-year-old children.

In none of the themes relating to environmental aspects did the children discuss how the actual change in features takes place. However, this is discussed in relation to the first conceptual theme, kinship and heredity. When the children discuss kinship and heredity as a reason for animals being
different, they mention that animals are “here and now.” It seems as if they are talking about individual animals. More specifically, the children convey the idea that one lion and one tiger are father and mother of the other smaller animals, respectively. From the data, it is not possible to conclude that the children actually talk about kinship on a group or species level. Talking about individuals, and not about a population, applies to the other three conceptual themes as well. In this regard, the children merely talk about the animals as individuals, and not as representatives of a population.

In relation to previous research on children’s discussions of reasons for evolution, this current study reveals two main differences. First, all children in this study actively took part in the discussions about animal diversity. This challenges the view that children mostly provide “don’t know” answers to questions about speciation and the origin of species before instruction, as reported in the recent study by Berti et al. (2017). One explanation for differences in the results might be that the posed discussion question in this study explicitly focused on the reasons for speciation (i.e., why are species within the same family different?). This question might have prompted the children to focus on conceptual aspects of speciation (Jaipal, 2010). Second, there were no discussions that involved creationist ideas, which was common among children without formal instruction about evolution theory in studies by Evans (2000) and Berti et al. (2010). This might be a reflection of secularization in Sweden and the less frequent exposure to religious views about the origin of species.

**Functions of materials in children’s meaning making about animal diversity**

This study has shown that the children used materials as semiotic resources in the discussions in at least three different ways: as resources providing meaning, as communicative tools, and as argumentative tools. The following discussion addresses four aspects of these functions, namely, (1) each of the materials had a different potential to serve as a resource providing meaning, (2) the children sometimes negotiated the use of the materials, (3) different materials had the same function, and (4) the same materials had different functions.

Given the four aspects above, and as previously shown by scholars such as Schoultz et al. (2001), access to materials as tools for thinking influences what children are able to discuss. This study contributes to these results and shows that materials have different “potentials” in serving as resources to provide meaning. The photographs represented features of the environment where the animals live, that included snow, warm habitats, grasslands, forests (Excerpt 3), cold habitats, and open fields (Excerpt 5). In addition, the photographs and the figurines provided meaning about animal characteristics, such as animal fur pattern and thickness (Excerpt 5), and animal size (Excerpt 1 and 2). The colors and topography on the world map provided meaning about climate, enabling discussions about climate and its effect on the animals’ survival (Excerpt 6).

Each material could be seen as implicitly directing children to construct a meaning. The photos provide specific meanings to the children, such as the idea that snow leopards live where there is snow. In this way, a photo is a more “closed” material than the map and the figurines. Because children’s meaning making is affected by the material’s meaning potential, it can be assumed that the meaning making about animal diversity would be different if children had access to other kinds of materials, or if all materials were removed. Overall, materials that support children’s meaning making can also prevent or constrain other meaning making processes, which, in turn, limits the meaning making to what can be discussed in relation to the materials provided.

On some occasions, the interpretation and use of the semiotic resources’ meaning potential were negotiated. One example of this is found in Excerpt 6, where Max questions Sarah’s conclusion that the white color on the map represents snow. On other occasions, the materials afforded no negotiation, such as in cases when the children used the materials as communicative tools. In this study, the figurines and the photographs were often referred to as “that one” or “these,” in combination with deictic gestures, instead of adopting the name of the species. The children moved the figurines around on the map, communicating potential actions made by the animals as
well as the effects of these actions. The absence of questioning such actions shows that none of the children had difficulty accepting that the figurines were representations of actual animals and that they served as socially shared semiotic resources. This also supports findings by Jaipal (2010) that verbal statements together with gestures reinforce meanings. Socially shared resources make it possible for the children to collaboratively construct conceptual meanings and discuss different scenarios (e.g., discussing what would happen to an animal if it lived in another habitat).

The same material sometimes served the same function within different themes. Interestingly, the photographs were used as resources providing meaning and communicative tools both when the children discussed environmental effects on the animals’ traits (Excerpt 3), as well as adaptation to the environment due to the big cats’ needs (Excerpt 4 and 5). In the same way, the figurines provided meaning and served as communicative tools when the children discussed kinship and heredity (Excerpt 1 and 2) and when they discussed essentialist meanings, such as that the animals must live in certain environments to be able to survive (Excerpt 6). These meanings differ in conceptual terms. The notion that the same materials served the same function in both themes show that the direction of the meaning making process depends on what aspects the children place in the foreground. Consequently, this indicates that the functions of different materials are not constrained to one conceptual theme alone.

The analysis also showed that the same material served several functions. In this regard, when Audrey, Rose, and Bella (Excerpt 1 and 2) discussed that animals are different because of kinship and heredity, they used the figurines exclusively. They observed similarities and differences in the color and size of the figurines and interpreted these differences as information about animals’ features. Hence, the figurine served as a resource that provided meaning. They pointed to the figurines and used them as communicative tools. Additionally, they used their observations as arguments, a finding suggesting that the figurines not only served as communicative tools, but also as argumentative tools.

The results from this study contribute to the findings from previous studies of alternative teaching strategies for introducing evolution theory in preschool and early primary school (Browning & Hohenstein, 2013; Kelemen et al., 2014; Nadelson et al., 2009). Nadelson et al. (2009) claimed that products generated during lessons can be used as sources of evidence, reflecting learning and understanding of evolution. In this study, the actions made with the materials and by communicative modes such as gestures and gaze are shown to reflect children’s meaning making. In relation to the conclusions reached by Browning and Hohenstein (2013), the children in this study used the materials to construct their own narratives. As they moved the figurines around the map, they created a chronology, linking events and arguing about the causes and consequences of these events. Despite not having had any formal instruction about evolution theory, the 6-year-old children in this study used the provided materials to make meaning through collaborative and individual observations, and acknowledging the meaning potential provided by the semiotic resources. Overall, the meaning making processes occurring in the discussions led to the development and ownership of logical claims.

**Conclusions and pedagogical implications**

The meaning potential of the different materials and the fact that the materials were used as communicative tools enabled children’s discussions about similarities and differences in animal traits. The children spontaneously used the materials to point out similarities and differences between the different animals. Similarities in patterns and color were used to argue for kinship and heredity. Differences in thickness and color of the big cats’ fur were used in discussions about why animals live in different parts of the world (need for adaptation). Moreover, the children argued that the animals’ differences in appearance were the result of environmental effects, and the children claimed that the big cats were in need of geographic separation due to their differences.

It is acknowledged in the recent literature (Nadelson et al., 2009) that evolution theory cannot be taught to preschoolers in the same manner as to older students. The results of this study show that
children are able to discuss abstract science phenomena. Tudge (1992) states that there is no guarantee that meanings made within peer groups are on a higher level than if children reason individually. However, the children in this study questioned their peers’ interpretations of the materials and interpreted them jointly. They followed their peers’ reasoning and introduced new conceptual themes to the discussions while using the materials. Hence, in relation to the zone of proximal development (Vygotsky, 1978), this implies that materials enable children to alter the role of being the more capable child. Providing access to materials that facilitate discussions about similarities and differences in traits among species in the same biological family can be a fruitful way to start to make meaning about evolution theory.

Because meaning making processes might be enabled and limited to the meaning potential of different materials, teachers need to take care when they choose materials to introduce evolution theory. Teachers as well as researchers need to consider appropriate tools for thinking (Schoultz et al., 2001) and should create tasks that build upon the situated practice of preschool and early primary school, as well as children’s previous experiences.

ORCID

Johanna Frejd http://orcid.org/0000-0002-7519-9259

References


