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Exploring the pedagogic relation - Supporting six-year-olds in making sense of physical motion

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Abstract: This article explores how verbal relations between child and researcher may support the child's reasoning and making sense of physical motion. In an earlier study, 64 children aged 6–14 participated in one-to-one reflective dialogues. Some of them developed their reasoning during the dialogue, and used an exploring approach to make sense of physical motion. For the present study, 6 transcripts were re-analyzed concerning the interplay between the researcher and the 6-year-olds who used this approach, aiming to explore the pedagogic relation, namely how the children used language to understand physical motion and how they were supported by the researcher. The analysis revealed some conditions for a pedagogic relation: the adult uses an *inviting approach*, directing the child's awareness by framing the phenomenon, directing and reflecting the child's awareness towards their use of language, and asking for the child's perspective. Children who used an *exploring approach* spoke of the phenomenon 'as', expressed awareness of their own use of language, and tested and developed meanings. The results are discussed in relation to science education in early childhood settings, and ways of helping children expand their reasoning using an exploring approach to scientific phenomena.

Keywords: Early childhood, Language use, Pedagogic relation, Reflective dialogues.

Introduction

Research on children's conceptions about scientific phenomena (e.g. Vosniadou & Brewer, 1992; Elm, 2008; Fleer, 1995) has shown that given the opportunity, young children are able to formulate and develop their conceptions about complex phenomena. According to the Swedish preschool curriculum, children in preschool should be given opportunities to develop understanding of the surrounding world and to develop meaning in scientific concepts. The curriculum also states that the preschool teacher

has the responsibility to support the children in their attempts at understanding (Skolverket, 2010). The quality of the relation created between adult and child is of central importance for whether or not the child wants to develop their reasoning and sense-making regarding the content matter. Studies of quality in preschool settings (Siraj-Blatchford, Sylva, Muttock, Gilden & Bell, 2002; Sheridan, Pramling Samuelsson & Johansson, 2009) emphasize learning/teaching through a process of reflexive co-construction as the most effective pedagogy in early childhood setting. This process, known as sustained shared thinking (Siraj-Blatchford et al., 2002), has been shown to support children in their thinking and reasoning about content matter. Sustained shared thinking is described by Siraj-Blatchford et al. as episodes where two or more individuals work together to solve a problem or clarify a concept, in which both parties contribute and the adult invites the child/children to develop and elaborate their thinking. The adult's way of speaking and the language they use are decisive for whether this kind of quality is created, and knowledge about the complexity and conditions of such interplay would provide an important contribution to creating opportunities for making sense in preschool settings. What, then, is it that characterizes the use of language in sustained shared thinking? When children between 6 and 14 were invited to one-to-one reflective dialogues with a researcher (Åkerblom, 2011), some of the children developed their reasoning about physical motion in a way similar to the sustained shared thinking described by Siraj-Blatchford and colleagues (2002) in preschool contexts. Even the 6-year-olds showed that they were quite able to develop their reasoning about complex phenomena, to present hypotheses about these phenomena, and to reflect on their own language choices. The interplay in these dialogues allowed the children to develop their reasoning and approach the content differently. The study was originally undertaken as an investigation of the role of language in conceptualization (Anderberg, Svensson, Alvegård, and Johansson, 2008; Åkerblom, 2011). The study presented in this article consists of a re-analysis of parts of the empirical material from the investigation. The re-analysis was carried out in order to explore the interplay more closely and discover why it led to development of meaning for some of the children. Dialogues in which 6year-old children interpreted the situation as an invitation to make sense of physical motion experienced in the "real word" were selected and analyzed. The particular language approach was identified as an exploring approach (ibid., cf. Barnes, 1975) and seen as being concerned with conceptualization of the content matter.

Other kinds of responses were also identified. Some of the 6-year-olds responded within a narrative framework (Heath, 1983) associating to their own experiences with balls and of the moon, or understood the questions as a request to show what they remembered being told about the phenomena (see Åkerblom, 2011). However, the present article focuses on the exploring approach, and considers this approach to be a prerequisite for understanding within a scientific framework; that is, learning to make sense of physical motion.

In the empirical investigation, the children were presented with two questions concerning physical motion: *Why does the moon not fall down*? And *what happens when a ball is thrown slantingly into the air*? They were then invited to reflect on their own choice of words addressing the questions. The children's responses in the dialogues were not analyzed as expressions of inner constructions, but rather as an ongoing activity of making sense. Here, the dialogue partner and the specific questions posed were crucial. Although the purpose of the dialogues was not originally to enhance learning, the reflective character of the dialogues proved to have didactic qualities. The present article discusses possibilities for supporting children in extending and expanding their reasoning using an exploring approach to scientific phenomena. The purpose of this article is to answer the following questions:

What qualities characterize the language strategies used by the six children to make sense of content matter?

What qualities characterize the language strategies used by the researcher in supporting the children's sense-making in the reflective dialogues?

An additional aim is to discuss the results in relation to science education in early childhood settings.

Background

The possibility of formulating and expressing one's experience plays a vital role in the learning process, just as awareness of how language works seems to be a decisive factor for development of understanding (Åkerblom, Anderberg, Alvegård and Svensson, 2011). Dewey (1956), Vygotsky (1986), Halliday (1993), and others have stated that use of language might be the first and most important resource for children's learning. Pramling (1983) showed that how preschool children reflect on and understand themselves as learners is related to the way they go about approaching the subject matter. Barnes (1975) investigated how children between 11 and 13 used language in classroom situations, and found that when they expressed themselves about the subject content and had opportunities to formulate what they knew, they were able to adapt the content for their own purposes and understanding of the world. He concluded that verbal language gives the possibility to reflect on thinking, when he studied how children tried to solve problems together and to make sense of a subject matter. He also identified different language strategies. One of those strategies that he called exploratory talk was characterized by many marks of insecurity, reformulations, and changes of direction. The children using language this way tested their hypotheses both against experience and against the content of the subject matter, held many possibilities open, and were ready to change their ideas. Barnes argues for the importance of exploratory talk for the learning process. However, not all children used this strategy in the interactions. Barnes also described an approach where the children were looking for clues and "correct" words and statements, in a reproductive fashion.

Research on children's conceptions has shown that ideas about physical phenomena appear in early childhood (e.g. Piaget, 1971; 1973; Osborne, & Freyberg, 1985; Vosniadou & Brewer, 1992). Einstein allegedly said that a physicist knows half of what she ought to know about physics by the age of three (Osborne & Freyberg, 1985). This notion underpins Bruner's idea of the spiral curriculum (Bruner, 1960), which holds that teaching should evolve around basic ideas and that any subject can be taught in a meaningful way to any child at any stage of development. Similarly, a longitudinal study of personal ideas in students' thinking about ecological processes showed that several students seemed to have a core idea: a personal theme that reappeared through the years. When asked where these ideas came from, the students often referred to early childhood experiences (Helldén & Solomon, 2004). However, the Piagetian studies and many other studies on children's conceptions focus solely on the children without taking the interview situation into account. Conversely, Vygotsky (1986) considered the significance of context and pedagogic relations and spoke of the pedagogic relation between the adult and child, when the adult's activities actually support the child to make sense by challenging the child's understanding, as the "zone of proximal development".

Several early childhood researchers point to the importance of scientific activities in the early years, as well as supporting children's reasoning as they establish and reflect on scientific ideas (e.g. Elm, 2008; Eshach, & Fried, 2005; Fleer, 1995; French, 2004; Thulin, 2011; Conezio & French, 2002). Solomon and Hall (1996) concluded that language use is vital for almost all learning, for articulating the tacit and linking thought to action. In addition, Pramling Samuelsson and Asplund Carlsson (2003) highlighted the role of language in learning, and showed that metacognitive dialogues have a large impact on children's understanding. Thulin (2006) saw that when children became engaged in science settings, they developed their skill at posing questions, leading to deeper engagement and understanding.

Fleer (1995) showed it was more critical to focus on concepts rather than procedures in communication with children in science settings. In a pilot study with a group of 6-year-old children (Åkerblom, 2008), the children were invited to reflect on what they meant when they used scientific terms after being introduced to critical aspects of gravity and the movement of planets. The results showed the fruitfulness of using reflection to make sense of scientific phenomena, and also revealed that the children, while reflecting on their own language, became aware of it. Another study conducted by Fleer (2009) examined how very young children develop conceptual understanding in science, drawing on Vygotsky's writings on everyday and scientific thinking. Fleer concluded that support for children's understanding of science should include playful investigations of phenomena, as well as systematic exploration of scientific terms. These and other studies point at the fruitfulness of working with language use and understanding scientific phenomena in preschool settings.

Some studies focus on the interaction between teachers and children around scientific content (e.g. Poimenidou & Christidou, 2010; Peterson & French, 2008). In a study of how preschool teachers and children address content matter in a science context, Thulin and Pramling (2009) showed that the teachers tended to speak in human terms about something non-human (in this case insects) in order to connect their language with children's experiences and terms. This anthropomorphic way of speaking was more common among the teachers than among the children. The authors emphasized the importance of making teachers aware of their language, and questioned whether this kind of speaking actually supports learning about scientific content matter. Sträng and Åberg-Bengtsson (2009) studied the interaction between a group of 5-year-olds, their teacher, and a guide in a science center exhibition about the water cycle. Several patterns of interaction were initiated by the adults. The science guide mainly used a narrative strategy, telling the children interesting facts and circumstances. The teacher (unsuccessfully) tried to direct the children's attention by posing questions to make the children draw their own conclusions. In pre-school after the visit to the center, the teacher used a strategy of asking the children for accounts and right concepts. The authors claimed that the children's way of acting strongly depended on the strategy chosen by the adult. In line with Thulin (2011), they argued that the language strategies used by the adults did not so much promote children's understanding of natural phenomena, but may rather have been means to achieve other goals. A common thread in these studies was that although the teachers' aims were to teach children scientific content, they did not use language strategies in a conscious way to direct the children's attention towards the content.

Theoretical assumptions

In this article, learning is considered in a phenomenographic, relational sense, concerning changes in the way a learner approaches a phenomenon in the world (Marton, 1981; Svensson, 1997; Marton, & Booth, 1997). An intentional-expressive research approach was used, giving particular attention to the question of how a learner approaches a phenomenon through use of verbal language (Anderberg, 2000; Anderberg et al., 2008). Language meaning is understood to be constituted within the activity of making sense of content. Additionally, the inter-subjective relation between the adult (researcher or teacher) and the child is considered as a condition for something to be expressed, both as a response to another and as an approach to some specific content. What is being said is expressed with a double intention: *about* something *to* another/others (Åkerblom, 2011), and these aspects are considered in the analysis.

The empirical study

The present study is a re-analysis of a part of empirical material collected with the aim to explore, analyze, and describe how 64 children aged 6, 10, and 14 used language to express their understanding

of certain physical phenomena in reflective dialogues. The re-analyzed material was all excerpted from dialogues between 6-year-olds and a researcher, and all excerpts covered children using a special language strategy to make sense of the questions they were asked.

Data Collection

Data for the original study were collected in a dialogue structure developed within the intentionalexpressive approach (Anderberg, 1999, 2000, 2003). The questions of the dialogue structure were intended to make the children express their understanding of a problem, and then reflect on a number of key expressions they had used when speaking about their conception of the problem.

Participants

In the original study, dialogues were conducted with 18 6-year-olds (11 girls and 7 boys)¹ from two preschool classes in the same school. The dialogues were conducted individually with the researcher, and lasted between 20 and 40 minutes each. The recorded material was then transcribed verbatim. The dialogues were carried out and transcribed in Swedish, and the analysis was performed on the Swedish transcripts. Examples from the empirical material used in this article were translated from Swedish to English with the aim of reflecting the Swedish wording as faithfully as possible, rather than providing a more idiomatic English equivalent. The six dialogues (from four girls and two boys) selected for the present study were previously analyzed and distinguished by the use of an exploring language strategy. In the original study, these six children were the only 6-year-olds who used that approach; the other 12 used other approaches (see Åkerblom, 2011).

Ethical considerations

The ethical guidelines of the Swedish Research Council were followed. The parents gave their written consent, allowing their child to participate in a one-to one digitally-recorded dialogue with a researcher. The children themselves were asked if they wanted to participate, and gave their consent. They were informed that participation was entirely voluntary, and that they could interrupt the dialogue at any time. The material was handled in such a way as to maintain anonymity. All the children were given pseudonyms as the dialogues were transcribed, and no personal information was recorded other than their age and gender.

Dialogue structure

In the dialogue setting, the child was asked the two questions: *What happens when a ball is thrown slantingly into the air?* and *Why doesn't the moon fall down?* The problems were chosen to match previous investigations about the epistemological role of language, which also focused on physical motion (e.g. Svensson et al., 2009). These questions also have the advantage of being concerned with commonly experienced phenomena (the movement of a ball and the moon) which can be talked about in a number of ways. This choice therefore allowed comparisons between groups with more and less experience of a theoretical conception of the problem.

All dialogues followed the same basic structure. The two questions were presented to the child, who then decided which one to start with. The child was then invited to elaborate on their conception of the problem; that is, a possible way to understand the problem. Expressions which were central in the child's explanation/description were then chosen by the interviewer, and focused on in the following sequence of the dialogue. Normally, content-words were selected which played important roles in the

¹ The analysis did not take into account either gender or any possible differences in language use due to gender. The only reason gender is mentioned is to show that the groups were not homogenous.

child's description/explanation of the problem. The child was invited to explore and identify what they meant by these expressions. The child was then invited to look for synonyms and related expressions, and to identify which meanings had been given to these words. The initial question was then repeated to maintain the focus of the dialogue. In the dialogue structure used here, the question was framed to make the child summarize what had previously been said; that is, to find another way of expressing "the same thing". At the end of the dialogue, the children were given the opportunity to reflect on the dialogue situation as a whole.

Data Analysis

The analysis was performed using qualitative *contextual analysis* as described by Svensson (2005). The methodology is both analytic and contextual in a specific sense – involving the analytic delimitation of a phenomenon/ research object and its parts – as well as being "contextual" in delimiting how the parts depend on their contexts. The starting point of analysis was to delimit the object of research as the children's experience of the function of their own language use in expressing conceptions.

The transcribed dialogues constituted the material for analysis. In the first phase of the analysis, each dialogue transcript was dealt with as a whole, with the global impression of each transcript in focus. In the next phase of analysis, all the transcripts were divided into sequences in which where the children, supported by the researcher, reflected on selected expressions. The child's activity during the reflective sequences was compared to other sequences, and grouped on the basis of similarities and differences. The re-analysis was conducted on a part of the dialogues that had been analytically selected in a former study. The re-analysis had a different focus, with emphasis on the interplay between the child and the researcher. The interplay was delimited as the phenomenon of the contextual analysis, and qualities were analyzed with the aim of exploring the researcher's language strategies related to the children's response.

Results

The following section examines episodes of interplay between the researcher and the child in which the child used an exploring approach. Specific qualities of the interplay are presented here, exemplified by extracts from the empirical material. The language strategy used by the researcher was identified as an *inviting approach*, distinguished by the qualities (*A1*) framing the phenomenon, (*A2*) directing the child's attention, (*A3*) change of attention, and (*A4*) directing the child's attention towards their own meaning-making. The language strategy used by the children, identified as an *explorative approach*, was distinguished by the qualities (*C1*) speaking of the phenomenon "as", (*C2*) awareness of thinking, knowing, and the function of language, (*C3*) change of meaning, and (*C4*) development of meaning using words.

Adult: inviting approach	Child: exploring approach
(A1) framing the phenomenon	(C1) speaking of the phenomenon "as"
(A2) directing the child's attention	(C2) awareness of thinking, knowing, and the
	function of language
(A3) change of attention	(C3) change of meaning
(A4) directing the child's attention towards their	(C4) development of meaning using words
own meaning-making	

Table 1. Language strategies used by the adult and the children

(A1) Framing the phenomenon

The researcher used starting questions in order to frame the phenomenon. Here is an example from the dialogue with Evy.

I: Let's see, I was going to ask about two things.Evy: Okay.I: I'll start by saying what I'm going to ask about, so that you can choose what to start to speak about. One is: what happens when you throw a ball slantingly into the air? That's one, and then the other one is: why doesn't the moon fall down? And you can choose what you want to start with.Evy: I'll start with the moon.

In mentioning the two questions in the beginning, the researcher points out the phenomenon as a dilemma, namely that some objects (like balls) fall down to earth, but other objects (like the moon) do not. The child is asked to choose, and the researcher invites the child to reason about the questions, rather than simply to arrive at "correct" answers or single facts.

(C1) Speaking of the phenomenon "as"

The children using an exploring approach commonly interpreted the situation as an invitation to make sense of physical motion experienced in the "real world". A central quality was that they spoke of the phenomenon in focus *as something*.

Gabriella spoke of the movement of the moon as a picture that she "saw".

Gabriella: ... I get a picture of space, when the moon spins.

The children often used their own bodies to express what they meant, like Ove, below, who used his fists to show the relation between earth and the moon.

I: ...you say that the moon is hovering, what did you think when you said that about hovering? Ove: Yes, that is just... The moon is here and earth is here (shows with his fists), then, then, then it is drawn around and it moves like this.

Evy showed how a ball came into movement by standing up from where she was sitting, and saying:

Evy: Yes, it goes up just because... I will show you on the floor... I: Yes?

Evy: It goes up just because you do like this (mimic kicking a ball). You take it, it is so light so you can kick it, then it just flies and does what you want it to do.

Evy, below, also used her hand to explain what she meant by the metaphor of *invisible tentacles*, when telling the interviewer why the moon doesn't fall. She made it clear that she was speaking *as if*, marking this with the words "*let's pretend*".

Evy: ...so they hold...for example, if this is the moon (shows with her hand), let's pretend, then this is the globe, and then it seems small but it is actually giant...

[...]

I: Okay... you said the earth flies around...?

Evy: Yes, it is to say it flies here and there, without you noticing it, the earth spins...

I: Yes? Evy: ...around.

Evy also pointed out the existence of different perspectives, and of phenomena that are not experienced with one's senses, like the movement of the earth or the actual size of the moon: "*It seems small but it is actually giant*...."

(A2) Directing the child's attention

The researcher used questions to direct the child's attention. Asking about the child's own experiences with balls and other falling objects, as well as their observations of the moon, was intended to make the child pay attention to their own experiences of the phenomenon. In this example from the dialogue with Ove, he was unsure whether a ball thrown slantingly would land further away than a ball thrown straight.

I: You said that the ball, when you throw it slantingly, then it *comes less far*, and you mean less far than what?
Ove: Than if you throw it like this (shows how he throws a ball straight).
I: If you throw it like that, straight?
Ove: Yes.
I: Is it so?
Ove: Or it might be the other way around, I don't know.
I: No? Maybe you can go out and test later, when the rain stops. Do you like to throw balls?
Ove: No.
I: Not so much? Do you prefer to kick them?
Ove: Yes.
I: So you prefer kicking to throwing?
Ove: Yes.
Ove: Sometimes I play basketball.

Apart from asking the child about their own experiences, the researcher also repeated the starting questions during the dialogue to redirect the child's attention to them.

(C2) Awareness of thinking, knowing, and the function of language

Another quality found in the explorative dialogues was that when asked, the children explained *how* they understood the phenomenon. Besides conceptualizing the phenomenon, many of the children also spoke about their own thinking and knowing. In the excerpt below, the researcher asked what Ove thought about when he said "*hover*" and Ove used gestures when answering and describing how he saw it.

I: How did you find out to use the word then, hovering?

Ove: I know it!

I: You know it!... what do you think about, when you say hover, hovering, what do you think about then?

O: I sort of think what... how it is in space and then I see that, here is the moon, here is earth (shows) sort of sailing around.

The questions about what Ove thought and meant prompted him to use metaphors, examples, and gestures to explain what he meant. Berta described thinking as pictures appearing in her brain:

I: What happens when you think? Berta: That there come pictures in the brain!

The children often used their own experience, giving examples of what they meant. In the extract below, Ove used a concrete example about throwing a pillow to exemplify what he meant by force. He also introduced his own word, *away-force*, to explain what he meant.

Ove: That... I think it is force, it has.. like we take a force, like if we throw a pillow, then we have a force, and so that, then it just flies with the force, and then downwards.I: Yes?Ove: Because then, then it has no such *away-force*, so then it just goes down.

Another central quality in all the explorative dialogues was that when the children were asked about words, the pictured language as *something*, as well as their own use of words as something to speak about and reflect on. Ove reflected on the sound of words:

I: About this, how words are used when you speak, is it something you have thought of before?Ove: Yes, like this, who came up with all the words, and it sounds...so if you say *meat sauce*, then, then it really sounds like it!I: Yes?Ove: Then it looks like it, like this, it sounds like it!

Mattias was asked how he came to choose a particular word:

Mattias: It turns up in my thought. I: It turned up in your thought? How do you mean, turn up? Mattias: ...When you stand like that, watching, stand, like this still, watching something, thinking of something, then you see it like a picture here inside your brain.

In the sequences below, Gabriella spoke of words having two different aspects: the form of the word, and what the word meant to her. She gave two different words the same meaning. She used the word *fast* about the movement of a ball thrown up in the air, and she was then asked to think of another word to say the same thing.

I: ... Is there another word that you could use instead of *fast*?Gabriella: *Speedy*!I: Yes? Are those two the same?

In this question, the interviewer intentionally refrained from defining what the "sameness" referred to (form or meaning), to encourage Gabriella to make the reference herself. Gabriella answered:

G: Not on the words, but otherwise it is probably the same thing.

She was then asked to compare *fast* and *speedy* in the context of throwing a ball, and whether there was a difference.

I: ... If you compare *fast* and *speedy*, when you are talking about the ball, is there a difference?

Gabriella: The letters.

Gabriella showed her awareness that two different words could be used with the same meaning. She was also aware that the difference was in the form (the letters).

Evy, below, spoke about the meaning of a word, in this case "strong", pointing out that the word could take on different meanings depending on the context in which it was used:

I: You said that those tentacles that you spoke about, they are very strong?
Evy: Yes.
I: And the word *strong*...
Evy: Yes?
I: is there something else you think about, with *strong*?
Evy: Yes, for example like strong... strong peppers and such.
I: Yes, yes like strong peppers, is it the same, *strong*?
Evy: No, since strong is when you are giant, so that you can carry stuff, and peppers are strong so you... oh, no, it's... ouch it burns! Like that!

In this section the language strategies used by the children were distinguished by awareness of their own thinking and knowing, but also about how they used their words. The children gave their own perspective on the phenomenon they were speaking about, and attempted to explain their understanding to the researcher using gestures as well as metaphors.

(A3) Change of attention

The researcher used questions to direct the children's attention alternately towards the phenomenon and towards the words that the child used to describe or explain the phenomenon. First she repeated the word to make the child notice the actual wording, and then she asked what the child meant by that particular word, like in the dialogue with Berta below.

I: What is it that makes the ball go down again then?
Berta: It falls.
I: It falls, how is that?
Berta: *it can't manage* up there in... up for a long time.
I: No? How?
Berta: I don't know.
I: When you say that *it can't manage*, how did you think then?
Berta: That it just falls, all the time down.

The researcher invited the child to change focus from the content of her explanation to the words she used to describe the specific phenomenon, going between the level of expressions and the level of experience.

(C3) Change of meaning

One characteristic of the explorative approach was that the children were open to using different words and different ways to explain. They tested possible meanings against their experience, and in some cases they changed the way they saw the phenomenon or the meanings they wanted to give to certain expressions. In the example below, Gabriella tested different words and metaphors in her explanation of why the moon doesn't fall. I: Why doesn't the moon fall down? Gabriella: Because I think that it's sucked upwards.

She started with the metaphor of "being sucked upwards" to explain why the moon doesn't fall.

Gabriella: ...When something else... it's sucked upwards all the time, and then... I think it's sucked upwards.I: How do you mean then?Gabriella: That it's kind of sucked upwards in space, that it blows upwards...I think.

When she was asked to explain, she tried the expression "blows".

I: Yes, and why is that?Gabriella: It... I don't know, that was a tricky question.I: When you said it's *sucked upwards*, what did you think then?Gabriella: I was thinking that, that earth sucks everything in towards itself, I thought.

She developed the idea of "sucking" as a movement towards earth, but she lacked the expression "gravity" or "attraction force". When asked about other expressions associated with space she came up with "flying".

I: Is there something else you think of when you talk about space?
Gabriella: ...Flying.
I: Flying! When you... before you said that the moon is *sucked upwards* and now you say *flying*... is there a difference between those two words?
Gabriella: Well, being sucked upwards is not exactly flying.
I: No? How is flying then?
Gabriella: You can steer yourself in all directions.
I: Yes?
Gabriella: And the moon can't, it can't go in all directions.
I: So the moon can't go, can it fly?
Gabriella: Well... it flies!

She tested the expression "flying" to describe the movement of the moon, but was not completely satisfied with this, as she associated this expression with a more active movement. However, she also claimed that the moon flies in some sense. When asked to picture the movement, she came up with the expression "spins", describing it as "like a large circle and the circle draws the moon around".

I: Can you picture it?Gabriella: Well... I get a picture of space, when the moon spins.I: Yes, the moon spins?Gabriella: Yes, I think so anyway.I: Is that the same as flying?Gabriella: No... But actually, I think it's like this, that... that it's a large circle that the moon is inside and then that circle draws the moon around.

The children tested their own meanings against their experience. In doing this, they sometimes found out that they would prefer to use different wordings than previously, thus developing their own understanding of the phenomenon during the dialogue.

(A4) Directing the child's attention towards their own meaning-making

In inviting the child to make personal sense of physical motion, the researcher was asking for the child's perspective and choice of words. Questions such as "*What do you mean/think about this?*", "*How do you want to use that word?*" and "*What do you mean by...?*" invited the child to be the agent of their own sense-making, as opposed to posing passive-form questions about the meanings of words in a more general sense, such as "*What does it mean?*"

(C4) Development of meaning using words

As the researcher asked the children to explain, to specify meanings, and to verbalize experience, the children sometimes noticed inconsistencies, changed their expressions, and extended their reasoning, like Gabriella above (C3) and Sandra in the example below. In the course of the dialogue, Sandra developed her conception of why the moon doesn't fall down. At first she said that she didn't know, but later in the dialogue she came up with "gravity" as a reason for the moon not to fall:

I: Why do you think the moon doesn't fall down? Sandra: I think I know... it's held up by gravity!

Here, gravity is something that holds the moon up. Sandra was then asked how she came to think of gravity and what she meant by it. The researcher invited her to specify how she was thinking and about the specific meaning of the words she was using.

I: It's held by gravity, how did you come to think about that?
Sandra: Well... I just came up with it!
I: Gravity?
Sandra: Yes?
I: What's that?
Sandra: It's so heavy for the moon to come down.
I: That it's heavy for the moon to come down?
Sandra: Yes.
I: Okay, how do you think then?
Sandra: That it can't.

She explained/described her conception of gravity as something related to a property of the moon.

I: How is that? Sandra: Because the moon is made from metal... I: Yes? Sandra: ...and so is earth...

She then described the meaning of gravity as having to do with a property of the moon, by saying that the reason that the moon did fall not down had to do with different properties of the moon and earth.

Sandra: ...and I think that... the moon is made from a different metal... I: You said this word, metal? What were you thinking of then? Sandra: ...when you... toys... like for example a magnet. I: So, a magnet... that's like metal? Sandra: Yes.

Supported by the researcher's questions, she developed the meaning of the word "*metal*", making an association with magnetic toy horses. When the horses point to each other's fronts they are attracted towards each other, but when they are placed the other way around, they repel each other. Through this sequence she explained her conception of gravity as something like a repelling relation between the moon and the earth, as different magnetic poles. In developing her conception, she used the word "*metal*", with a meaning associated with magnets and magnetism. Asked again about gravity, she answered:

I: if I ask you a little bit more about gravity, what's gravity?
Sandra: Metal in earth.
I: Metal in earth?
Sandra: Yes.
I: Is gravity like metal?
Sandra: Yes.
I: So... would you say it's the same thing?
Sandra: Yes.
I: Gravity and metal?
Sandra: Yes.

The repeated questions by the researcher made Sandra specify what she meant with gravity and explain that she saw it as a synonym for metal.

Discussion

The aim of this article was to explore the interplay between the researcher and the children in episodes when the children used an exploring approach. Knowing more about how children use language to make sense, as well as being aware of how to support their sense-making, has implications for science education in early childhood settings.

All six children whose responses were re-analyzed interpreted the dialogue situation as an invitation to make sense of physical motion as experienced in the "real world". One central quality distinguishing the explorative approach was that the children spoke of the phenomenon in focus *as something.* They used their own bodies, as well as metaphors and examples from their experience, to explain how they understood the movement of different objects. When asked, they often used the metaphor of a picture or a film that they "saw" in front of them. Another quality was that the children, when asked about a phenomenon, described *how* they saw the phenomenon. Besides conceptualizing the phenomenon, many of them also spoke of their own thinking and knowing. That means that they conceptualized their own language, thinking or knowing "as something". Being able to speak about one's own use of language or thinking is often interpreted as a metaconceptual skill, pointed out by many researchers as a condition for access to one's own thinking and use of language and the capacity to reflect on and elaborate with it (e.g. Astington, 2000; Olson 1970; 1977; Ravid & Tolchinsky, 2002; Pramling & Asplund Carlsson, 2008; Vygotsky, 1986; Åkerblom et al. 2011).

Another characteristic of an explorative approach was that the children were open to using different words and different ways to explain. They were willing to test possible meanings against their experience, and in some cases they changed the way they wanted to see the phenomenon or the

meanings of certain expressions. Testing and trying different explanations and words in some cases led to development or specification in the way they made sense of the phenomenon. These findings are in line with language strategies used by older children in classroom interactions (Barnes 1975). As in Barnes' studies of explorative speech, the younger children's use of language was characterized by reformulations and changes of direction. They tested their hypotheses both against experience and against the content of the subject matter, they held many possibilities open, and they were ready to change their ideas. As the children saw the phenomenon as something, as well as being aware of their own language, this gave them the opportunity to shift focus during the dialogue, and to experience their own use of language about the phenomenon. Aspects of simultaneous awareness are significant in phenomenographic research on learning. To be simultaneously aware of two different perspectives of something is seen as critical for how that thing is understood (Marton, Runesson & Tsui, 2004; Pramling Samuelsson & Asplund Carlsson, 2003). The children in the study expressed simultaneous awareness of how they saw the phenomenon and the language dimension; what words they used to speak about it, as well as what they meant by those words.

The other aspect of the interplay was how these children were actually supported to make sense in the reflective dialogues. Although the purpose of the dialogues was not originally related to learning, the character of the dialogues proved to have didactic qualities in that the children were supported to make sense of the phenomenon in focus. The fact that the researcher was a pedagogue, used to interacting with children of pre-school ages, was probably also significant for the didactic outcome of the dialogues. The activity could be described as a change in how a child relates to a part of the world. What was previously implicit became explicit in a learning movement. The researcher's aim was to invite the children to speak about the phenomenon in focus, and to reflect over their own choice of words and how those words served them to express themselves about the phenomenon. In pursuit of this aim, she tried to direct the children's attention towards the phenomenon. Studies of how children reason about scientific phenomena have shown that children are highly responsive to adults' use of language (e.g. Aronsson & Hundeide, 2002; Schoultz, Säljö & Wyndhamn, 2001; Sträng, & Åberg-Bengtsson, 2009). The responsiveness is here seen as a didactic possibility for the adult to support the child's sense-making and awareness in a specific direction. Pramling Samuelsson and Asplund Carlsson (2003) proposed metacognitive dialogues with children both as a way to find out how they reason and as a way to create learning situations. They regarded the dialogues as invitations for children to think, reflect, and express their thoughts while making sense. They also pointed out the similarities between the role of the researcher and the teacher in metacognitive dialogues (2003). However, while metacognitive dialogues focus on the child's conceptualization and reasoning, the notion of sustained shared thinking points to relational aspects of learning and the adult's involvement in children's sense-making.

There were several qualities of the researcher's use of language that were interpreted as support in making sense of physical motion: an inviting approach, that implied *framing* of the phenomenon, *directing the child's attention* towards the phenomenon, *change* of *focus* as the researcher directed the child's attention towards their own use of language about the phenomenon, *asking for the child's perspective*/personal meaning of the phenomenon, and *inviting* the child to make sense. However, there are other important aspects of the relation between the researcher and child. For any development of reasoning to take place, the child must want to express themself, must feel safe, must find the content meaningful, and must feel invited to advance in making personal sense. This happens when the child feels invited to act and speak as a meaning-creating agent. The approach is seen as inviting when it actually leads to the child using an exploring approach, and then it becomes *a pedagogic relation*.

Even though much the same language strategies was used by the researcher to provide support for some of the children to make sense, those strategies did not support the other 6 year olds in the larger study. Their approach was interpreted either as a narrative approach or as a call to remember what they had been told. Interestingly, this is in line with the strategies initiated by adults in a study of interaction between a group of 5-year-olds, their teacher, and a guide in a science center (Sträng & Åberg-Bengtsson 2009). The science guide used a narrative strategy, and the teacher encouraged the children to remember concepts and right words in circle time. Based on those results, as well as other studies about interaction between children and adults in early childhood settings about science, it seems that the children using those strategies themselves were familiar with them. Conversely, they did not seem used to taking a meta perspective on language use or on themselves as learners. Accordingly, even though the researcher attempted to invite those children, the interaction did not become a pedagogic relation in the sense discussed here. This exemplifies the importance of focusing on the actual interplay and what is created in the interplay, when it comes to the pedagogic relation. It also shows that the pedagogic relation does not depend solely on the language or other strategies used by the researcher or teacher, but also on how the meeting is constituted. The fact that so many of the 6year-olds did not become learners in their own right suggests that the verbal and reflective approach used in the dialogues was not enough for them to make sense of the two questions. This is related to Fleer's (2009) conclusion that support for children's understanding of science should include not only systematic exploration of scientific terms but also playful investigations of the phenomenon in focus.

Conclusion

What conclusions can be drawn from the present investigation of how to create pedagogic relations in early childhood? The assumption is that knowing more about the pedagogic relation and the function of language may have implications for how to support children to make sense about scientific phenomena. Inviting the children to reflect on how words are used in specific contexts seems to be a fruitful strategy to support them in extending their reasoning, and doing this in groups of children seems even more fruitful. Strategies used by the researcher, such as framing, directing the children's attention, and inviting the children to make sense, may be further developed in pedagogic settings; for instance, the phenomenon in focus could be framed by means other than verbal. In addition, models, objects, and activities to represent the phenomenon should be used to create common experiences among the children to help them conceptualize. More clarity about the aim of the activity would also help the children to regard the situation as meaningful. The question of "content matter" is not unproblematic. In the present investigation, the children's conceptions were not classified as more or less "scientifically normative". Instead, it was assumed that being able to conceive the phenomenon of physical motion (and understand that it could be seen in a number of ways), combined with reflection on the role of language in that activity, was more critical for learning than seeing the object in one specific way. Children do not experience physical motion in a Newtonian way, unless it is pointed out to them. Doing this is certainly a challenging task, but not an impossible one.

Speaking about and being aware of language function, thinking, and learning seemed to be difficult for some children, and hence is something that requires training in early childhood settings. However, awareness may be created when differences in ways of seeing and meaning become visible in teacher-supported dialogue in groups of children. An important condition for awareness is to give children access to a variety of speaking situations, where they can express themselves verbally in meaningful ways. They need to be the agents of their own language use when speaking about specific content which can be related to their personal experience. It is also important that the teacher is in charge of the learning content, to direct the children's awareness towards a specific direction. This requires awareness on the part of the teacher, both about critical aspects of the content and about their own use of language and what it does to the child.

Invitation to language games

Pramling Samuelsson and Asplund Carlsson (2003; 2011) see learning as a dimension of playing, since to children, both play and learning are concerned with "making sense" and seeing something as something specific; also, both play and learning proceed simultaneously on a verbal as well as a reflective level. Wittgenstein (1974) saw playing as closely connected with learning – the only way to learn how to use words is to play with their function. The notion of "playing" points at a number of conditions for making sense. The activity should be dynamic, creative, and meaningful for the players involved. The setting and conditions need to be agreed on, and the players should know what the game is about. Even if the notion of "playfulness" points to something that is open-ended and holds many possibilities, it does not mean that the activity lacks aim. On the contrary, the explicit content focus is a critical aspect of playing with language to make sense. Accordingly, the teacher needs to enact pedagogic situations where knowledge can come to movement in language, and invite children to make sense of specific content.

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