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Teaching chemistry and physics in preschool: a matter of establishing intersubjectivity

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ABSTRACT
This paper describes analysis of teaching instances that are part of an in-service preschool teachers programme about chemistry and physics in preschool. The aim is to develop knowledge about the communication established between teacher and children in relation to an object of learning, specifically the role of intersubjective communication in relation to an object of learning. A set of science activities with a specified object of learning was developed in groups of teachers and researchers. A qualitative analysis of the communication in relation to the chosen object of learning was performed. The focus of the analysis was excerpts representing differences in intersubjectivity related to the object of learning and what can be said to characterise the communication between teachers and children in these situations. The results show that intersubjectivity can occur in different ways with different consequences for children’s opportunities to experience the intended object of learning. In connection to this, the importance of teachers having a mutual simultaneity in the communication with children about a specific content is highlighted. The teachers have to create links between the child’s perspective and the object of learning. Intermediary objects of learning are discussed as supporting elements in the conquest of new knowledge.

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Intersubjectivity; object of learning; preschool; early years science

Introduction and background
This paper describes an analysis of teaching instances that are part of an in-service preschool teacher’s programme in Sweden. The overall aim of the project is – together with teachers – to study model-based teaching and collaborative inquiry learning of what is stated in the national curriculum for preschool as ‘chemical processes and physical phenomena’ (Swedish National Agency for Education, 2016, p. 10). Our interest is here directed towards intended and enacted teaching of science (Marton, 2014), with a particular focus on the verbal communication established between teachers and children in the enacted learning situations in preschool. The three-year professional development (PD) programme is ongoing and the reported instances took place during the first year.
Science in preschool

Since the introduction of the national curriculum in Swedish preschool 1998, science is a content area with goals to strive towards (Swedish National Agency for Education, 2016). Questions about different didactic aspects such as what content, what methods, when to start and how to consider children’s perspectives have been actualised. Among preschool teachers, there may be a concern that school’s traditional way of teaching should form the norm for preschool, hence rendering pre-school too school-like. Since science has a long history in school curricula, the way school works can easily form starting points for natural science in preschool, i.e. that preschool teachers form a mini-version of school science (Thulin & Helldén, 2011). In order to face this concern, you can ask questions about how the Swedish preschool tradition – with play, theme work, topic integration and children’s everyday life – can form the starting point for how the science content area can be taught in the context of preschool. It is in this context this article is situated.

Teaching science in preschool

Teaching science in preschool can be seen as a complex process with several aspects that a teacher has to consider. Research has for example identified teachers’ content knowledge as one important factor for children’s learning (Gitomer & Zisk, 2015; Nihlfors, 2008). However, content knowledge is not the only requirement. Research also points out teachers’ pedagogical content knowledge and attitudes to science – views on their mission and taken for granted assumptions – as having impact on children’s learning (Fleer, 2015; Hundeide, 2003; Spektor-Levy, Baruch, & Mevarech, 2013; Thulin, 2011).

Above this, many researchers point out the quality of the communication which is established between children and teacher as a key factor for children’s possibilities to learn (Fleer & Pramling, 2015; Pramling Samuelsson & Asplund Carlsson, 2008; Thulin, 2011; Thulin & Jonsson, 2014). These statements have caught our interest and the aim with this study is to develop knowledge about the communication established between teacher and children and in relation to an ‘object of learning’ in preschool, that is the knowledge or ability that children should develop about a specified content (Marton, 2014; Pramling Samuelsson & Asplund Carlsson, 2008).

Theoretical framework

When didactic approaches to children’s learning are discussed as stated above, the quality of the communication between teacher and children is highlighted (Pramling Samuelsson & Asplund Carlsson, 2008). The ability to interact with someone and to share attention to a content in focus can be seen as a fundamental aspect of teaching (Doverborg, Pramling, & Pramling Samuelsson, 2013). However, research has found that shared attention is not enough for learning, the participants also have to establish a kind of agreement in the dialogue. This agreement is about sharing perspective and being engaged in the same activity. This kind of acting can theoretically be named intersubjectivity. Previous studies (e.g. Trevvarthen, 1979) show that intersubjectivity can be recognised in early infancy between parent and child and that intense and sympathetic ways to absorb an infant’s attention can lead to mutual turns of attending and displaying in communication. Also Stern...
(2004) sheds light on the meaning of the concept intersubjectivity and expresses that it is about an ability to share experiences and feelings with another person.

As argued by Rommetveit (1974) intersubjectivity in communication is more of an ongoing process than a state, where participants seek to establish enough joint understanding, temporarily sufficient to keep communication or an activity going. Intersubjectivity may be described as characteristic in all human communication but it almost has to be taken for granted to be possible to achieve. That is, to strive for temporarily sufficient intersubjectivity in communication, each one participating needs to believe that they see things in a similar way (ibid.). Ivarsson (2003) points out that when participants take part in communication they do it with different experiences, which affect their possibilities to share mutual understandings about the content communicated. An illusory intersubjectivity (ibid.) is at risk when a local (deictic or contextualised) (Rommetveit, 1974) language is dominant and its meaning is strongly dependent on the context where it is used. Unspecified words in such local language contribute to a risk that participants in communication do not share understanding or even recognise that they talk past each other. The alternative to a local or deictic language would be a de-contextualised specific use of language henceforth called ‘expansive language’. This means helping children to expand their language, e.g. to introduce words and concepts belonging to either a general level or a scientific language (Doverborg et al., 2013). Both illusory intersubjectivity (Ivarsson, 2003) as well as sufficient intersubjectivity as stated above (Rommetveit, 1974), are important for the present study, where communication between teachers and children around objects of learning in science are analysed.

From our earlier research – with focus on science learning in preschool – the concept ‘mutual simultaneity’ has been formulated (Thulin, 2011; Thulin & Jonsson, 2014; Thulin & Redfors, 2017). The concept was used in describing the result of research focused on science communication in preschool (Thulin, 2011). It was shown that the science content in focus risked to be placed in the background of children’s learning due to the teachers’ normative positions towards science and preschool assignments. The concept mutual simultaneity refers to the fact that teachers’ awareness in a learning situation – at the same time – needs to be focused on the child’s perspective and the object of learning. The teacher has to establish a mutual relation with the child, characterised by intersubjectivity, which includes both the child’s perspective and the current object of learning. In this study we are influenced by both concepts – intersubjectivity and mutual simultaneity – as useful tools in the analysis of data, where mutual simultaneity is considered as one variety of intersubjectivity.

As stated above, science activities in preschool have historically been focused on biology (Thulin, 2011). Therefore, this project investigates work with chemical processes and physical phenomena, as formulated in the current national curriculum (Swedish National Agency for Education, 2016). Furthermore, many studies have found that young people have a low interest in science, especially Chemistry and Physics (e.g. Oskarsson & Karlsson, 2011; Sjöberg & Schreiner, 2010). Hence, we in this project have striven to take science in society – in children’s everyday life – and child-centred approaches as points of departure.

Against this background, our interest is directed towards teaching science, with particular focus on the verbal communication established between teachers and children in enacted learning situations in preschool. The study is guided by the research question:
How can intersubjective communication be described in relation to an object of learning in science?

Methodology

This article reports on a study of teaching instances that are part of an in-service preschool teachers programme about science. The PD programme takes place in a school district in a medium-sized Swedish town and the part reported on here involved five preschools (children age three-five) and one preschool teacher from each team during February–March 2017. The children’s ages are specified in connection to each excerpt below. A work team in preschool consists of teachers with different education where the preschool teacher has an academic education with a bachelor’s degree. The work teams independently chose and developed, in dialogues with children and with support of researchers, activities concerning water purification, water management, and energy production by windmills, as objects of learning. This project uses a semantic view of theoretical models (cf. Adúriz-Bravo, 2012), where theoretical models are viewed to form families or classes linking theories with experiments and practices, and where the focus is on the explanatory powers of the theoretical models. The work teams in planning the teaching activities strove, with support of a researcher, to establish a consensus theoretical explanatory model of the science phenomenon, sometimes referred to as a precursor model (Ravanis, Koliopoulos, & Hadzigeorgiou, 2004), which also was the intended object of learning.

Video recording was used to study the implemented activities. In total, fifteen activities were observed. Each activity is about 20–50 min long and involves teachers and children working with the chosen scientific phenomenon. A qualitative analysis (Bryman, 2016) was initially processed and transcribed by all four researchers who watched the videos in whole. In this first step of analysis, we came to consensus about how to define intersubjectivity in the communication, pursuant to our theoretical references (Ivarsson, 2003; Rommetveit, 1974; Trevarthen, 1979). In our interpretation, intersubjectivity as an analytical tool refers to communication where teacher and child/children seek to share perspectives, not only attention, when addressing aspects of the chosen object of learning in science. Their communication then appear coordinated enough to keep the object of learning in focus, either verbally and/or non-verbally by bodily expressions like pointing, or showing what they mean by movements. With this definition, the transcripts were read and analysed by the researchers. In the second step, the analysis focused excerpts representing qualitative differences in intersubjectivity related to the object of learning and what characterised the communication between teachers and children in these situations. Hence, intersubjectivity about other subjects that the communication could contain was left out, like for example, what the children had done during the weekend. In the third step, the focus was on excerpts showing intersubjectivity in relation to the object of learning of at least three turns. By ‘turns’ we mean participators’ verbal and sometimes non-verbal expressions, which in the transcriptions are numbered. We could then count turns of communication where they were responding to each other. After another round of discussions among the researchers, the requirement for selections was increased and excerpts were extended to include 8–20 turns, where the communication was
interpreted to have intersubjectivity related to the object of learning. In the fourth and final step of analysis, a variety of intersubjective dialogues in relation to the object of learning could be distinguished. Examples of these are presented below as variations of ‘Illusory intersubjectivity’ and ‘Sufficient intersubjectivity’ (Ivarsson, 2003; Rommetveit, 1974). The research adheres to the ethical guidelines of the Swedish Research Council (Swedish Research Council, 2017).

Results

During the analysis, variations of intersubjectivity emerged. These varieties are presented and discussed below in connection to representative excerpts with focus on what characterises the communication between teacher and children in these situations. All names appearing in the data are fictitious.

Illusory intersubjectivity

In communication concerning an object of learning, two varieties of illusory intersubjectivity were identified: Unspecifed focus and Divergent foci.

Unspecifed focus

The sequence described below shows the communication between a preschool teacher and two children 5 years old, the boy Danu and the girl Ilsia following up of an activity the preceding day. The main object of learning expressed by the teacher is for the children to have the opportunity to learn different ways to purify ‘dirty’ water by using varying materials. This was tried out by using plastic bottles as wastewater-treatment plants, with different filters of varying permeability. The plastic bottles were cut in half and the upper part of each bottle placed in its lower part so that the upper part constitutes a funnel. Thereafter, the funnels were filled with sand, gravel, charcoal or a coffee filter, respectively. In this step, dirty water is once again poured onto the filters. The teacher’s modification, trying the filtration into three bottles, aims at visualising the variation between the filters for the children and to make them notice the most effective filter for water purification. However, the teacher realises that descriptions of variations in how the water may appear after being purified in different ways is needed. The need to introduce this became obvious to the teacher when differences in the children’s understandings during the purifying-water activity became visible. The children described it as that there were different colours of the water. This process is analysed as the emergence of an intermediary object of learning, or step, the children need to experience and understand on their way towards the main object of learning. An intermediary object of learning can be defined as an object of learning that children have to experience and understand on their way to conquering knowledge in relation to the intended object of learning. As the excerpts below show, this is not always known by the teacher in advance (when the activity is planned), but becomes visible in the enacted teaching. As the analyse shows, the teacher in this sequence aims to show how different purification methods may influence what happens to the dirty water if it is purified. The analysis focuses how intersubjectivity around the intermediary object of learning also can be described as an illusory intersubjectivity with an unspecified focus when it is
unclear if the teacher and children share understanding, even though they seemingly share attention.

<table>
<thead>
<tr>
<th>Turn</th>
<th>Speaker</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>141.</td>
<td>Teacher</td>
<td>No, don’t know. One can only guess what one thinks. No. If you are to pour dirty water here on the gravel (to Ilsia). What do you think then?</td>
</tr>
<tr>
<td>142.</td>
<td>Ilsia</td>
<td>(Inaudible, shrugs)</td>
</tr>
<tr>
<td>143.</td>
<td>Teacher</td>
<td>No. What do you think (to Danu) if one pours water on it? (Points to Ilsia’s bottle.)</td>
</tr>
<tr>
<td>144.</td>
<td>Danu</td>
<td>Mmmmm… grey!</td>
</tr>
<tr>
<td>145.</td>
<td>Teacher</td>
<td>It will turn grey? What do you think will happen when I pour water in this then? (Takes a bottle with funnel and filter but without any purification material as sand or coal.)</td>
</tr>
<tr>
<td>146.</td>
<td>Ilsia</td>
<td>Be that. (Points to the bottle with dirty water.)</td>
</tr>
<tr>
<td>147.</td>
<td>Teacher</td>
<td>It will be that dirty? Yes?</td>
</tr>
<tr>
<td>148.</td>
<td>Ilsia</td>
<td>Because you didn’t have anything in it.</td>
</tr>
</tbody>
</table>

Before the excerpt above it is stressed by the teacher that the question is what the children think will happen when water is poured over sand, gravel or charcoal in the funnels. Ilsia has chosen gravel for her water purification filter. The teacher emphasises that they do not have to know the answer, but are welcome to guess what they think and asks ‘What do you think then?’ (turn 141). Ilsia shrugs her shoulders and her answer is inaudible (turn 142). The teacher seems to confirm her way to answer with a short ‘No’ and continues asking Danu the same question about the same bottle with gravel (turn 143). Danu thinks the water turns grey (turn 144). The teacher makes sure about Danu’s answer and then asks what the children think will happen in the teacher’s bottle where the purification method consists of a coffee filter (turn 145). Ilsia thinks it will continue to be dirty (turn 146) and the teacher asks ‘It will be that dirty? Yes?’ (turn 147) to make sure what Ilsia means. She continues, ‘Because you didn’t have anything in it’ (turn 148). This could be understood as Ilsia, besides giving her answer, also gives an explanation to why she thinks the water will continue to be dirty.

At two occasions, the teacher seems to talk about the purification filter as ‘it’ (turn 143) or ‘this’ (turn 145), at the same time clarifying the concrete material by pointing at or taking the bottle they use. The small word ‘it’ can refer to the gravel (as in turn 141) or maybe the water. In turn 145 the word ‘it’ may also refer to either the purifying material or to the water being poured. The word ‘this’ in the same turn 145 could mean either the funnel or in the purifying filter without other purifying material. In turn 143 the verbal expression is supported by a pointing action, which may contribute to intersubjectivity being established around the intermediary object of learning. However, the use of an expansive language and precise and adequate terms (such as treatment plant, purification filter, gravel, and water) might be more meaningful in order to establish temporarily sufficient intersubjectivity in the exemplified situations. Otherwise, is there is a risk of an over-interpretation of words like ‘it’ and ‘this’. Thereby also a risk of an illusory intersubjectivity (Ivarsson, 2003), meaning that part-takers in a dialogue think they agree on what is communicated but that this assumption may be illusory if not clarifying words or terms are used to point out what is in focus.

**Divergent foci**

How the preschool teacher and children can all be focusing the object of learning and still ‘talk past each other’ is illustrated in the following situation from another preschool. In this excerpt, the teacher and five children, age three, seem to agree on the words used in communication but not on what the words are referring to. The preschool teacher’s
chosen object of learning is water purification and the biological/ecological aspects of this. In a first, intermediary step towards the main object of learning, the teacher wants the children to notice that snow is dirty and this is visualised through the teacher and some children together collecting snow from outside, to melt in plastic tubs. The teacher’s next activity, and the present situation, can be seen as a second intermediary step towards the main object of learning. It aims for the children to learn that dirty water can be purified in different ways, with varying results. In practice, this will be illustrated by three plastic bottles working as three different wastewater-treatment plants, with filters of varying permeability. The bottles are cut in half and the upper part of each bottle is placed in its lower part so that the upper part constitutes a funnel, similar to the example above. Thereafter, the three funnels are filled with stones, sand and a coffee filter, respectively. In a last step, water is poured onto the filters. The teacher has created the three treatment plants from a model she found on the internet, where the three funnels were put in one another so that the water ran through all three before reaching the lower part of a bottle. This way, the water is filtered through in turn stones, sand and coffee filter – wastewater-treatment plants in the form of a ‘water purification tower’.

The teacher’s modification, splitting the filtration into three bottles, aims at visualising the difference, the variation, between the filters for the children and to make them notice what filter of the three are the most efficient for water purification.

When the below dialogue takes place, the teacher and the children have prepared the first bottle and filled it with stones. The water is poured onto the stones and the teacher focuses the object of learning. She directs the children’s attention to the dirty water, she asks for the children’s hypotheses about whether the water will be purified and she acknowledges the children’s answers. She includes the children when she asks them to e.g. help her pour water or add stones. The teacher also uses an expansive language including the use of the word filter and ‘filtrate’ but despite all this the point is missed, as seen in the below excerpt. Important for the interpretation of the excerpt, as we understand it, is to know that the everyday word ‘clean’ and the more technical word ‘purified’ is the same word in Swedish, ‘rent’. The actual children do not understand the difference between everyday ‘clean’ and the technical ‘purified’ with the result that the aim with the activity is missed. In the excerpt, ‘rent’ has been translated to ‘clean’:

79. Teacher (Holds the bottle where the dirty water has been filtered through the stones. The water is of the same brown colour as before. The bottle’s upper part with the stones are still left in the bottle’s lower part, containing the water.) Was the water cleaned?

80. Children Yes!
81. Teacher Is it clean? (Lifts the pitcher with water left in it and holds it next to the bottle with the stones/filtered water.)
82. Children Yes.
83. Arne But it’s brown.
84. Teacher Is it brown? Is the water clean if it’s brown?
85. Nero Yes!
86. Teacher Is it?
87. Nero Yes, look there! (Points to the stones in the bottle.)
88. Teacher Yes but look here. (Puts the pitcher down but continue to hold the bottle with the stones/filtered water and points to the lower part with the water.)
89. Teacher The water has been pouring through here (shows through the stones), through the stones. (All children follow with interest.)
90. Arne Through the stones.
91. Teacher What do you think Farah? Is it clean? (Holds up the bottle with the stones/filtered water.)
92. Farah Yes.
When the water has poured through the stones it is still very dirty and brown, but despite this, the children answer ‘Yes’ repeatedly to the teacher’s question about whether the water has been cleaned. This seems strange at first and turns 79–82 display a lack of intersubjectivity, despite both children and teacher focusing the object of learning, water purification. The explanation for this twofold focus can be found in turns 84–87. While the teacher (and Arne in turn 83) focus the brown water, Nero points to the stones in the plastic bottle and says ‘Yes, look there!’ (turn 87) as an answer to the questions whether the water is clean when its brown. The boy focuses the cleaning of the stones, not the water, and this is interesting. Does the misunderstanding arise around the everyday word ‘clean’? What is children’s experience of that word? In children’s everyday life the meaning of ‘clean’ is often about someone or something, e.g. the hands, being washed by water. It is persons or things that should be cleaned by help of water, not the actual water. What would have happened if the teacher would have stopped and focused the word ‘clean’ when teaching the object of learning? And in accordance with this, took time to clarify the purpose of the stones in the funnel, that is, that the filter will be dirty after the filtration while the water is supposed to be purified/clean. Also worth noticing is when the teacher asks Farah if she also thinks the water is clean (turn 91). During this, the teacher holds up the bottle with both the upper part (the stones) and the lower part (filtered water). Is Farah focusing the stones when she answers ‘yes’ to the question or is she just following the other children’s previous answer? Would a separated bottle with the stones parted from the filtered water have helped the children focus the object of learning? The excerpt highlights the need for teachers to consider children’s previous verbal experience of words and terms, when working towards an object of learning.

**Sufficient intersubjectivity**

Another variety of intersubjectivity is ‘Sufficient intersubjectivity’, which here, in the context of teaching science, is identified as ‘Mutual simultaneity’ and presented by two examples below.

**Mutual simultaneity**

The sequence described below is an excerpt from the communication between a preschool teacher and three children during a teacher-led activity with six children aged four and five in a third preschool. The intended object of learning expressed by the teacher is for the children to experience that water purification is a process in several steps. The teacher has encouraged the children to try different filter materials, one at a time, before jointly constructing a wastewater-treatment plant in terms of a ‘water purification tower’, similar to the one described above. The children have not experienced significant changes of the watercolour from using the individual filters. However, now when studying the dirty water being poured into the constructed ‘purification tower’ they can discern transparent (clean) water emerging at the lower end of the ‘tower’. The intermediary object of learning that water can actually be purified through filtering is experienced.

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73. **Teacher** Now, watch the water that comes out! Can you see that it begins to drop there? How does it look?
74. **Ingrid** It is dripping, dripping, dripping
75. **Teacher** How does it look?
76. **Oscar** It is little clean!!!
77. Ingrid  It becomes clean water!
78. Helga Yes!
79. Ingrid  It works like it gets clean like that! It becomes clean water like this!
80. Oscar This is what we should do! To make it clean.
81. Teacher Yes, you should have used all your filters together. Maybe we should have used … (names all the used filters) then it might have been like this?
82. Ingrid And also this (points to the stones and the sand) became – it became black
83. Teacher Yes
84. Oscar Finally!

In this sequence, the teacher prepares to pour the contaminated water into and through the constructed purification facility. The children are attentive and the teacher directs their observation towards the outlet at the bottom of the purification facility. An example of sufficient intersubjective communication takes place including the exclamation ‘This is what we should do! To make it clean.’ (turn 80). The teacher then connects back to the previous exercise with different filters stating that they would have needed to jointly apply all the filters to the contaminated water and Oscar agrees with this. Notice also that Ingrid (turn 82) introduces another focus, namely that the stones and the sand has become dirty. However, that is not acknowledged by the teacher and the other children, and does not lead to illusory intersubjectivity as in the example above. Instead, it could have been picked up on to enhance the children’s experience of filtering.

The following teaching situation from yet another preschool involves three children, a girl (Fatima) and two boys (Mario and Ari), and a preschool teacher (Teacher). The children are four and five years old with different cultural background and varying access to the Swedish language. The expressed object of learning is wind energy, what it is, and how it may be used. In the current situation, the demonstration of a miniature windmill is central in the teaching and can be said to constitute an intermediary object of learning, i.e. an aspect that needs to be understood ‘on the way’ to the main object of learning.

37. Teacher  And then I thought I’d show (Brings out a miniature windmill/bottle.)
38. Fatima  And this. (Shows with the hand in the air how it spins.)
39. Teacher  Yes, yes.
40. Mario  It’s the wind force.
41. Teacher  Yes.
42. Mario  It looks like a airplane.
43. Teacher  Yes, it looks like a airplane but I call this a windmill.
44. Mario  That what you built in lego.
45. Teacher  Yes I built, tried to build one yesterday in lego too. But how do you think this works, what do we need?
46. Fatima  Blow, airy-ing. (Shows with the hand in the air with a spinning motion.)
47. Balli  The wind.
48. Ari  This is like a helicopter.
49. Teacher  Like a helicopter, you can also compare it to that, or to a propeller.
50. Teacher  Should we call it propeller?
51. Ari  Shall we try?
52. Child  Yes.
53. Fatima  (Nods)
54. Teacher  Then let’s start the air Mario.
55. Mario  (Turns on the fan)

The sequence starts with the teacher in turn 37 bringing out a miniature windmill, saying ‘And then I thought I’d show’ but she does not get further in the initiated meta-communication about what will happen, since the children show their immediate enthusiasm by trying their understandings of what is about to be shown to them. Fatima shows her understanding by making a spinning motion with her hand (turn 38), something the
preschool teacher acknowledges by saying ‘Yes, yes’ (turn 39). Mario adds the comment ‘It’s the wind force’ (turn 40). The statement could be interpreted as Mario trying to clarify either Fatima’s motion demonstration and/or presenting his own understanding of what is about to be shown. The miniature windmill – consisting of a bottle-shaped body with a propeller at the top – is placed in front of the children when Mario states that ‘it looks like a airplane’ (turn 42). The teacher chooses to acknowledge Mario’s statement by repeating what Mario says, but does not settle for this. She also chooses to challenge the child in direction towards the intermediary object of learning by saying ‘But I call this a windmill’ (turn 43). The statement shows how the teacher links to the metaphor used by the child to describe the windmill, that is, links to the child’s frame of experience, takes it into account – by repeating – but at the same time chooses to develop/expand the reasoning by use of an expansive language where the word windmill is introduced. When the teacher puts words to the intermediary object of learning she frames the situation, as well as clarifies the focus of the directed common attention. In the following turn (44), Mario seeks acknowledgement for being ‘on the right track’ together with the teacher, by making a comparison with something the teacher built in LEGO® the previous day. The teacher acknowledges Mario by putting words to what happened the previous day, when saying ‘Yes, I built, tried to build one yesterday too with lego’ (turn 45), at the same time implying that it did not fully work. The present statement also illustrates how the teacher again chooses to expand the reasoning in direction of the intermediary object of learning, by formulating a question to the children: ‘But how do you think this works, what do we need?’ (turn 45). The children answer by expressing their hypotheses. Fatima implies that it might have to do with air and motion, by saying ‘blow, airy-ing’, at the same time showing hand-motions in the air (turn, 46). ‘The wind’ says Mario (turn, 46). This statement can be interpreted as a meta reflection of, or an attempt to put words to, what Fatima expresses in her statement (turn 46). The dialogue illustrates a movement from local language to expansive (de-contextualised) language (turn 46–47).

In the statement that follows, Ari is using a metaphor as a description of how he understands the propeller on the miniature windmill, ‘This is like a helicopter’ (turn 48). The teacher meets Ari by considering the metaphor Ari uses, ‘Like a helicopter’ (turn 49). The teacher acknowledges the child by repeating the metaphor expressed by the child, at the same time clarifying that the use of a metaphor is a comparison, ‘You can also compare it to that’ (turn 49). The teacher also chooses to make use of the situation by adding an expansive language, ‘or to a propeller’ (turn 49), which is underlined in the statement that follows, ‘Should we call it propeller?’ (turn 50). The dialogue sequence is ended by Ari suggesting that they should try out the miniature windmill, agreed by the others in terms of acknowledgment (turn 52) and nodding (turn 53). Following this, the teacher urges Mario to start the air (turn 54) and Mario does so by turning on the fan (turn 55). The teacher’s call to Mario is a call to start the air – not only to start the fan. Through this choice of words, the teacher clarifies what is needed for the propellers to rotate: Air needs to be added (turn 54). By use of this statement, the children’s attention is directed towards the object of learning.

The children’s enthusiasm can be understood from the view that there is a mutual relation between children, teacher and the object of learning. The pattern of interaction may also be seen as an example of the importance of a teacher establishing a mutual simultaneity in the teaching situation (Thulin, 2011; Thulin & Redfors, 2017). The teacher
listens to children’s perspectives, considers what the children say or express, but also challenges the children’s experiences by directing the attention towards a possible object of learning. The teacher directs her attention at the same time towards children’s perspective and towards the possible object of learning, aiming at establishing a relation between the two.

Discussion

Several researchers focusing children’s learning of a specific content emphasise the importance of establishing a mutual relation between the child and the object of learning, in the teaching situation (e.g. Pramling Samuelsson & Asplund Carlsson, 2008). An aspect accentuated is the teacher’s consideration of children’s perspectives, of children’s expressed experience or knowledge in relation to the object of learning in focus. Still, this is not enough. In this study, the communication between teachers and children in preschool about a science object of learning is in focus. The result shows some critical aspects of the communication established worth highlighting.

To create links between children’s perspectives and the object of learning

The Swedish curriculum (Swedish National Agency for Education, 2016) stipulates teachers’ responsibility to create conditions where children can make new experiences and further develop their understandings. In this process, we see a need for teachers to be engaged in creating links between children’s perspectives and the object of learning. Ways of dealing with these links’ influences the possibility to establish intersubjectivity (Rommetveit, 1974). This study shows two qualitatively different ways to describe varieties of intersubjectivity; illusory and sufficient intersubjectivity. While illusory intersubjectivity can give the impression that teacher and children have agreed on how to understand the object of learning, sufficient intersubjectivity shows a communication with signs of a mutual understanding between teacher and child/children. An important theoretical argument is, according to Rommetveit (1974), that sufficient intersubjectivity comes and goes in communication as can be observed in the category mutual simultaneity. In this study, we chose to show moments with temporarily sufficient intersubjectivity, which we mean demands a continuous effort from the teacher. On basis of the definition of Rommetveit (1974), we argue the need for teachers to establish mutual simultaneity in the teaching situation (Thulin, 2011; Thulin & Redfors, 2017) where one point of departure is to consider and make use of children’s perspectives (Thulin & Jonsson, 2014). This is accomplished by the teacher considering, at the same time, what the children recognises and the intended object of learning, aiming at establishing a relation between the two in order to challenge and expand the children’s experiences.

When creating links between children’s perspectives and the object of learning the language used in the actual teaching situation is crucial. One aspect of verbal communication is characterised by a local language with no outspoken meaning. This can in some cases keep the conversation going, but the risk with an illusory intersubjectivity and non-mutual experience is that the meaning gets lost. There is a difference between using words like ‘this’, ‘that’, ‘it’ compared to use of more clarifying de-contextualised words, such as for example science concepts. According to the theory of developmental pedagogy
(Pramling Samuelsson & Asplund Carlsson, 2008) a child’s experienced object of learning is what s/he can express at a certain time, while changed conditions can contribute to new experiences and thereby developed ways of children’s understanding, expressions and communications. In this light, teachers’ use of an adequate, expansive language seems crucial.

To establish and make use of intermediary objects of learning

When children’s possibilities to learn are discussed, the direction of the attention is often stated as an important point of departure to consider (e.g. Pramling Samuelsson & Asplund Carlsson, 2008). The teacher has to be aware of both what the children are expected to pay attention to in the current situation, the intended object of learning, and what they actually are occupied of/with, the children’s perspectives. This puts specific demands on the teacher. At the same time the teacher, in the learning process needs to handle the two perspectives. S/he has to find ways to support childrens attention with consideration of their perception of the object of learning. Our results show that teachers handle this in different ways and with different outcomes. When the excerpts were analysed in detail it became apparent that the establishment of ‘intermediary objects of learning’ plays an important role in this process, and this result is new to us. In earlier research, the object of learning – learning goal to strive for – is often pointed out as a core in the learning process and as far as we know there is a lack of discussions about the use of intermediary objects of learning when young children’s learning are discussed. Otherwise, there is a risk of separating the object of learning from the children’s perspectives and experiences. The main object of learning can be seen as too abstract and difficult, sometimes for both children and teachers. The result from this study places the intermediary object of learning on the science teaching agenda and shows that an intermediary object of learning can constitute a supporting element in the conquest of new knowledge.

The establishment of an intermediary object of learning is visible in the examples of mutual simultaneity. In the example with the windmill, the object of learning was stated as wind energy and the demonstration of a how a miniature windmill works was one of the intermediary objects of learning. On the way towards the main object of learning, the teacher and the children did not just start using the windmill. Instead, the teacher gave the children ample time to discuss their experiences and understandings of critical aspects of the windmill. The teacher considered and made use of the children’s perspectives while at the same time kept the object of learning in focus. The opposite could be observed in the example presented under the category Divergent foci. In this situation, no intermediary object of learning was planned, but during the analysis, it became apparent that it could have been useful. The analysis shows that the teacher focused on the purification process of the water, while the child’s attention was directed towards the water cleaning the stones. Although the teacher’s and the children’s attention were directed at the same ‘water purification tower’, they focused different aspects of it. This situation shows that there is a variety of understandings at stake. The concept purify has one meaning for the teacher and another for the children. The teacher talked about the purification process of the water but the children talked about washing (the stones). An introduction of an intermediary object of learning such as purifying – discussions
and experiences – could have contributed to insights and a shared direction of attention. So, our conclusion is that intermediary objects of learning seem to be useful in the learning process, and helpful in establishing sufficient intersubjectivity, which in turn supports the learning process towards the main object of learning.

When children’s learning is discussed, paying attention to and making use of children’s perspectives are of importance (Pramling Samuelsson & Asplund Carlsson, 2008). As a preschool teacher, you always have to be responsive to children’s experiences and interests and sometimes change the implementation when the activities prepared for do not seem to work in the actual situation. This approach is not new; it is a point of departure for every preschool curriculum in Sweden so far. One contribution from this study is – as we see it – the verbalisation and activation of intermediary objects of learning as a critical aspect in the teaching situation. Using intermediary objects of learning can contribute to bringing the content closer to the children’s world of experiences, making the learning process more concrete and communicable to the children, and perhaps also for the preschool teachers.

**Conclusion and implications**

In Sweden, many preschool teachers lack specific education for teaching science with a focus on physics and chemistry. It was not until the reformed preschool teacher education programme in 2011 that these parts of science were included. Against this background teaching science in preschool together with children age one to five years – as the situation is in Sweden – can be seen as a challenge for the teachers. Many questions about choice of content and teaching approaches are on the agenda. Hopefully, the results of this study can shed light on the situation and provide tools and support for both planning and implementation of science teaching.

Research shows that children’s learning is strongly dependent on the established communication (Fleer & Pramling, 2015; Thulin & Jonsson, 2014; Thulin & Pramling, 2009). Children want to understand the surrounding world and share it with others. In this study, the result contributes to highlight the quality of the communication in the learning situation. Teachers’ need to establish mutual simultaneity in the communication is pointed out. That is, an ability to simultaneously take into account the children’s perspective and the intended object of learning. Hence, the teacher has to find ways to support the creation of links between the children’s perspective and the object of learning. In addition, the teaching benefits from a balanced use of local (contextualised) and expansive (de-contextualised) language, including scientific concepts belonging to the object of learning. It is found to be of importance when teaching a specific content, but should be considered also in daily communication in preschool. Furthermore, the result shows that teachers’ awareness of intermediary objects of learning can be of importance when teaching science in preschool and that more research in this direction is needed. Experiences from the ongoing professional development programme as well as earlier research (Nihlfors, 2008; Thulin, 2011) show limitations related to teachers’ attitudes and content knowledge. Didactic aspects related to science teaching in preschool is an area in need of more research. Further studies on both occurrences and views of intermediary objects of learning and how to communicate and implement our results in preschool practice are called for and will be in focus during the continued project.
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References


