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Why do teachers adopt or resist a pedagogical idea for teaching science in preschool?

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ABSTRACT
Numerous initiatives are carried out across the world to support science teaching in early childhood education. However, professional development research shows that in order for teaching interventions to bring about successful changes in practice, it is key that teacher’s beliefs, confidence and knowledge change. As a complement to studies showing how teachers change, this article examines why teachers adopt a pedagogical idea for teaching science in preschool. Drawing on Clarke and Hollingsworth’s model for teacher professional growth, the article analyses interviews with teachers that have implemented and developed a pedagogical idea for teaching science in preschool. The results indicate that teachers adopt the pedagogical idea because it helps them to discern and build on science content in everyday practice, which they prefer to their previous way of teaching science through occasional experiments. Further the results show that teachers balance several external influences on what is good preschool pedagogy. The particular pedagogical idea eases that balancing act since it aligns with, and helps teachers to make meaning of, many of these influences.

INTRODUCTION
What children of preschool age know in terms of general science has shown to be a strong predictor of their future science achievement in school (Morgan et al. 2016). Therefore, it is worrying, from an equity perspective, that science teaching tends to be deprioritised in early childhood education (ECE), compared to teaching literacy, numeracy and arts (Greenfield et al. 2009). The lack of science teaching in ECE has been connected to teachers’ lack of confidence and content knowledge in science (Garbett 2003; Sackes et al. 2011). Across the globe, numerous initiatives have been carried out to support teachers to provide science learning in ECE. The initiatives span from the transnational science programme *La main à la pâte* (Académie des Sciences, France), with 40 partners in 5 continents, to national programmes such as *PrimaryConnections* (Australian Academy for Science), and local projects such as the teacher–researcher collaboration, which this article builds on (Areljung 2016). Further, many schools and preschools use materials...
for hands-on activities that are constructed by external actors and packaged in ‘science boxes’, such as the commercial Empiribox (United Kingdom). The science boxes as well as the science education programmes are often combined with voluntary or compulsory professional development (PD) activities. Yet, professional development is a wide-ranging term, covering occasional one-way transmission of knowledge as well as long-term engagements that profoundly enhance teachers’ professional autonomy (Kennedy 2014). In order to successfully change teaching practice, it is often key that the PD activities lead to changes in teachers’ beliefs, confidence and knowledge (Clarke and Hollingsworth 2002). Though there are several examples of PD studies showing how ECE teachers change (e.g. Dyment et al. 2014), few explicitly report on why teachers change. Addressing that gap in research, this article seeks to respond to the research question: Why do teachers adopt, or resist, a pedagogical idea for teaching science in preschool? Thereby the article sets out to contribute knowledge of importance to forming PD activities for ECE teachers.

The article builds on data from a teacher–researcher collaboration in which teachers implemented and developed an idea for science teaching in preschool. This case is particularly interesting because it provides an example of sustained teacher change. It is evident, from texts and pictures that the teachers continuously publish online, that the pedagogical idea is still central to the teachers’ practice, 1.5 year after our collaboration ended.

**Preschool science teaching**

When it comes to understanding how and why teachers implement science teaching in preschool, one significant factor to take into consideration is the ways of teaching that are familiar to teachers. Recent Swedish studies report that teachers tend to intertwine science with aesthetic work and learning with the whole body and all senses (e.g. Westman and Bergmark 2014). Further, Ljung-Djärf, Magnusson, and Peterson (2014) have shown examples of teachers tending to plan science teaching around ‘what to do’ rather than around how children can make meaning of what is done. Ljung-Djärf et al. relate the teachers’ focus on ‘what to do’ to a Swedish preschool culture, which juxtaposes the school culture of focusing ‘what to learn’ (cf. Pramling and Pramling-Samuelsson 2008). To juxtapose school culture is also proposed by researchers who argue that science education in the early years should be formed in its own right, rather than being a product of school science standards pushed down to ECE (e.g. Siry 2013). The tendency of resisting school standards is not specific to the arena of science education. Historically, Swedish preschool stakeholders have established the uniqueness of preschool pedagogy by positioning it away from school pedagogy (Tellgren 2008). A number of Nordic researchers in ECE display resistance of school stereotypes, such as resistance towards lesson-like framing of learning activities (Otterstad and Braathe 2016), and specific subject learning that is isolated from other subjects (Klaar and Öhman 2014). Seeing that ECE teachers internationally are currently facing an increased focus on children’s academic learning outcomes (Brogaard Clausen 2015), ECE teachers are managing a balancing act of, on one hand, supporting children’s academic learning outcomes in science and, on the other hand, resisting school science standards.

A relatively common alternative to the stereotypical school science approach is to frame science in ECE as playful investigations and to regard children as naturally curious (Eshach and Fried 2005). The vision of the child as a natural explorer aligns with child
development theories, which have been influential in the shaping of ECE internationally (Cannella 1997), and with Reggio Emilia pedagogy (Stegelin 2003), which is gaining ground in ECE across the world (OECD 2006). Though pedagogies that build on children’s own investigations can involve different levels of teacher mediation, researchers raise concerns that preschool children are left to learn science on their own, lacking the instruction necessary to make scientific meaning of their discoveries (e.g. Fleer 2009).

In summary, previous research suggests that teachers’ implementation of science teaching in preschool depends on their view of children and science and ways of teaching that are familiar to teachers. Further, research has shown that the implementation of science teaching in preschool involves negotiations between the individual teacher, the preschool where he or she works, and external actors (Sundberg et al. 2016). It is important to explore these, and other influences further in order to outline reasons that teachers adopt or resist pedagogical ideas for teaching science in preschool.

**Method**

The article builds on interview data from a teacher–researcher collaboration whose overarching aim was to support science teaching in preschool. Below I outline the Swedish context, the project design, the data production and the analytical process.

**The Swedish context**

Swedish preschool pedagogy builds on a holistic approach where learning, fostering and care are seen as intertwined and equally important, and where ‘curiosity’ and ‘lust for learning’ are central concepts (Swedish National Agency for Education 2011). The curriculum does not state any expected individual learning outcomes, but practice is assessed at an institutional level. When it comes to science content, the curriculum states that the preschool should strive for children to develop their ability to discern, explore and talk about science as well as their knowledge of chemical processes, physical phenomena and understanding of relations in nature (Swedish National Agency for Education 2011, 10). Of all children between 1 and 5 years, 83 per cent are enrolled in preschool (Swedish National Agency for Education 2016). The share is 48 per cent for 1-year-olds and 88 per cent for 2-year-olds (Swedish National Agency for Education 2016). This means that Swedish preschool is an example of institutionalised science education for children from the age of 1 year, which is rare from an international perspective, where science teaching often targets children from 3 years and older (Sikder and Fleer 2015).

In Sweden, the common case is that 3–4 teachers work in a team with a group of 15–20 children. The staff typically consists of several professional categories and though the preschool teachers have a special responsibility for education in Sweden, all staff are responsible for both education and care. I am not drawing on the individual education background of the staff in this paper, so I have chosen, for the ease of reading and anonymity reasons, to refer to all staff as teachers. I recognise that this generalisation is troublesome since it could be read as down-playing the academic degree of preschool teachers, which is not my intention.

**Project outline**

This particular project was initiated by me, and five educators working in a pedagogical development centre, from here on referred to as ‘The Centre’. The problem inventory
and goal formulation of this project have been presented elsewhere (Areljung 2016), but in short our main objective was to support teachers’ work with chemistry, physics and inquiry in preschool (Figure 1).

It turned out that the critical idea of this project was to approach chemistry and physics through colloquial science verbs. This idea will from here on be referred to as ‘the verb idea’. While our experience from preschool practice was that science themes were usually labelled with nouns, such as ‘water’ and ‘the forest’, we hypothesised that verbs related to chemistry and physics, such as melting and rolling, would support teachers to work with physical phenomena and chemical processes. In order to test our hypothesis, we engaged teachers to implement and develop the verb idea in practice. At this point, the verb idea basically consisted of a list of verbs, including short descriptions of how the verbs relate to physics and chemistry (see Table 1, and for an extended version [Areljung 2016]).

The implementation and development phase lasted for 1.5 years. During this phase of the project, our aspiration was to explore if and how the verb idea was useful for teachers. The teachers were free to use the verb idea in the way, and to the extent, they found suitable in relation to the different age groups and to their own and the children’s interests and capacities. Professional development was intertwined with the project, in that the teachers, the educators of the Centre, and myself met six times to discuss the teachers work, drawing on pictures or videos from practice supplied by the teachers.

The aim of this article goes beyond the goal of the project since I do not seek to evaluate the usefulness of the particular pedagogical idea, but to identify reasons to why teachers adopt or resist a pedagogical idea regarding science teaching.

Data production

The teachers, who worked in teams in three preschools, were asked to participate in the project because they had previously shown an interest in collaborating with The Centre. Altogether they were 10 participants: 6 preschool teachers and 1 leisure-time teacher, with university degrees, and 3 child minders, with a secondary training in ECE. As explained above, I will refer to all staff as teachers for the ease of reading.

The teachers’ participation in the project entailed that they, over the 1.5 year period, implemented the verb idea in practice and that they took part in six project meetings.
The teachers invested time and engagement in the project and in return they got the opportunity to develop their science teaching, supported by the educators at The Centre and me. Though the educators and I had been key actors in an initial stage of shaping of the verb idea, the teachers’ participation was crucial to testing its relevance to practice. Further, the teachers’ participation was key to the development the verb idea because their experiences from implementing it in practice meant that the verb idea was challenged, strengthened and extended.

In the last month of the project, I conducted three semi-structured group interviews, one with each team. Eight of the teachers participated, while one teacher was ill during this period and one asked not to participate in the final interview. The reason for conducting group interviews with the teacher teams, rather than individual interviews, stems from the assumption that professional development is highly dependent of the cultural-historical setting of the preschool (Nuttall 2013), where the team of teachers represent a ‘community of practice’ (Wenger 1998) which produces specific, culturally and historically situated, standards for what counts as valid actions and ways of knowing within the preschool practice. The work team’s shared views of science teaching and learning have shown to be important to how science activities are carried out in preschool practice (Sundberg et al. 2016).

In a group interview, it is likely that the teacher utterances correspond to the dominant view of what are valid actions and ways of knowing within the particular group (Cohen, Manion and Morrison 2011). Thus, the strength of the group interview is that it supposedly displays what passes as valid views on science teaching and learning within the preschool work team.

Each interview lasted for about one hour and revolved around four themes:

- The teachers’ experiences of planning and working with science, with the verb idea as a starting point
- If, how and why the verb idea had contributed to changing their ways of working
- What the teachers perceived that the children learnt from the activities
- What knowledge the teachers perceived that they needed in order to work with the verb idea

Table 1. Examples of chemistry verbs and physics verbs (Areljung 2016, 238).

<table>
<thead>
<tr>
<th>Chemistry verbs</th>
<th>What are the verbs about?</th>
<th>Physics verbs</th>
<th>What are the verbs about?</th>
</tr>
</thead>
<tbody>
<tr>
<td>mix, dissolve</td>
<td>how substances mix with each other</td>
<td>spin, rotate, swing</td>
<td>movements around a central point</td>
</tr>
<tr>
<td>separate</td>
<td>how mixes can be divided into their components</td>
<td>roll</td>
<td>movements around a central point, and sideways, towards a surface</td>
</tr>
<tr>
<td>absorb</td>
<td>how a solid substance takes up a liquid</td>
<td>shine, reflect, sound, echo</td>
<td>how light waves and sound waves and how they move in spaces</td>
</tr>
</tbody>
</table>

This study does not seek to distinguish the teachers from each other, but to identify a variety of reasons that teachers adopt or resist a pedagogical idea that concerns science. However, during the interview, I sought to grasp examples of personal reasons for adopting the pedagogical idea, as well as to gather input that would make the dominant view more complex. Therefore, I specifically directed, or repeated, questions to teachers who
I judged to have said relatively little about the topic currently discussed (cf. Fontana & Frey 2005).

Since the interviews revolved around a pedagogical idea that I, together with educators from The Centre, had introduced, it is plausible that the interviews suffered from interviewer-bias. Any resistance by the teachers was likely played-down during the interviews, and especially the critiques that still applied. In an attempt to reduce the interviewer-bias, I posed questions that opened up critique and when teachers gave generic comments about why they appreciated or resisted the verb idea, I asked them to give specific examples.

**Ethical considerations**

The preschool staff were informed, in writing and verbally, about the aim of the project, the use of data, and their right to refrain from participating. Further, the teachers have been informed about my efforts to keep individuals anonymous. The staff consisted of nine women and one man, of whom seven women and one man participated in the interviews. For anonymity reasons, the teachers’ names have been replaced with pseudonyms that are not gender-exclusive.

**Analytical tool**

The analysis of the interview transcripts was guided by Clarke and Hollingsworth’s (2002) model of teacher professional growth, which has been used extensively in research that concerns teacher change (e.g. Dyment et al. 2014). The model is considered suitable for this study because it takes into account four interconnected domains of change: the personal, external, practice and consequences domain. I posit that the model can be used to identify different types of influences that matter to teachers’ adopting or resisting a new pedagogical idea for science teaching in preschool. In Clarke and Hollingsworth’s (2002) model, the personal domain represents the teacher’s beliefs, knowledge and attitudes and the external domain is about information and stimulus from outside the teacher’s practice, such as intervention programmes and publications. The practice domain addresses the testing of new strategies in one’s professional practice, while the salient outcomes that can be connected to the professional experimentation fall within the consequences domain. The salient outcomes are tied to what the teacher values, which is why they could include improved student achievements as well as an increase in student collaboration in the classroom.

Clarke and Hollingsworth’s model is developed in relation to school environments, which may be why it refers to ‘conversation with colleagues’ as a part of the external domain (Clarke and Hollingsworth 2002, 953). However, since the shared beliefs of the community of practice have shown to be important to how science practice is carried out in Swedish preschools (Sundberg et al. 2016), I judged that the personal domain was not sufficient to capture the various beliefs that affects teacher’s adoption or resistance of a pedagogical idea. Consequently, I included a ‘community domain’, embracing the work team’s beliefs about teaching and learning, in the analytical tool.

The transcripts were labelled with two types of codes (see Table 2). First, I employed open coding to mark how the verb idea was reinforced or challenged in the transcript.
sections. This was done to identify the various types of reasons for teachers’ adopting or resisting a new pedagogical idea. Second, I interpreted whether the content of the section concerned any of the change domains and labelled it accordingly. This was done to differentiate between the types of influences that affect teachers to adopt or resist a new pedagogical idea. I will illustrate my use of the analytical tool with the following teacher quote, which concerns a ‘rolling’ activity:

You start at the same time, keep your clothes in the same way, you have agreed to keep your eyes open this time. But the children move like this (the teacher shows how children diverge as they roll). Why is that? What makes it like that? And then the children investigate up and down and back and forth, but it is always like that. What do we look like? I am a little shorter and you are a little taller, how does that matter?

I labelled the above quote with the code ‘Children realise that we roll differently depending on what we look like’. After having coded all the three transcripts, I constructed categories to gather groups of codes (see Table 3). For example, the above code was grouped under the category ‘Supports children’s investigations, hypotheses, and conclusions’. Although most categories include transcript sequences from all three preschools, I will, in the results section, present the categories in relation to the preschools where they appear relatively often.

Table 2. Analytical tool: the questions asked when reading the transcripts, and the type of corresponding responses, which either rendered a label in form of an open code or in form of a change domain.

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: (How) is the pedagogical idea reinforced or challenged?</td>
<td>If reinforced or challenged → response in the form of an open code</td>
</tr>
<tr>
<td>2: Does the content of the transcript section concern changes in teacher beliefs, attitudes, or knowledge, connected to science teaching in preschool?</td>
<td>If yes → Personal domain</td>
</tr>
<tr>
<td>changes in the work team’s shared beliefs about teaching and learning?</td>
<td>If yes → Community domain</td>
</tr>
<tr>
<td>change in influence from external actors, connected to science teaching in preschool?</td>
<td>If yes → External domain</td>
</tr>
<tr>
<td>changed practice, connected to science teaching in preschool?</td>
<td>If yes → Practice domain</td>
</tr>
<tr>
<td>outcomes, connected to the changed practices?</td>
<td>If yes → Consequences domain</td>
</tr>
</tbody>
</table>

Table 3. Examples of open codes, the categories formed to gather groups of codes and the corresponding change domains.

<table>
<thead>
<tr>
<th>Examples of open codes</th>
<th>Categories</th>
<th>Change domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>I used to think that science was a little scary, like the chemistry or physics classroom – but not anymore</td>
<td>Supports teachers to transform their negative relation to science</td>
<td>Personal domain</td>
</tr>
<tr>
<td>I used to think it was impossible to work with science with small children – but not anymore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Children realise that we roll differently depending on what we look like</td>
<td>Supports children’s investigations, hypotheses, and conclusions</td>
<td>Consequences domain</td>
</tr>
<tr>
<td>Children realise that much water makes soup and less water makes chocolate balls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Children who do not usually talk much are caught by the discussion about tornados</td>
<td>Supports children’s discussions</td>
<td></td>
</tr>
</tbody>
</table>
The above quote was labelled ‘consequences domain’ because it addresses a positive outcome of their practical experimentation. The outcome is judged as positive, from the teacher’s perspective, based on other parts of the interview transcript, indicating the work team’s shared belief that children’s voices and their bodily experiences are important parts of teaching and learning.

Results

Below, three vignettes are presented to provide examples for adopting or resisting the pedagogical idea, across the five domains. Though the article does not seek to compare the three preschools, I judge that the results make better sense presented in relation to the specific activities that the teachers draw on during the interviews. After the vignettes follow a summary of reasons for adopting or resisting a pedagogical idea, in relation to the five change domains.

Vignette 1: The Sound Preschool

The Sound Preschool is for children aged 1–2 years and here the teachers Shannon, Sandy and Val participated in the interview. In this preschool, the teachers’ focus for science activities has been on how things sound and how children can contribute to producing sound. The teachers created physical spaces for children’s investigations, including a ‘sound wall’ covered with materials such as corrugated card board and bubble wrap, which produce different sounds when the children strike them with their hands. The teachers point out that, though the children do not say much, it is possible to tell from their body language that they draw conclusions about sound from their interactions with the materials. During the interview, it turns out that Sandy, outside working hours, often turns to a photo sharing website for inspiration regarding the preschool’s physical environment. Sandy says that, thanks to the science verbs, it is possible to discern new things in the photos:

I spend quite much time on the computer, and I can make use of … I can see that this too is physics or chemistry. I see it with other eyes. It [science] is not these test tubes anymore. In that sense it has helped me a lot (…) via the verbs I have learnt to see that we can use this [material] if we are going to work with rolling, or sounds or whatever we do.

All three teachers expressed that they have previously found science difficult or even threatening. Val recalled believing that ‘it was more or less impossible for us to work with these big things [physics and chemistry] here, with the children’. The teachers mentioned that, in the beginning of the project, they found it hard to grasp the meaning of the verbs and also to imagine how to work with them for a long period. They referred to a lecture, given by me and another science educator during the first semester of the project, as an important inspiration because we showed how other preschools work with science and also because we showed that science ‘can be this easy’. The teachers spoke of the science verbs as eye-opening, emphasising that the verbs have helped them to see the surrounding environment in new ways and to be better attuned to children’s explorations of scientific phenomena. For example, the teachers talked of how they have changed from seeing sound as a disturbing element in practice, to asking questions that lead children towards investigating how things sound:
Sandy: Sound is always there, but I have often found it exhausting before.
Shannon: It has been more like: ‘Hush!’ and ‘No, don’t hit that!’ But lately I have rather said: ‘Okay, you can knock on the drying cabinet, but how does it sound on this door and how does it sound on the floor?’ Maybe one, as we talked about before, ‘says no but yes’ [referring to a recent lecture with a well-known Reggio Emilia pedagogista]. That one makes the children not only knock on the drying cabinet but asks ‘how does it sound if you hit something else’. There has been a difference.

Vignette 2: The Mix Preschool
In the Mix Preschool, the children are 3–4 years old. The teachers Chris, Mel and Sam participated in the interview. During the project period, the teachers’ focus for science activities had shifted from mixing things to how things dissolve in water. A recurring theme in the teachers’ talk was how teaching is managed in a time perspective. The teachers described their previous work with science as a matter of ‘ticking the box’ to be done with the science part of the curriculum. Chris stated that their new way of working felt more meaningful, because ‘[t]he children get to meet things again and again and again’. When asked to expand on why it is good that children meet things many times, Chris said:

Well, they discover different things. They may say one thing the first time but then they start pondering. Like when they got the task ‘What can melt in water?’. They use the word ‘melt’ [instead of dissolve]. They tried plastic tubes and all kinds of things, until they found out … Because one child tested a paper baking cup, and it melts. And then they wanted to put paper in water, because it melts. Those kinds of things. To test many times.

The teachers repeatedly portrayed their previous work with science by referring to an experiment box that they brought to display experiments that were ‘a bit like magic to the children’. During the interview, the teachers positioned themselves away from the experiment box, and Mel put forward their new way of working as well-integrated with other curriculum goals:

The verbs provide you with a different way of thinking. Because otherwise, well you can read about how other preschools work, and they take out experiment boxes. And then they have completed it [their work with science]. While we, when we work with the verbs we involve mathematics, language … we practically cover the whole curriculum with one verb.

Whereas Mel emphasised that the science verbs make way for theme work that include more curriculum goals than only the science goal, Sam perceived that the team had been too limited in the subject area of science. Sam found the verbs ‘unscientific’ at first, and also narrow in the sense that the verb list did not embrace all of science. Further, Sam pointed out an uncertainty when combining science activities with, for example, painting activities:

When they [educators from the Centre] were here last time I asked about the paper balls that the children had remade. I didn’t know if we could go further and do something with them, if we could create a snow man or something. How narrow are we in this science track? One can regard this as science too, as you [Author] say, that you mix water colour to a certain concentration. But at that point I thought that maybe we shouldn’t do creative work.
In the above quote, Sam mentioned an external influence from the educators at the professional development centre, who were also partners in this project. Moreover, The Centre was in charge of a course concerning pedagogical documentation that the team participated in during the project period. The teachers’ wish to make use of documentation was apparent during the interview. Mel connected the use of documentation to the possibility of distinguishing science verbs in children’s actions:

That is why it is good that we have pedagogical documentation and the protocol for reflection, and that we can look at films or photos, asking: what can we see them doing? And focus on what the children do, they may be squeezing, or splashing.

In addition to pedagogical documentation, the interview revealed that the teachers were in a process of learning more about Reggio Emilia pedagogy, and that it was difficult for them to separate the impact of the verb idea from the impact of trying to work with Reggio Emilia pedagogy. The teachers recognised an alignment between their work with science and Reggio Emilia pedagogy, ‘because [Reggio Emilia] is about investigating things, and that has to do with science so it fits together’.

Vignette 3: The Swirl Preschool
The Swirl Preschool is for children aged 4–5 years. The teachers Kim and Casey participated in the interview. The teachers said that they chose to work with physics verbs that can be explored with the whole body, that is, rolling, spinning and swirling. The children, for example, watched tornado video clips and made models of their own tornado-making machines. Further, they spent much time painting, dramatising and discussing how tornados come to be and how it feels to swirl with your own body.

Casey: One of the children is really fascinated by tornados and has been wanting to watch videos really often. (…) So he watches them and gets on the floor spinning himself and sits down again watching the video. And he asks: Why are there tornados? There are a few children who have to know. They like facts.

According to the teachers, ‘swirling’ engages the children in intense discussions, for example, once when ‘many children entered the floor to show their ideas, a bit angrily’. These discussions often stem from planned situations where children gather to talk about photos of previous activities, guided by a teacher. Kim said that the teachers initially planned for children to discuss without teacher intervention, but that ‘sometimes I dare to go back to saying what I think. And it does not bother [the children], it is just my theory. They do not have to share it if they do not want to’.

The teachers emphasised that the verb idea has opened up to ways of framing science activities in time that are different from their former tendency to quickly finish things. This was portrayed as an important change since their ‘dream has been to work with long projects, but it has failed for different reasons before’. Further, The teachers emphasised that their new way of working goes beyond ‘a box that you take out and take away’. When I asked what it is about the science verbs specifically that matter to the possibility of working in new ways, Kim responded:

Besides the fact that it has to do with doing? Well, because you are in it all of the time, it makes you focus on the processes, and not on where you should reach. (…) We become relaxed and the children become relaxed in all of this. We can get away from the achievement thing and just do it.
Further, Kim highlighted that the combination of project partners has been important, and the fact that there is no ‘guru’ that they must relate to when forming their work with science:

I think it is about this thing between you [Author] and the Centre, because the Centre is much into aesthetic processes. And you are scientific, essentially. And then they come with the idea that one should provide children with aesthetic experiences. And how do you do that in science? You have no idea, you just have to try, and do it. There is no one else who has done this much, not that we know of. No one of these persons that everybody talks about. There is no guru in this area. So you are quite free.

Diversity of reasons for adopting or resisting the verb idea

As Clarke and Hollingsworth (2002) point out, the change domains are interconnected. However, in order to highlight the various types of factors influencing teachers in preschool, the summary of teachers’ reasons for adopting the verb idea are discussed under each change domain. Since the interview transcripts contained relatively few examples of resistance, the reasons for resisting the verb idea are merged into one paragraph, presented at the end of the section.

Personal domain

Almost all teachers mention that they previously found the science subject difficult and they talk of the verb idea in terms of an ‘eye-opener’, surprised to see that science ‘can be this easy’. The teachers say that, from previously perceiving science teaching as a matter of conducting experiments, they can now discern science phenomena in situations that they could not before, such as when children knock on the drying cupboard, or in pictures on a photo sharing site. In all, the data suggest that the teachers adopt the verb idea because it empowers them by enhancing their perceived subject knowledge and teaching competence.

Community domain

The results suggest that the teachers adopt the verb idea because it fits with the community beliefs about teaching and learning, which includes that practice should builds on everyday processes rather than specific experiments, and on everyday material rather than ‘test tubes’. As for the teams’ beliefs about teaching and learning, the teachers readily state that they ask questions, provide material and sometimes emphasise concepts connected to children’s activities, but what they say little about is whether the teachers themselves challenge children’s thinking. However, the teacher statement ‘sometimes I dare to go back to saying what I think’ reveals that the matter of intervening with children’s thinking creates tensions for teachers in preschools.

External domain

The data show that the teachers deal with several external influences, such as Reggio Emilia pedagogy, a course in pedagogical documentation, and various ‘gurus’ in the field of preschool pedagogy. The teacher statements indicate that they adopt the verb idea because it offers a way to deal with, or make meaning of, many of these external influences. For example, teachers connect their approach to children’s
investigations of sound to a lecturer’s recommendation of ‘saying no but yes’. Further, the teachers emphasise that Reggio Emilia pedagogy aligns well with science, since both are about investigating. Given the seemingly heavy external influence that teachers are under, it is noteworthy that one of the teachers points out the combination of project partners as a key factor. Apart from the teachers themselves, the project group consisted of educators working at the Centre, who are influential in the local field of preschool pedagogy and promote Reggio Emilia pedagogy and pedagogical documentation, and a science educator/researcher. Thus, the results suggest that the teachers adopt the verb idea because it is ‘multiple approved’ by stakeholders representing both the science side and the preschool pedagogy side.

**Practice domain**
The change in the personal domain, when it comes to discerning scientific phenomena in everyday practice, can be related to what teachers say about drawing more on science content in children’s everyday activities than they did before. Further, a central change in practice concerns how science is managed in time and space. The teachers repeatedly portray their previous way of conducting science activities in the form of an experiment box, representing occasional happenings, mainly conducted in order to ‘tick the science box’ in the preschool curriculum. In their descriptions of their current work with science, the teachers reject the experiment box, and emphasise that they intertwine science activities with several curriculum goals and that they let children engage with the same material over and over again.

**Consequences domain**
The teachers point out that the children produce questions, investigations and conclusions relating to the science verbs, such as, why things sound different when they roll, what items dissolve in water and how tornados come to be. Though the teachers say that they provide questions and material during the activities, it seems as if the conclusions that children draw from the activities are generally free from teacher mediation. The results suggest that the verb idea is adopted because it can be used to promote children’s autonomous production of knowledge.

**Resistance**
The interviews include relatively few examples of resistance towards the verb idea. The examples that do come up are that the science verbs were perceived as unscientific or abstract and that it was difficult to imagine how to work with them for a long time or to intertwine them with curriculum goals other than science goals. The teachers’ resistance towards the verb idea was generally moderated by their colleagues during the interviews and nearly always told in past tense, hence, that they used to be sceptical but are not anymore. This tendency can be read as a consequence of the interviewer-bias outlined in the method section. However, the fact that the teachers still work with the verb idea, to date 1.5 years after the end of our collaboration, indicates that the teachers’ reasons for adopting the verb idea surpassed any resistance towards the verb idea.
Discussion and conclusion

The results indicate that teachers deal with several influences about teaching and learning in preschool that need to be negotiated when implementing new pedagogical ideas in practice. Among these influences are the national curriculum and its holistic approach to subject teaching (Swedish National Agency for Education 2011), the preschool culture of focusing on ‘doing’ (Ljung-Djärf, Magnusson, and Peterson 2014), the Reggio Emilia pedagogy, and pedagogical documentation, all which, according to the teachers, align well with the verb idea.

A prominent result is that the verb idea is adopted because it enables teaching beyond the detached space and time dimensions of ‘the experiment box’, that is, a box that contains material for science experiments. Most of the teachers in this study signal that they have been uncomfortable with teaching science through the experiment box. As a metaphor for teaching, the experiment box coincides with school stereotypes of lesson-like time frames (cf. Otterstad and Braathe 2016). Further, the experiment box does not match preschool conventions of integrating the science subject with other subjects (Klaar and Öhman 2014) or with aesthetic work (Westman and Bergmark 2014). The results suggest that the teachers adopt the verb idea because it helps them to position their teaching away from school stereotypes. The results have bearing in a national as well as in an international context where ‘science boxes’ are common, particularly in the early years of compulsory school, but also in preschool. Science boxes are often promoted as empowering teachers and making science teaching ‘happen’ despite teachers’ low content knowledge in science. The present results trouble the empowering argument by displaying the disempowering force of science boxes, in terms of their making science teaching a foreign, disentangled, event in the teacher’s practice.

The results presented herein suggest that the verb idea offers a way in to science for teachers that find it difficult to work with the subject in preschool. The colloquial connotation of the science verbs appears to do two things: first, it makes science seem less difficult, and second, it helps teachers to discern science in everyday practice. However, I want to stress that the verb idea itself is not expected to compensate for teachers’ lack of content knowledge, neither does it − as one of the teachers points out during the interview − cover more than a small part of science. Despite the teachers’ expressed unwillingness to only ‘tick the box’ in the curriculum, I recognise the risk that others may interpret the verb idea as a list of verbs to tick in order to dispense with the science part in the curriculum. Further, I recognise that verbs, as a word class that signals action, may augment the focus on ‘what to do’, rather than on how children can make meaning of what is done (cf. Ljung-Djärf et al. 2014). Future studies are needed to examine how the verb idea unfolds in practice in terms of teacher mediation and science learning opportunities afforded to children. Particularly interesting is how teachers unpack and extend the working theories, that is, tentative ideas about relations in the surrounding world (Hedges 2014), which emerge as children engage with scientific phenomena.

The analytical tool used in this article has been helpful because it distinguishes as well as interconnects factors that matter to why teachers adopt a pedagogical idea. Using the change domains as analytical concepts, enabled me to differentiate between the types of influences that affect teachers’ adoption or resistance of new pedagogical ideas. The results highlight the significance of the ‘community domain’, which indicates that a
community domain be added to Clarkes and Hollingsworth’s (2002) model of teacher professional, when using the model in a preschool context where teachers work in teams. While this study identifies a variety of reasons that teachers adopt or resist a pedagogical idea, it is small in scale and is likely to mainly capture the dominant view of the work team, at the expense of the individual voices. It can thus be discussed whether the ‘personal domain’ can be separated from the ‘community domain’. In this article, the ‘personal domain’ is distinguished from the ‘community domain’ through the examples of teacher empowerment. For example, the teachers give accounts of how they, personally, have changed from finding science difficult, to seeing science phenomena in their everyday lives, at work and at home. Yet, further studies, that involve individual interviews as well as observation data from practice, are needed to learn more about how reasons connected one change domain affects reasons connected to another change domain. This approach is in line with what Clarke and Hollingsworth (2002) depict as the mediating processes, enactment and reflection, that connect the change domains.

The reasons for adopting or resisting the verb idea that are displayed in this article are partly dependent on factors beyond the particular verb idea, such as the ‘multiple approval’, while some reasons are tied to the verb idea per se, such as the everyday connotation of the particular science verbs. Nevertheless, these are all reasons that teachers adopt or resist a pedagogical idea for science teaching, and as such they provide useful insights for designing professional development activities for preschool staff.

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