Pre-school children's collaborative science learning scaffolded by tablets – A teacher's view

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This paper has also appeared in: Finlayson, O., McLoughlin, E., Erduran, S. & Childs, P. (Eds.) (2018) Electronic Proceedings of the ESERA 2017 Conference. Research, Practice and Collaboration in Science Education. Dublin, Ireland: Dublin City University.

ISBN 978-1-873769-84-3.
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Abstract

The potential of tablets to support communication during collaborative inquiry-based science learning in pre-school has previously been reported (Fridberg, Thulin & Redfors, 2017). Children communicate in a more advanced manner about the phenomenon and they focus more readily on problem-solving when active in experimentation or Slowmation production. Here, we shift focus to the pre-school teacher's perspective on science and the work model with timelapse and Slowmation. The pre-school teacher's talk about the teaching was analysed from three perspectives: the relationships between teacher-science, teacher-children, and children-science. Possibilities and challenges expressed by the pre-school teacher in relation to the three perspectives were identified and, interestingly, the analysis shows most possibilities in the children-science relationship. In contrast, most challenges are found for the teacher-science relationship, in terms of lack of knowledge. We argue for the need to further discuss pre- and in-service pre-school teachers' experiences of science and science education.

Keywords: Pre-school, science, tablets

Introduction

One identified important factor for children's learning, whether in pre-school or in the education system as a whole, is teachers' content knowledge (Nihlfors, 2008; Gitomer & Zisk, 2015). Research also points to some key factors where teachers' knowledge of science is one central issue for the learning (Siraj-Blatchford *et al*, 2002; Yoshikawa, 2013). Furthermore, Fleer (2009) expresses the link between early childhood teachers' limited science knowledge and teachers' confidence and competence to teach science. However she, together with other researchers, also point to pre-school teachers' pedagogical content knowledge (PCK) and attitude towards science as having an impact on children's learning (Fleer, 2009; Thulin, 2011; Spector-Levy *et al*, 2013).

In this study, we make use of timelapse photography and *Slowmations.* Timelapse photography is a technique that shows a slowly changing event in accelerated speed, which is accomplished by photographing the event at certain intervals and, when played at normal speed, the event seems much faster. A *Slowmation* on the other hand is a stop-motion animation played in slow motion to explain a science concept (Hoban, 2007). The work model implemented with children aged 3 to 6 (Fridberg, Thulin & Redfors, 2017) constitutes four different learning contexts: i.e. hands-on experiments, timelapse photography, stimulated recall, followed by *Slowmation* creation, where the children represent explanatory models in different materials, and which is versatile and opens up possibilities for the children to generate, represent and discuss explanatory models.

From a theoretical framework primarily based on phenomenography and variation theory (Marton & Booth, 1997), focusing on developmental pedagogy (Pramling Samuelsson & Asplund Carlsson, 2008), this work aims to analyse variations of, in retrospect, expressed experiences by the teacher, for the four different contexts of science learning during a semi-structured interview.

The research question guiding the study is:

- What differences in referential meaning can be ascribed to the teacher's statements about the science teaching work model, especially concerning possibilities and challenges?

Method

A semi-structured interview with open-ended questions was performed with the teacher one year after the finalisation of the project. The teacher answered spontaneously, with follow-up questions from the researcher. In addition, we used stimulated recall where the teacher watched selected parts of the video-recorded activities with the children, and was asked to reflect on his role. The activities were chosen to represent four enacted learning contexts analysed previously (Fridberg *et al*, 2017). The teacher's statements were analysed and categorised with specific focuses, depicted in Figure 1.

Through a phenomenographic analysis, we could identify variations of experienced possibilities and challenges with parts of the science teaching work model, as described by the teacher.

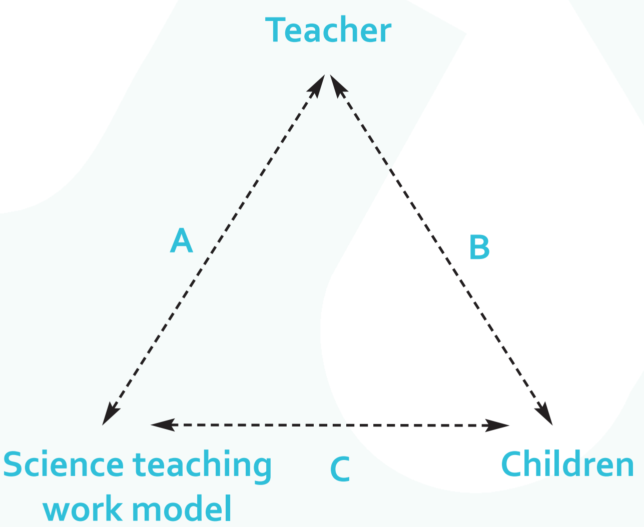

Figure 1: The triangle of analysis depicts the three relations A, B, C focused in the analysis of the teacher's statements, related to A) the object of learning in terms of the science teaching work model, B) the children, and C) the children's relation to science or the work model.

Results

The challenges and possibilities identified in the analysis of the teacher's statements involving science and the work model will below be summarised as belonging to the themes: *knowledge*, *number of children*, *children's previous experiences*, *time constraints*, and *interactions*.

Challenges described by the teacher include his experienced lack of knowledge in science, even though he also stated that the project increased his knowledge. Another challenge expressed is connected to numbers, when too many children take part in the activities. This was manifested in the teacher expressing the need to take a more controlling role in the situation, compared to when there are fewer children involved. Fewer children allow for him to stand back and the discussions among the children were more fruitful and less stressful. However, in addition, the teacher stressed that the number of children is only one factor influencing the outcome. The results achieved during the production of *Slowmations*, etc. also depend on the individual children involved and their previous experiences and ability to co-operate. Yet another experienced limiting factor is time and the pressure the teacher felt to reach conclusions and 'get somewhere' during the timeframe of the activity. This resulted in the teacher sometimes seeing himself as someone who provided the answers too quickly, or feeling that he did not give the children space to think through the activity. He described how the lived/felt time pressure sometimes negatively influenced the discussions between him and the children.
The teacher reported that, during the project, he came to expand his view of natural science from one restricted to biology to then include also chemistry and physics, something that can be thought of as opening up opportunities. This result also concurs with the results of Thulin and Redfors (2017), who found a large portion of students having changed their views accordingly from pre- to post-test related to a science course in pre-school teacher education.

The possibilities described lie in the work model itself. It takes into consideration the children's interest in tablets and captures many of the areas in the pre-school curriculum, such as natural science, mathematics and language, but also values and interaction. The work model, with discussions, hands-on experiments and timelapse/*Slowmation* production, where the children represent the phenomenon in different materials, is versatile and opens up the learning of the science phenomenon from several perspectives. This, according to the teacher, is consistent with the pre-school teacher's mission to include all children based on their individual needs and pre-conditions.

Most possibilities described by the teacher are found in the relationship between the children and the object of learning (side C in the triangle, Figure 1). He stated that the teachers and their attitudes to the work model or science are the limiting factor, not the children. These results can be compared to Thulin (2011), who stated that the children were interested in the content and asked content-related questions. The children have no difficulties working with experiments, movie production, etc. The results depend on the attitude of the teacher, who needs to be positive in order to have a fruitful outcome. Interestingly, and to the contrary, most challenges are described in the relationship between the teacher himself and the object of learning (side A in Figure 1), in terms of experienced lack of knowledge.

Discussion

An increasing number of studies (Ainsworth, 1999; Prain & Waldrip, 2006) suggest that students' learning is enhanced when they create digital artefacts, such as representations of science concepts. Through this creation of an explanatory model, skills such as creativity, problem-solving, communication and collaboration can be developed (Nielsen & Hoban, 2015). We have previously studied and proposed a work model for children's collaborative science learning through the use of computer tablets. This teaching model includes discussions, experiments documented by timelapse photography, stimulated recall for the teacher and children through watching timelapse movies, and a subsequent production of a *Slowmation* movie, where the children represented their explanatory model in, for instance, playdough or LEGO® (Fridberg *et al*, 2017). Prain and Tytler (2013) argue that there are particular learning gains for students when they construct their own representations of scientific processes and concepts. These gains include the development of students' cognitive and reasoning strategies, the promotion of contexts that engender meaningful communication of science understandings, and of activities that are highly engaging for students. Our results were in agreement and revealed the timelapse movies as beneficial for the children's model-based reasoning about the science content (evaporation), and the *Slowmation* movie production helped the children to think about explanations for, and representations of, the science content. Another interesting aspect of young children and their interaction with digital technology is described by Kjällander and Moinian (2014). They studied pre-school children's playful use of applications on tablets and described how their interactions resisted the pre-existing didactic design of the application. Instead, the children in their study transformed the application setting and objects into something that made sense and had meaning for them. The children designed their own process by making sense of affordances provided by the digital resource in relation to their own interest and previous experience. This finding reflects children's agency and opens up the way for thoughts on consumer and production processes in the digital arena (Kjällander & Moinian, 2014). We consider our proposed work model with timelapse and *Slowmation* production to fit well into an agentic view of childhood (Fridberg *et al*, 2017). In the present study, we expand our previous work, which focused on the children, to include the teacher's views and experience of science and the jointly developed work model.

In order to help children to learn about something, it is important that the teacher considers children's previous experiences, as well as the object of learning (Pramling Samuelsson & Asplund Carlsson, 2008; Thulin, 2011; Gustavsson, Jonsson, Ljung Djärf & Thulin, 2016). During the interview, the teacher highlighted the importance of the children's prior experiences when he stated that *'It's about what they have in their luggage too'* as he described the lived curriculum. It is not the age of the children, but their prior experiences, which set the limits according to the teacher and this concurs with the variation theory as described by Marton (2015). Important for a teacher to consider is what the learners have not yet learned to discern about a certain object of learning, since these 'lacking pieces' are critical aspects for further learning.

In a recent national report, Skolinspektionen (2016) describes how the science subject in Swedish pre-schools often is acted out in somewhat random experiment activities, without guidance towards a specific object of learning. The teacher in the present study pointed out the benefits of the work model, including several subjects and aspects of science such as, for instance, language, technology and mathematics.

During the work process, the teacher also saw other important parts of the curriculum being expressed, such as value systems and the children's ability to interact with each other. He suggested the work model to be used prior to a parent-teacher conference, since it would enable him as a teacher to learn things about the children and their capabilities that he didn't know about. The teacher talked about children whom he knew to be a bit shy and withdrawn surprising him by being active and expressing their thoughts during the timelapse and *Slowmation* production. He connected this to the pre-conceptions and taken-for-granted assumptions that adults and teachers often have about children's capabilities.

Structural factors challenging the work with the model and science included the number of children participating in the activity: the more children, the more stressful a situation for the teacher to handle. However, he also pointed to the influence of *which* children one, as a teacher, groups together in the activities, something that may be viewed as a relational factor that either limits or enables the learning. If the children co-operate easily with each other, the group can be larger. Another structural factor challenging his work included an experienced lack of time during the activities. This, according to the teacher, influenced his discussions with the children in a negative way, and prompted him to provide them with the correct answer to his questions, or to move on too fast without giving the children time to think as much as he would have liked them to. However, the main structural factor expressed by the teacher as limiting for his work is his experienced lack of knowledge in science.

Interestingly, and striking from the analysis, most challenges are expressed in the teacher-learning object relationship (A) and in terms of the experienced lack of knowledge, while most possibilities are described in the children-learning object relationship (C). Different children show interest in different parts of the versatile work model, and the teacher viewed them as capable. Instead, he pointed out that it is the knowledge and attitude of the pre-school teacher towards science and the work model that will determine possible opportunities and challenges. In this case study, the teacher was stimulated by the work model, but was less well prepared for the science content. Research on primary science teachers of young children shows that teachers have insufficient knowledge of the subject and pedagogical content knowledge (Appleton, 2008; Fleer, 2009; Thulin, 2011; Spector-Levy *et al*, 2013). Other studies also point to early childhood teachers' lack of science subject matter knowledge (Kallery & Psillos, 2001; Garbett, 2003) but, to date, only a few studies have focused on practising in-service pre-school teachers (Andersson & Gullberg, 2014). This relates to justification for science in pre-school and the 'being' and 'becoming' perspectives, where 'being' refers to viewing children as actors in their own lives and letting them meet the science primarily for their own sake, while the 'becoming' refers to future uses of an early grounded knowledge. Thulin & Redfors (2017) do not polarise the two perspectives, but show that student pre-school teachers revealed a slight pre-dominance for the society – 'becoming' – perspective. However, from the results presented here, we can say that both teacher and children benefited from and experienced a 'being' perspective concerning their model-based reasoning.

In this study, different dilemmas that the teacher encountered when working with science and the work model could be identified. In the teacher's own words, *'It's a balancing act all the time, it's really tricky'*. The teacher has to consider and handle several factors at the same time, such as time management and children's interactions, when teaching a subject manifested in the curriculum about which he is not really comfortable with his knowledge. He talked about the need for support, from both the children's and the teacher's perspective. The children are dependent on him and his attitude towards the subject, and he in turn needs support in the form of someone with whom to discuss ideas, thoughts and questions. Or, in other words, the need for someone who supports his work through discussions about the intended and enacted object of learning. In Thulin & Redfors (2017), the majority of student pre-school teachers were positive about science and this result is contrary to the general impression in western countries that young people share negative views of science. Like the student pre-school teachers in the Thulin & Redfors survey, the pre-school teacher in the present study expressed a positive attitude to science. Instead, it was a feeling of not knowing enough about different science matters that the teacher in this study saw as the challenge in his work. This is further reflected in what we, as teachers in the pre-school teacher programme, encounter in our work with students and the science subjects. Our experience is that the students struggle with model-based reasoning, while the attitude towards the subject is one of positivity and curiosity among most students.

This raises an important question. When different content in the Swedish pre-school curriculum is discussed, it is often from the children's perspectives, and about how the content can be presented to fit the children's interests and previous experiences. Eshach (2006) reasons that the teacher perspective is equally important to consider when working with science in early years:

'I thus argue that educators should seek after such science activities that not only fit the children's needs but also the teachers' abilities, motivations and needs. (...) But to succeed in using such an approach, a kindergarten teacher must receive sufficient scientific support. (...) Thus, I argue that K-2 science education should be teacher-centered as well as student-centered, as opposed to the traditional student-centered approach' (Eshach, 2006).

Here, and in earlier work, we have seen the importance and benefits of intertwining science content and science education research results in working with in-service pre-school teachers – a view supported by Andersson and Gullberg (2014), who suggest four skills of which pre-school teachers can make use when teaching science: children's previous experiences; capturing unexpected things that happen in the moment; asking challenging questions to further investigations; and 'situated presence', that is, remaining in the situation and listening to the children. By making use of these skills, pre-school teachers may shift focus from their experienced insufficient subject matter knowledge to instead reinforce their pedagogical content knowledge (Andersson & Gullberg, 2014).

At the same time, we argue that a polarisation between science and science education is not beneficial. In intertwining support of science content with implementation of work models such as the one presented here, both knowledge of explanatory models in science and competence in handling activities with children can be seen to improve.

Conclusion and implications

The timelapse/*Slowmation* work model shows promise for future developmental work concerning both children and teachers. We agree with Eshach (2006) that support for teachers' work with science content in pre-school is needed, and the work model described by us could be viewed as one such support structure, through its framing and meaning-making of the science content. The work model with timelapse and *Slowmation* production concurs with teaching from a child perspective and an agentic role of active children in collaboration (Fridberg *et al*, 2017). In the present study, where previous work has been expanded to include the teacher's views and experience, we have found several distinct and important implications for pre- and in-service pre-school teacher education.

Results from this research on uses of our work model for science teaching have given a list of implications – four 'points-to-make' for teacher education and pre-school practice.
Firstly, teaching with and about the work model entails and highlights the importance and fruitfulness of having planned teaching activities with formulated intended objects of learning, which open up several overarching learning goals in the curriculum, such as communication, co-operation and world views, and bring in aspects of other subjects, including language, technology and mathematics. Secondly, it combines digital technology and science learning objects. Thirdly,

the work model facilitates active scaffolding by a teacher, but also brings into light the importance of

- support for pre- and in-service teachers on science content and science education principles;
- focusing on both 'being' and 'becoming' perspectives on teaching and children's learning;
- holding back and giving children time and opportunity to work things out; and
- managing the balancing act of holding back, giving answers, keeping order and letting children explore.

Fourthly, it highlights the children's capacity for problem-based collaborative inquiry to solve formulated questions, thus helping the teacher to keep focus on the learning object, to structure collaborative group work and plan group sizes based on communication skills and allotted time – all important aspects of collaborative inquiry in early years.

Using the work model helps the teacher to keep focus on the science learning objects through the activities, especially the *Slowmation* production. The process of planning and evaluation of intended – enacted – lived learning objects is an interesting and, in many countries, novel challenge for pre-school teachers. Project-based education for pre- and in-service pre-school teachers focusing on teaching with the work model will most likely bring all the points above into fruitful and generative discussions, especially because an interesting support structure for single teachers would be teams of teachers starting science projects together by formulating the intended and the enacted object of learning. In future studies, possibilities and challenges for these team-based formulations, during work with the work model, will be further investigated.

To conclude, our study points to great potential in the versatile science teaching work model as a teacher's tool for scientific explorations and discussions in pre-school. Furthermore, it casts a light over the pre-school teacher role in science teaching and contributes to important discussions about that role.

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