CHILDREN'S ENTANGLEMENTS WITH SCIENTIFIC CONCEPTS: EMBODIED SCIENTIFIC SUBJECTIVITY IN PRESCHOOL EMERGENT SCIENCE

This aim of this study is to explore how scientific concepts can take part in increasing children's possibilities to act, explore and become. The study takes its point of departure in combining perspectives from emergent science (Siraj-Blatchford, 2001), new materialism (Barad, 2007; de Freitas & Palmer, 2016), and gender theory (Barad, 2003). The empirical data consists of video-recordings and field notes from a field study in a Swedish preschool in a group of five-year old children. The focus of the field study was the children as they played and explored without specific guidance from the teachers. This paper considers how scientific concepts can work as creative playmates in children's play (de Freitas and Palmer, 2016) and a video sequence where a girl explores together with a swing, gravity and kinetic energy is analysed. During the analysis, Barad's (2007) theory of agential realism as well as diffractive methodology are being used. Early findings show how the swing, scientific concepts and phenomena worked as co-creators – not only of the girl's scientific explorations, but also of her capacities and identity construction. For example, by entangling with the matter and forces, she could jump higher and longer than from the ground and become as someone brave and strong. In the paper it will be discussed how children's explorations of/with scientific phenomena, and the mutual processes of (gendered) becoming (Barad, 2007), can materialize (Barad, 2003) in their bodies and minds and in this way co-create children's embodied scientific subjectivities. A contemporary challenge in science education thus becomes to see that "the beauty and pleasure of understanding", is an ontological question as much as an epistemological, in which learning and becoming, matter and meaning are of equal importance.

Keywords: Gender Issues, Investigative Learning, Early Childhood Education

INTRODUCTON

Drawing on new materialist thought (Barad, 2003, 2007) this study aims to create knowledge concerning how scientific concepts/phenomena can come to matter, not only for children's explorations and learning, but also for their becomings. As such, there are interconnections between the study and emerging field of science identities research (e.g. Carlone, Scott and Lowder, 2014), but the study utilises different theoretical perspectives. In a new materialist perspective, learning is not just connected to humans or human meaning-making, but instead seen as material-discursive processes. Furthermore, knowing is seen as always mutual and simultaneous with processes of becoming (Barad, 2007). That is, processes of knowing occurs in the same time as children (humans) become as (gendered) subjects and in these processes materials, things, places, discourses, and concepts are seen as co-creators. In this sense, learning becomes an ontological question as much as an epistemological. When it comes to learning scientific concepts De Freitas and Palmer (2016, p.12013) explain how, in a new materialist perspective "…the focus turns to how children are entangled with concepts rather than merely engaged in (mis)recognizing them" and state that scientific concepts can work as creative playmates in children's play.

Emergent science as material-discursive processes

The origin of the concept of "emergent science and technology" (Siraj-Blatchford, 2001) aims to shift the focus on learning science in preschool, from individual children's conceptual understanding of a

predetermined teaching content to science as a social practice, something already being explored by the children daily during play. The concept has been applied as a means to problematize the image of science as facts children need to learn in the "correct way" and engage with how preschool children explore and co-create science (see for example Siry 2013). Recently, studies using new materialist perspectives have contributed with a view on (emergent) science, not as social practices, but as material-discursive practices. In this perspective, children are not seen as exploring science "on their own" while they play, rather they explore and become *together/entangled with* the material-discursive surroundings (Areljung, forthcoming; Haus and Siry, forthcoming) as well as *together with* scientific concepts and phenomena (de Freitas and Palmer, 2016; Haus, 2018). To further this knowledge, two research questions are explored:

- How can scientific concepts and phenomena – such as kinetic energy, gravity and force – work as co-creators of preschool children's explorations, learning and becomings?
- What could these material-discursive processes mean for children's constructions of scientific subjectivities and for how scientific subjectivity can be thought of in general?

METHOD

Data for the study comes from a field study made in a preschool outside a bigger city in Sweden, in a group of 25 children (five years old) and three teachers. During the field study, participant observations, including video recordings and field notes, were made over a period of 5 months. In total the observations amounted to 155 hours, out of which 12 hours were video-recorded. The study adheres to the Swedish Research Council's principles for research ethics (Swedish Research Council 2011) and has been approved by the regional board for research ethics. During the field study I moved around between the places where the children were. Sometimes activities that showed a potential for emergent science were sought out, at other times I sat down where some children were playing/exploring to see what evolved. The Swedish preschool curriculum does not include specific learning goals. Instead, the curriculum formulates what the preschool should offer the children. Learning is described as strongly connected to children's play and explorations of their surroundings and not only to activities which clearly are guided by teachers. In an early stage of the analysis all the video sequences were gone through and sorted after the places where they were constructed. The reading was also guided by the conceptualizations of emergent-science as socio-material practices and scientific concepts/phenomena as creative playmates and sequences were scientific concepts could be understood as functioning as creative playmates were chosen for a more detailed analysis. In this paper, one such sequence, where a girl, a swing, gravity and kinetic energy are co-acting is analyzed. This sequence (4,5 minutes) was chosen as a point of departure for this study. In the analysis, Barad's diffractive methodology and diffractive readings (Barad 2007) are used. Diffractive analyses are about looking for differences within phenomena, focusing on encounters, co-actings and entanglements, and what these differences might do. During the readings, different agents (bodies, materials, scientific phenomena, discourses) have been followed and it is explored what these do with the researcher's thinking together with the theoretical concepts – also treated as agents co-creating thoughts.

RESULTS

The preliminary analysis indicates that the swing and scientific phenomena worked as co-creators – not only of the girl's scientific explorations, but also of her capacities and identity construction. For example, by playing and entangling with the forces (de Freitas and Palmer, 2016), she could jump higher and longer than from the ground and become as someone brave and strong. When seeing identities as never preexisting but instead iteratively constructed depending on who and what are intra-acting at the moment (Barad, 2003) the

girl's qualities and identity were in the moment co-created with for example the kinetic energy. Furthermore, to "get/create" these capacities and identity in this situation, the girl had to time her bodily movement with the swing's transfer between potential and kinetic energy (Pendrill and Williams, 2005), and in the right moment, jump off the swing. To "understand" scientific phenomena, as kinetic and potential energy, can thus be seen as an embodied process, intertwined with identity construction.

DISCUSSION AND CONCLUSIONS

One preliminary conclusion is that children's explorations of/with scientific phenomena can be part of children's identity construction and that the explorations over time could be part of an embodied scientific subjectivity in terms of materializations in their bodies (and minds). As such, new materialism creates affordances for close readings of how scientific phenomena create affordances and constraints for an individual's becomings as scientific, in contrast to how 'science identities' research typically considers how individuals relate to broader socio-cultural characteristics of science as a community. However, what also is of importance is to not only state that the girl in the data could become as "brave" and "strong" in the entanglements with the swing and scientific phenomena, but also to pose questions of how these explorations and entanglements were made possible "from the first place". One reason for this could be due to her being the only human agent in the situation. "Being alone" could sometimes increase, or be necessary, for girls' possibilities to occupy a place and explore without interruptions (Author, 2018). As such, teachers need to take gendering processes in consideration when it comes to children's possibilities to extend their capacities in entanglements with scientific phenomena. This in turn means that, when working with children's conceptual understanding and scientific subjectivity, teachers need to take gendering processes and children's embodied becomings into account.

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