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Student Preschool Teachers' Experiences of Science and Its Role in Preschool

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Abstract This article reports on student preschool teachers' views of science and its role in preschool. Three cohorts of students have been given a written questionnaire with open-ended questions before and after a one-semester course including science (specifically Chemistry and Physics) in a 3.5-year preschool teacher programme in Sweden. The science content in the course is integrated with other subjects and lecturers with different subject backgrounds work together in forming an integrated and meaningful context. A phenomenographic qualitative analysis of responses to the questionnaires before and after the course is presented. The analysis indicated that many students equate science with biology (nature studies), and several did not adjust this view even though chemistry and physics were explicitly taught. Surprisingly few students were negative towards science, none after the course. However, several remain hesitantly positive. Most students described 'what' and 'how' perspectives of science, but few developed a synthesised view of science activities. However, there was a shift towards a more integrated perspective after the course. Also the quality and eloquence of the students' responses were noticeably improved in responses given after the course. Prior expectations and implications of the results for preschool teacher education are discussed.

Keywords Preschool · Pre-service teacher education · Science · Early childhood education

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Background and Introduction

Research concerning science education in preschool—and in the school system as a whole—has identified teachers' content knowledge as one important factor for children's learning in the field (Nihlfors 2008; Gitomer and Zisk 2015). However, content knowledge is not the only requirement. Research also points to preschool teachers' pedagogical content knowledge and attitudes toward science—views on their mission—as having impact on children's learning (Fleer 2009; Thulin 2011; Spektor-Levy et al. 2013). According to Hundeide (2003) individuals—preschool teachers, parents and so on—are bearers of different normative (taken for granted) assumptions about what constitutes a good preschool, effective parenting and, for that matter, the importance of different content areas of science in early childhood education—assumptions which in turn affect established communication and learning environments. Hence, there is a need to problematize the goals for science in preschools and consequences for pre- and in-service preschool teachers' education (Thulin 2006, 2011; Andersson and Gullberg 2012; Roychoudhury 2012; Sundberg and Ottander 2013).

When pedagogical implications concerning children's learning are discussed, the importance of considering the learners' prior experiences is stressed (Marton and Booth 1997; Helldén 2005; Eshach 2006; Samuelsson and Carlsson 2008). This can be transferred to students in teacher education and to teaching situations at university level. Therefore, urgent questions for pre-service teacher education are: How can the needs of students in the preschool teacher education be met concerning Science and science learning? Can teacher education influence students' views, beliefs and attitudes? The open-ended questions in this study represent an attempt to acquire knowledge about students' experiences and attitudes concerning science.

This article presents a study concerning students in preschool teacher education and their attitudes to science. The students are in their third semester (of seven) in their 3.5-year education. The investigated one-semester course includes physics and chemistry, but intertwined with other content. The course is a full-time semester course, which in Sweden corresponds to 40 h per week during 20 weeks for the student. There are no other courses in parallel. It is the first time the students meet this science content during the preschool teacher programme. The results of the study are expected to contribute to a research-based development of preschool teacher education.

Science in the Context of Preschool

Children's curiosity and willingness to understand the surrounding world can be seen as driving forces for learning science in early years (Eshach 2006). Different interpretations of the content area appear when science is discussed in a preschool perspective. One concept used is emergent science. Emergent science can be seen to signify that science in preschool should be directed towards the meaning of investigations, in order to initiate an interest in problem solving and inquiry (Siraj-Blatchford 2001). Science in a preschool perspective can also be described as letting children have opportunities to experience what 'the nature of science' can mean and how it is involved in daily lives and society (Siraj-Blatchford et al. 2002). Siraj-Blatchford (2001) emphasizes the importance of letting children meet and confront different materials and investigations, which will contribute to the visibility of content and connections, and also let children put words to what is happening, sharing discoveries and events with both adults and children.

Other researchers emphasize the importance of learning about connections in, for example, nature. Giving the children possibilities to develop awareness about how different parts of nature are in dependent relationships and that humans are part of that whole, an approach that can help children expand a preparedness for change (Magntorn and Helldén 2007). Both (1997) and Harlen (2006) describe the content field science in preschool as observing, asking questions, being exposed to variations, communicating and reflecting, but also emphasise that science is about imagination, wonder and creativity. A slightly developed definition is discussed by Eshach (2006) who argues that science concerns two different content areas: 'domain-specific or conceptual knowledge' and 'domain-general knowledge or procedural knowledge'.

> Domain-specific or conceptual knowledge: by understanding scientific concepts in specific domains children might better interpret and understand the world in which they live. The second statement emphasizes domain-general or procedural knowledge: 'doing science', it claims, contributes to the development of general skills required not only in one specific domain, but also in a wide variety of domains, not necessarily scientific ones (s. 2).

Osborne et al. (2006) complement the definition by adding a field of knowledge concerning 'ideas about science' (p. 29). Ideas about science as an object of learning can be understood as meta-reflective dialogues, i.e. to communicate: purpose, what and how perspective, and your own role in relation to the experienced science content (e.g. Samuelsson and Carlsson 2008).

Science in preschool can be discussed from different perspectives. One way to justify science in preschool takes its point of departure in society. This is based on supranational and national policy documents and is often talked about in terms of "children need to learn because society needs the knowledge". The goals are in the future. A comparison could be made to Osborne and Dillon (2008) who, in their report on science education in Europe, showed that science education in school often had the aim to educate for further careers in science and took little account of general education perspectives. From this position it can be said that society has ambitions for coming generations. Through a 'proper' upbringing and education children can become important contributors to a changed direction. This view of children corresponds to the concept 'children as human becomings' (Qvortrup et al. 1994; Halldén 2003).

Another way to motivate science in preschool is through a pronounced child perspective, i.e. to see 'children as human beings' (Qvortrup et al. 1994; Both 1997; Halldén 2003). Children as 'beings' means—in early childhood research—to emphasize children's perspectives, listening to the children and taking their perspectives. Focusing on children's ways of experiencing the surrounding world and the contextualization of children's voices. To view children as 'beings' is to consider children as actors in their own lives, and let them meet the content area primarily for their own sake. Science is part of the surrounding world, a world also the youngest children are engaged in understanding and making sense of (cf. Engdahl 2011). Hence, science becomes a natural part of life, and something children meet with the same curiosity as, for example, different languages and expressions.

The intention here is not to polarize between the two perspectives 'becomings' and 'beings', which are both needed. Instead, this study is influenced by the fact that a specific justification of a specific content tends to affect the didactic approach selected by the teachers (cf. Hundeide 2003).

Teacher Competence

There is hardly any consensus on science teaching in a preschool perspective but research points to some key factors (Zetterqvist and Kärrqvist 2007). Often teachers' knowledge within the field is cited as one important prerequisite for children's learning (Siraj-Blatchford et al. 2002; Yoshikawa 2013). Fleer (2009) in expressing "inherent in many studies that have been framed from a constructivist perspective is that early childhood teachers' *limited science knowledge* is linked directly to teacher confidence and teacher competence to teach science" (p. 1073). From a cultural-historic perspective the reasoning could be changed and instead directed towards how teachers use their knowledge—together with children—in practice. Which means teachers' views of children, children's learning and the role teachers perceive for themselves is reflected in children's possibilities to learn. "The challenge goes beyond content knowledge to teacher beliefs and pedagogy practices" (Fleer 2009, p. 1074). Fleer et al. (2014) use the term 'sciencing', which refers to how teachers and children scientifically relate to their preschool environment (p. 38). They show that with a 'sciencing attitude' teachers have unique possibilities to teach science in preschool (Fleer et al. 2014).

A research review (Nordenbo et al. 2008) points out three areas of teacher competence that appear to have an impact on children's learning about different content like science, namely relational competence, structural competence and didactic competence. The didactic competence includes subject knowledge (Nordenbo et al. 2008). Relational competence can be transferred to those patterns of interactions established between children and teachers in a learning context. Successful teachers can be said to possess an ability to communicate with children in a sustained shared thinking way (cf. Sylva et al. 2004).

The relationship between, on the one hand, patterns of interactions established in the communication between children and adult and, on the other hand, what and how children learn have been made visible in several studies (cf. Sylva et al. 2004; Yoshikawa 2013). Teacher qualifications influence children's development and learning, but qualification is not only a question about level of education. It also seems to relate to teachers' ability to interact with children.

A study concerning the effect of preschool programs in the US identifies two main inter-related dimensions of the teacher-child interaction (Yoshikawa 2013, p. 6). Firstly, interaction that supports both children's learning in general and learning of specific content areas. Secondly, a warm and responsive teacher who establishes "interactions characterized by back and forth—serve and return—conversations to discuss and elaborate on a given topic".

In a cross-sectional approach variation of learning environments in preschool in relation to how children experience different aspects in the areas of language/communication, mathematics, and interaction have been studied (Sheridan et al. 2009, p. 243). In learning environments that showed high quality the teachers were deemed to act 'learning oriented', they were focused on what it means to know something. Results from the study point to the importance of teachers' pedagogical awareness. Teachers' view of knowledge and learning in preschool is presented as a key factor in the boundary between high- and low qualitative preschools. These situations where teachers communicate from an integrated child–adult perspective (cf. shared sustained thinking) appear to contribute to children's learning in a positive way.

The view that a shared sustained thinking only is a question about mutuality in the communication is problematized in research focusing a specific content like science. Teachers can communicate mutually and child-oriented, but still miss the actual learning object. In research concerning science in preschool Thulin (2011) introduces the importance of a *mutual simultaneity* in the established communication. *Mutual* in the way teachers are responsive to children's perspectives—not only through listening, but also through seeing the children's perspectives as an expression of their experiences and how they understand—taking the children's perspectives seriously and as a starting point for further conversations. *Simultaneity* in the sense that the content in focus for learning and the child's daily experiences are simultaneously taken into account, i.e. the teacher needs to simultaneously take into account children's experiences, and create links to the (new) science content in focus, so the child can distinguish the new phenomenon as something special (Larsson 2013; Thulin 2011; Thulin and Jonsson 2014).

Aim

The aim of the study is to develop knowledge about different ways students experience Science and the role of Science in preschool, before and after a one-semester course with science content. The course includes Chemistry and Physics, intertwined with arts, theories of learning and perspectives on pedagogies for meeting every child, and runs the third semester of a 3.5-year preschool teacher education programme.

The research questions guiding the analysis are

- In what ways do students experience Science in relation to preschool and the perspectives 'what', 'how', and 'why'?

- What differences in referential meanings of aspects of Science in preschool can be described?
- What shifts can be seen between answers given before and after the course?

Theoretical Framework

The theoretical framework is based on phenomenography with a focus on developmental pedagogy (Marton 1981; Marton and Booth 1997; Samuelsson and Carlsson 2008). This framework is built on a theoretical assumption that there is a reality outside the individual, which, for the individual, gets its meaning depending on how the individual experiences it. Hence, phenomenography has human experiencing as object of study (ibid.). The focus is on how individuals experience objects and phenomena of the surrounding world. The categorisation of different ways of experiencing is built on the "referential meaning of the conceptions" (Svensson 1984, p. 21). From a phenomenographic perspective a human being not only creates a relation to the surrounding world but also creates knowledge which, in turn, forms experiences of the objects and events in the world (Svensson 1984).

The choice of a qualitative method is based on an approach to understanding the social reality from a student perspective: here the students' attitudes, conceptions and apprehensions in relation to science in preschool. The analysis focuses qualitatively different ways of describing experiences (Marton and Booth 1997). Distinguished descriptions are collected into separate categories. Each category represents a narrow spread of described meanings (Marton and Booth 1997). Focus for the analysis is to visualise students' experiences of science and to identify qualitatively different meanings in responses to each question in a questionnaire consisting of five open-ended questions, see below. By this choice—of method for the analysis—the results were expected to be useful in relation to teacher education, especially concerning addressing students' diverse perspectives on science.

Design

This research project is centred on a course in preschool teacher education. The aim is to get an insight into students' experiences and thoughts about science, but also opinions on science in a preschool perspective. Students' stated experiences when they start the course and after completion of the course are in focus. The epistemological perspective underpinning both the research project and the course design stems from phenomenography and developmental pedagogy (Marton and Booth 1997; Samuelsson and Carlsson 2008). This theoretical point of departure emphasises the importance of considering students' experiences in relation to the object of learning and how to design the actual learning situation.

The Course

The investigated 3.5-year preschool teacher education programme consists of seven one-semester thematic courses, i.e. during each semester different subjects are integrated to form one whole course. The third-semester course covers the subject areas science (focusing chemistry and physics), technology, music and art intertwined with pedagogical aspects about meeting all children and learning theories (Vygotsky 1995; Sommer 2002; Samuelsson and Carlsson 2008).

The teachers, in the course, are subject specialists, but have all an interest in early years learning, some have also a background as preschool teachers. There is an aim not to separate the subject science from general pedagogy and theories of teaching and learning. The subjects are integrated to form a meaningful context and lecturers with different subject backgrounds cooperate (cf. Thulin 2011). The syllabus of the course accentuates the creation of a learning discourse that stimulates communication between content (e.g. science), children's perspectives and learning and the teacher's role. Hence, the course contains subject-integrated projects as described below. The focus of this article is science and that part of the course is described in more detail.

The intention of science is to predict and describe real-world phenomena by explanations utilizing theories and theoretical models. In the scientific research process empirical and theoretical work is intertwined leading to construction, confirmation or modification of theories and theoretical models. It is an interactive process of discussions, experiments and observations within the science community. However, different views of science are possible (cf. Erduran and Dagher 2014). The science perspective in this course is a semantic view of models focusing on the explanatory power of theoretical models (Adúriz-Bravo 2012), where theoretical models are viewed to link theories with experiments and practices. Hence, at the core of the course is synthesis of the two domains discussed by Eshach (2006) for children's science learning; content (concepts, theories, theoretical models) and investigations (hypotheses, problematizing, questions, experiments).

The course aims, concerning science, for the students to be able to come to grips with and use qualitative explanatory models from the first parts of the course in planning, developing, and implementing teaching activities with children during practice teaching. The course is based on the idea of contrastive teaching (Schecker and Niedderer 1996; Redfors 2006) and it consists of interactive lectures and lab-work, and alongside these, group-based project work. The students work in groups developing science-based activities that they implement and evaluated during a 4-week period of practice teaching towards the end of the semester.

Method and Analysis

A written questionnaire with five open-ended questions (see below) has been piloted and distributed before and after the described semester course. A double blind comparative analysis of responses from 107 students aiming to reveal qualitatively different ways of experiencing is presented. Three cohorts have been given the survey with 89 students participating in both pre- and post-tests. Students are coded according to cohort as A01–A28 (23 students), B01–B30 (27 students), and C01–C49 (39 students).

As stated above a phenomenographic analysis of student statements in individual responses was performed with a focus on the variations of meanings presented. The unit of analysis was student statements in their responses to the open-ended questions. The analysis allowed for student responses to contain several statements. However, it ended up in one categorisation for each of the student responses, i.e. no response was categorised in more than one category. Two researchers separately read and categorised ten responses, met—discussed and modified the categories for each of the five open questions. Then the researchers read and re-read the responses individually and applied the renewed categories in an iterative process on the remaining responses, met again and discussed, modified the categorisation in some few cases, and to a minor extent also the categories. The final categories and frequencies of the categorisation are given in Tables 1, 2, 3, 4 and 5 for the five questions. The categories describe students' views of the content area and capture differences in referential meanings of different aspects of science-in-preschool as perceived by the researchers. The different categories are described in detail in connection with each question in the "Results" section below.

The categorisation of pre- and post-responses are compared on group-level and probable influences from the course are discussed. Citations inserted are translated excerpts from the transcribed and analysed material; its purpose is to illustrate students' perceptions within each category.

Ethical Considerations

The research adheres to the ethical guidelines of the Swedish Research Council (Swedish Research Council 2011). All participants were informed and agreed to voluntary and anonymous participation with a right to abandon participation.

Results

The emerged categories and the results of the analysis are presented in Tables 1, 2, 3, 4 and 5 below, and specific instances are discussed for each of the questions. The "Results" section is ended with a general description of the results, which is problematized and discussed in the final discussion.

Question 1: How Would You Describe the Content Area Science; What is Science to You?

Seeks an answer to how the students view the concept Science. The evolved main categories describe the students' views of how science can be described, what science comprises. Hence indicating what they, as teachers, would be likely to accentuate during future teaching. The categories are:

Science is nature studies (N)

Captures responses describing science as solely the study of nature

Ex. *Science is about the nature we are living in, from animals to plants and humans. How everything affects everything else* (student A02, pre)

Science is the school subjects Bio, Che and Phy (Ä)

Captures responses describing science through mention of the school subjects biology, physics and chemistry

Ex. *To me science is chemistry, biology and physics, labwork and so on* (student B05, pre)

Science is the study of everything on Earth (J)

Captures responses describing science as something used to describe all kinds of objects and events on Earth, sometimes also explicitly including the rest of the universe and sometimes mentioning the school subjects

Ex. *Science is a broad subject including: Biology, Chemistry, Physics, Technology, environment and mathematics. Science explains how the world and the universe works* (student B02, pre)

Science is important, something we all need to know (A)

Captures responses describing science as something important, something everybody needs to know, without describing the content

Ex. *Science is something everybody must know* (students A09, pre)

Unsure, Don't know enough, No answer (U)

Table 1 Categories for question 1: How would you describe the content area Science; What is Science to you?

Categories	Pre-test	Post-test
Science is nature studies (N)	55	9
Science is the school subjects Bio, Phy and Che (Ä)	15	11
Science is the study of everything on Earth (J)	16	67
Science is important, something we all need to know (A)	1	0
Unsure, Don't know enough, No answer (U)	2	2

Number of categorised statements from students taking part in both pre- and post-test

The frequencies from the categorisation are given in Table 1. Notice the large percentage of students coming into the course with a view that science is all about nature and the study of trees, plants and animals.

A shift in the responses between the pre- and the post-test can be seen. A much larger percentage of answers are categorised as "Science is the study of everything on Earth" for the post-test. Examples of students' different answers to question 1 in the pre- respectively the post-test are given to further describe the categories and their boundaries:

Pre Science is about the nature we are living in, from animals to plants and humans. How everything affects everything else. (student A02, N)
Post Science is Physical phenomena, Biology, Technology and Chemistry. (student A02, Ä)
Pre For me Science is flowers, animals, development of things, like processes both below and above the surface (of the Earth). (student A22, N)
Post Science for me is a very broad subject. Animals, plants, birds, compost and cycles. Previously I did not consider Physics and Chemistry as parts of Science. (student A22, J)
Pre Chemistry, Physics, Biology, Technology. Science to me is about the human body, atoms and such. Things I find difficult. (student A26, Ä)
Post Biology, Chemistry, Physics, sustainable development, curiosity, experiment, hypotheses, contemplations. (student A26, Ä)

Student A26 is an example of someone being categorised the same way, before and after the course, but the post-test answer is richer and carries more nuances.

Question 2: How Would You Describe Your Own View of Science?

Seeks the students' views and experiences of Science. The evolved categories came to describe the student statements in terms of positive or negative attitudes. Describing how the student feels about science. The categories are:

Not positive to science (NP)
Captures responses describing negative feelings towards science
Ex. *Have not had a positive view of the science subjects. Just remember terribly boring physics lessons in secondary school, that you just want to forget* (student A01, pre)

Hesitantly positive to (HP)
Captures responses describing hesitantly positive feelings towards science
Ex. *I can think that some things are interesting, but I do not have a big interest* (student A15, pre)

Positive to Science (P)
Captures responses describing positive feelings towards science
Ex. *I am positive to science and think it is an interesting subject* (student B02, pre)

Unsure, Don't know enough, No answer (U)

The categorisation of the responses is given in Table 2. Each of the categories has an internal structure and possible sub-categories are discussed in the text.

Notice that statements categorised as not positive to science (NP) and unsure (U) only occur in the pre-test. There is a shift from NP and U to the other two categories and all statements are categorised as either hesitantly positive (HP) or positive (P) in the post-test. The work during the course has given rise to generally more positive views of science. However, notice that only 14 of the 89

Table 2 Categories for question 2: How would you describe your own view of Science?

Categories	Pre-test	Post-test
Not positive to science (NP)	14	0
Hesitantly positive (HP)	30	35
Positive (P)	39	54
Unsure, Don't know enough, No answer (U)	6	0

Number of categorised statements from students taking part in both pre- and post-test responses were categorised as NP in the pre-test, i.e. only 16 % were not positive towards science. A small number compared to what is perceived as a general idea concerning preschool teachers (Sundberg and Ottander 2013). In addition, the hesitantly positive (HP) category encompasses answers, especially in the pre-test, explicitly stating that the study of nature is of interest, and also students stating that they are positive towards work with children about science. The positive group covers responses mirroring the categorisation of question 1 with responses highlighting nature studies and that science is important. Both HP and P include a large portion of responses explicitly saying that their views have changed after the course. Additional examples are given to illustrate the shift towards the more positive categories from pre- to post-test.

Pre A bit negative, thinking back on the science I took in secondary and upper-secondary, which was not a positive experience. (student B05, NP)

Post Curious, but a bit held back. Difficult, but willing to learn more. (student B05, HP)

Pre Bad, uninterested. Want to get better at it. (student A26, HP)

Post Positive, new interest. Not as difficult as I thought. (student A26, P)

The categorisation of student A02 below shows that an increase of interest does not always mean a change of categorisation from HP to P.

Pre Not very active. I live in nature and for mine and others best I need to take part in and take care of nature, but I am not a researcher and stick to the 'shallow'. (student A02, HP)

Post At the outset reserved due to lack of knowledge. Now my interest has increased and I have a much less limiting view of the subject! (student A02, HP)

Question 3: What Do You Think Science is About in Preschool?

Seeks an answer to what the students think about science activities and teaching in preschool. What they can be expected to focus in planning future science teaching. The categories evolved to concur with the well known 'what' and 'how' perspectives of science teaching in the field of science education research. The categories are the following:

What (W)

Captures responses describing only the perceived contents of the students' future science teaching
Ex. *Decomposition like in the compost, bugs and crawlers, leaves and trees, what animal that eats what and so on* (student A22, pre)

How (H)

Captures responses describing only how the science teaching is perceived to be done, describes only the 'doing'
Ex. *It is to discover, investigate, study and test scientific phenomena or to discover the living things in a forest or in a lake. To watch a star form* (student C26, pre)

What and How (WH)

Captures responses describing both 'what' and 'how' aspects of science teaching.
Ex. *That children get to experience different phenomena in nature and reflect over these. Like changes in a compost, changes in trees during different seasons, decomposition, to do experiment* (student A08, pre)

Unsure, Don't know enough, No answer (U)

The categorisation of the responses is given in Table 3. The three categories encompass sub-categories or groups of statements lifting one or both of a child perspective and a focus on nature studies. More students are referring to child-centred perspective in the post-test. The number of students associating science with nature studies only, is much lower in the post-test (2 students) compare to the pre-test (23 students) for this question too.

Notice that a large part of the responses are categorised as W both in pre- and post-tests. But a trend for the shift between pre- and post-test is from W and H to WH, so more of the students find it important to describe both what (W) and how (H) aspects of science in preschool after the course. Examples of students' answers on question 3 to exemplify this shift from H and W to WH are given below.

Pre To be out a lot in the woods and so on. (student A24, H)

Post A lot of what the children have in their everyday life outside, like water. Follow up on the children's ideas and discoveries. Let the children investigate phenomena in their everyday life. (student A24, WH)

Table 3 Question 3: What do you think Science is about in preschool?

Categories	Pre-test	Post-test
What (W)	53	45
How (H)	15	7
What + How (WH)	20	37
Unsure, Don't know enough, No answer (U)	1	0

Number of categorised statements from students taking part in both pre- and post-test

Pre I think it is about building the basis for thinking about the environment. But also how things work like physics and chemistry. (student C04, W)

Post It is about building the basis for interest, explain and discover, investigate how different phenomena works. Why that is so—becomes so. (student C04, WH)

Question 4: What is Especially Important to Consider While Working with Science in Preschool?

Seeks the students' priorities in terms of work with science in preschool. What their future priorities in the planning of science activities is likely to be. The evolved and refined categories for this question are:

Child perspective (C)

Captures responses prioritising the children's perspective, putting the child in the centre

Ex. *To work with it on the children's level and with things they have an interest in. That the children get to test different things* (student A01, pre)

Teacher perspective (T)

Captures responses describing science teaching from a teacher's perspective, unfolding what a teacher should do.

Ex. *To know what you talk about by finding out the facts before teaching the children* (student A13, pre)

Combined Child and Teacher perspective (CT)

Captures responses describing a double priority—both child and teacher aspects of science teaching are mentioned.

Ex. *Get the children to help so that they can join in and explore, and make it interesting and exciting* (student C21, pre)

Unsure, Don't know enough, No answer (U)

The categorisation is given in Table 4. Also these categories have an internal structure of sub-categories. The focus on nature studies is more common in the pre-test responses, like for the earlier questions.

Notice that the shift from pre- to post-test in this case is again towards the composite perspective (CT). Also striking here is an overall improved quality and a greater attention to details in the post-test responses. Examples of this are given here.

Pre To work with it on the children's level and with things they have an interest in. That the children get to test different things. (student A01, C)

Table 4 Question 4: What is especially important to consider while working with Science in preschool?

Categories	Pre-test	Post-test
Child perspective (C)	21	15
Teacher perspective (T)	42	20
Child + teacher perspective (CT)	26	54
Unsure, Don't know enough, No answer (U)	0	0

Number of categorised statements from students taking part in both pre- and post-test

Post To all the time start from what the children have an interest in and thereafter direct the learning. The children must get a positive experience. Listen to the children and let them think and discuss themselves. That the children know a lot and can learn from each other. To be a knowledgeable pedagogue. (student A01, CL)

Pre That the children get to concretely see what has happened in a compost, for example compare with what it looked like earlier through photos. (student A08, T)

Post To pose open questions to the children that gets them to reflect, to make science visible for children and that the children get to be active and participating and exploring their world. (student A08, CT)

Below is an example of a very clear shift from a focus on the teacher's role in the pre-test to a more composite perspective in the post-test.

Pre To get the children interested in the subject. Make it as interesting as possible, listen to the children. (student A21, T)

Post Raise all children's hypotheses. No wrong answers. Make the activity interesting to the children. Start from the children's interests. Start from everyday situations. (student A21, CT)

Question 5: Why is Science Justified in Preschools?

Seeks an answer to what the students think is the reason for the inclusion of science in preschool teaching requirements. The evolved categorise came to coincide with the perspectives discussed above on children as 'beings' or 'becomings' (cf. Halldén 2003; Qvortrup et al. 1994).

Society (becoming) (S)

Captures responses prioritising the children's future role in society.

Ex. *The older children in school do not get good enough grades = bad interest. Therefore we need to* *increase their interest early in order for teenagers to better their results and grades* (student A17, pre)

Children (being) (C)

Captures responses describing science teaching from a teacher's perspective, unfolding what a teacher should do.

Ex. *It is important to teach the children in time about what is happening around them, why and how things happen* (student A16, pre)

Combined Society and Children perspective (SC)

Captures responses describing a composite priority—both 'being' and 'becoming' aspects of children's science learning are mentioned.

Ex. *So the children get to know and in the future will be able to influence and that they themselves shall have opportunities to investigate and discover now* (student A05, pre)

Unsure, Don't know enough, No answer (U)

The categorisation is given in Table 5. Notice that there is a shift away from a focus on Society (becoming) only towards the other two categories. The students have picked up the importance of the child centred perspective from the course work, but not all that shift do so to the combined perspective (SC).

Notice, also in this case, more developed responses in the post-test. Examples of shifts towards the combined perspective SC are given below.

Pre It is about the future of the children. (student A02, S)

Post Because it is something that has always been around us. To teach the children about sustainable development science is relevant and to meet the children's curiosity about the subject. (student A02, SC)

Pre It is important to teach the children in time about what is happening around them, why and how things happen. (student A16, C)

Post Because it belongs to everyday life, and the future and many have a curiosity that often can be answered to through science. (student A16, SC)

Table 5 Question 5: Why is Science justified in preschools?

Categories	Pre-test	Post-test
Society (becoming) (S)	55	36
Children (being) (C)	10	22
Society + children (SC)	20	30
Unsure, Don't know enough, No answer (U)	4	1

Number of categorised statements from students taking part in both pre- and post-test

Also some responses shift from a focus on society and children as 'becomings' towards a more child-centred perspective on children here and now—children as 'beings'.

Pre The interest for science is overall low in Sweden and to change this we should give the children an early start to raise the interest. (student B02, S)

Post Children are curious on their own and we can open new doors where the children get to explore more of their everyday life. (student B02, C)

Summary of Results

Based on the research question *What do students perceive as Science in relation to preschool and the perspectives* 'what', 'how', and 'why', the analysis suggests that many students experience science as equivalent to studies of nature, what is often referred to as green Biology, this is the case both before and after the course, but several students change their way of describing 'Science' to something more inclusive, broader than biology, incorporating chemistry, physics and everyday science phenomena.

Not many students show a one-sided How-perspective in their description of science, which might have been expected given the discussion on the focus on 'doing' in preschool (Samuelsson and Carlsson 2008). However, notice also that less than half of the students show an integrated What-How perspective also after the course. Most students refer to a 'becoming' perspective in justifying science in preschool. The importance of science and the children's and the society's need of knowledgeable citizens is accentuated. After the course students are evenly spread across the three categories S, C and SC (see Table 5).

What differences in referential meanings of aspects of science in preschool can be described? Few students are negative towards science, none after the course. However, several remain hesitantly positive. Most students described 'what' and 'how' perspectives, but few developed a synthesised view of science activities. Both teacher and child centred perspectives were used, and the fraction of the aimed for composite perspective increased. Ending up in an even distribution between child- and teacher-perspectives. Hence, there is a shift towards a more integrated perspective after the course.

What shifts can be seen between answers given before and after the course? The individual movements of students from pre- to post-test are analysed in detail and will be presented elsewhere. However, shifts on group level presented here show that many students saw science as biology (nature studies) and several did not adjust even though chemistry and physics was explicitly taught. Notice that surprisingly few students were negative towards science at the outset, and none remained so after the course. Other shifts have been towards more child-centred views and towards more integrated views of the two domains of science; domain-specific or conceptual knowledge and domain-general knowledge or procedural knowledge (Eshach 2006).

Discussion and Implications

In the following the results and implications for preschool teacher education is discussed.

From Generally to More Developed Explanations

The students' answers after the course are generally more developed than they were before the course. Although there are similarities in individual replies, the answers after the course are in general more developed. It is as if several of the students during the course keep their original views, but during the course they deepen and expand their arguments and explanations. They use an expansive language related to children's learning and the role of the teacher. Also, students' responses have over time evolved from general to more specific statements. In some responses, for example, it became clear that there is a shift from focus on content to a broader view of learning science, which include both content and an educational approach (cf. Table 3 and the cited responses to question 3 from students A24 and C04). Students' answers in the post questionnaire can be related to Eshach's (2006) discussion of science in a preschool perspective, including both conceptual and procedural knowledge.

The Importance of Integrating Science with Theories of Teaching and Learning

A shift also became visible from 'what' (content) or 'how' (process) perspectives to a more composite view, from either child or teacher perspective, to an emphasis of both perspectives and from seeing science as nature to a broader view of science, encompassing also Chemistry and Physics. Shortcomings in preschool teaching could be related to teachers' lack of subject knowledge, and one way to address this has previously been to unilaterally 'refill' with subject knowledge. During the actual course teachers of science and pedagogy cooperated. Students were taught science and pedagogy separately, but had the possibility to integrate the two subjects through thematic projects running parallel to lectures and labwork. It was also an explicit requirement that they should do so, which follows from the idea of contrastive teaching (Schecker and Niedderer 1996). This has been a way to connect learning theories to science content in a meaningful way. Maybe this approach is a contributing factor to the more developed reasoning in the post questionnaire. Therefore, on the basis of the results presented here, we argue for the importance of intertwining specific subject knowledge (in this case chemistry and physics) with theories of early years learning and discussions about missions and attitudes with the science content in focus (cf. Fleer 2009; Thulin 2011). This also makes explicit reference to future professional activities concerning science during the preschool teacher education more natural.

Students' Interest in Science: A Challenge for Teacher Educators?

Many studies have found that young people have a low interest in science (e.g. Oskarsson and Karlsson 2011; Sjøberg and Schreiner 2010). Results presented here show something else concerning work with science and children in preschool. Only a minority of the students (16 %) were in their first answers not positive to science (see Table 2). This result is contrary to the general impression in western countries and gives rise to new discussions. Has talk about young people's negative views of science become taken for granted? If so, there can be a risk that this characterizes teacher educators' meetings with students. Views concerning for example "it is no use" can build a raster for the established communication (Hundeide 2003; Fleer 2009). An excessive use of artificial associations may be another interpretation. Already Dewey (1916) warned for such approaches and stressed the importance of seeing science as a part of nature and everyday life, to treat it as a whole, with its own natural connections and involvement with human life (cf. Thulin and Pramling 2009).

When students' learning is discussed the importance of starting with the learners' perspective often is emphasised (Marton and Booth 1997; Helldén 2005; Eshach 2006; Samuelsson and Carlsson 2008). Finding out ways to make student preschool teachers' experiences and prior knowledge visible is a challenge to every teacher educator. The results presented here support the importance of using meta-communicative dialogues (Osborneet al. 2006; Samuelsson and Carlsson 2008) in order to make the student preschool teachers' experiences, in relation to the content, visible, and discuss 'what' and 'how' perspectives.

Students' Justification of Science: A Question for Teacher Education

How students justified science is another interesting question, which is made visible in Table 5. In the pre-test most students justify their answers from a society—'becoming'—perspective (55 of 89). In the post-test the students' answers are spread out in the different categories but there is still a slight predominance for the society—'becoming'—perspective. This result would be interesting to investigate further from some different points of departures. In light of the results here it could be important to investigate and discuss hidden messages and perspectives that implicitly characterize the teaching in preschool teacher education. Also, questions about how the student preschool teachers justify science in early childhood education may be relevant to investigate further, especially in connection to their practice teaching.

Conclusions

In many countries there is an educational system in need of change, and teaching and learning of science should be more tightly connected to our 21st century society (Tytler 2007; Dede 2010), including care for the needs and choices of the youth (Osborne and Dillon 2008; Oskarsson and Karlsson 2011). Science teaching in school is often criticized for aiming at future careers as science students or scientists, taking little or no account of the more general aspects of science in society (Harlen 2006; Osborne and Dillon 2008). What about science teaching within preschool teacher education? Tytler (2010) expresses it like this

> Specific knowledge should not be conceived of as a driving force in the curriculum and pedagogy. Rather, the focus should be on developing students' natural curiosity and disposition to engage in science explorations and with significant science ideas about how scientist work (Tytler 2010, chapt. 4.8).

Results presented here implicate that this perspective could be of specific importance in preschool teacher education. Also that students—during their education—need to experience the importance of a *mutual simultaneity* in an established communication. *Mutual* in the way teachers are responsive to children's perspectives and taking the children's perspectives seriously and as a starting point for further conversations. *Simultaneity* in the meaning that the content in focus for learning and the child's daily experiences are simultaneously taken into account so that the teacher can create links to the science content in focus (Thulin 2011; Larsson 2013; Thulin and Jonsson 2014).

Furthermore, this study highlights the importance of establishing and addressing students' attitudes to science. This connects to discussions about considering the importance of the history and traditions of early childhood education and how it can be related to views about science in pre-school (cf. Sundberg and Ottander 2013). In summary it calls for a renewed and inclusive discussion concerning preschool teacher's knowledge and science teaching in preschools.

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