

Do we dare to teach physics? - Primary science student teachers development of subject matter knowledge and a positive attitude towards physics

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Introduction

We know from research that primary school teachers have limited science knowledge which results in a low confidence of teaching science (Appleton, 2003, 2005, 2006). We also know that in particular primary teachers hold conceptions about physical phenomena similar to those hold by school children, although expressed in a more sophisticated language (Cochran & Jones, 1998). The low confidence often results in a teaching limited to 'science activities that work' (Appleton, 2003) related to science pedagogical content. Further to this, teachers who have little subject matter knowledge have limited options "...especially if they lack confidence to choose activities that work from science topics about which they know little, or to acquire new science content knowledge for themselves" (Appleton, 2005, p. 42). With this in mind, by focusing attention on how student teachers develop subject matter knowledge and positive attitudes as particular aspects of the knowledge base for teaching (Shulman, 1986, 1987), important factors for this development to occur need to be mapped and conceptualized. In 1986 Shulman focused attention on the subject matter knowledge (SMK) by emphasizing that a teacher cannot explain to his/her students the principles underlying physical phenomena if he/she does not explicitly understand them. Subject matter knowledge refers to a teacher's quantity, quality and organisation of information, conceptualisations and underlying constructs in a given field of science (Zeidler, 2002). Shulman (1986, 1987) argued further that only subject matter knowledge was not enough for teaching. Hence the question of how the subject matter knowledge was to be transformed made him introduce the term pedagogical content knowledge (PCK) as a special amalgam of subject matter knowledge and knowledge of general pedagogy. In the context of primary science teacher education, research has indicated that primary student teachers often experience physics as difficult and abstract resulting in difficulties to transform the content to the students (Author 1, in press). During physics courses the student teachers learn to use laws and formulas, but they do not manage to link these formulas to the everyday phenomena that they are supposed to teach in primary school. Research has also indicated that science knowledge is a significant factor that influences primary teachers' attitudes towards and confidence in teaching science (Appleton, 2006, Harlen & Holroyd, 1997). There is a relationship between primary teachers' subject matter knowledge and their attitudes which in turn affects pupils' understanding and attitudes (Jarvis & Pell, 2006, Osborne & Simon, 1996). Therefore, the project that underpinned this study aimed to make physics more comprehensible and attractive for primary student teachers so that they become able to teach physics in a stimulating way to young children. Research Questions The following research questions formed the basis from which a research study was constructed to appropriately respond to the overall purpose of the study:

- What factors do primary science student teachers consider as important for their development of subject matter knowledge in physics?
- How do these factors contribute to the student teachers' development of SMK and a positive

attitude towards physics?

Methodology

To collect data in order to capture the complexity of student teachers' perceptions of their development of subject matter knowledge and attitudes in physics, a multi-methods design was used (field notes, questionnaire and interview). During all the video seminars the science educator (first author) made (1) field notes to document comments and reflections during the video-seminars that was raised by the student teachers. After the eight weeks of coursework, a (2) questionnaire including a story-line (Gergen, 1988) was used to elicit the student teachers' perceptions of their development of subject matter knowledge from the beginning to the end of the course. In addition five questions were used to make the student teachers describe their storyline, but also to elicit their ideas of their attitudes to the course and to their own learning. Finally, after the course, all the 40 student teachers were invited by the science educator (first author) to participate in a (3) semi-structured interview (Cohen et al., 2000) in order to get a deeper insight into their ideas and perceptions. As it was the end of the term and summer vacation, twelve student teachers volunteered to participate. Of those twelve, five were selected. The main criteria for selecting the student teachers were that their story-lines were qualitatively different and that they had written verbose answers on all the questions in the questionnaire. In the interviews, firstly the student teachers were questioned about their experiences of the course. Then they were asked to carefully comment on their story-lines and to explain what had caused the high and low points, the directions or changes of directions and the directions of inclines. Finally they were asked to further elaborate their answers in the questionnaire. The research design will be further presented at the conference.

Expected Outcomes

Findings Of the 40 storylines 60 % were labelled progressive constant, 37.5 % were progressive with ups and downs, 2.5 % were stable and none were regressive. Concerning the progressive constant the student teachers mentioned in their answers to the questionnaire that they had learnt a lot but some things were more difficult than others. Some of them referred to why they needed to learn physics and expressed that they were motivated because they thought that it was important to really know the things that you were going to teach. Some of them also expressed that as it was a long time since they studied physics and that they felt a bit unsafe in the beginning but during the course they had learnt a lot and became much safer. All of them expressed that the workshops were good as they really forced them to get deeper into the real content and to discuss with their peers. Some of them commented that the experiment in the elevator was very nice as they could use their bodies in order to learn about the forces and acceleration. One student teacher mentioned that the "ups" were when she was helped in her own thinking in the discussion, both during the workshops but mostly during the seminars when they discussed with the teachers. ST: For me it is important to get further in my way of thinking and that I get a piece of puzzle and with the help of others I can go further. The teachers gave us some fuel in the discussions and like that we could advance further in our own thoughts. They also mentioned their "ups" during the seminars when they had the opportunity to discuss how they could use the knowledge with small children. One student teacher emphasized that she had a "down" during the workshop on electricity because she did not know what to do. Brief examples from Interview data During the interviews the five student teachers were supposed to elaborate their answers in the questionnaire and comment on their storyline. Within the data two main categories (1. Student teachers learning subject matter knowledge for themselves and 2. Student teachers learning subject matter knowledge for primary teaching) and several sub-categories ((a) connecting theory into practice through experiments, everyday phenomena and

problem solving; (b) Discussing with someone with more knowledge or explaining to others; (c) Meaningful knowledge; (d) Self-confidence) of student teachers' learning were highlighted.

1. Student teachers learning of subject matter for themselves

a. Connecting theory into practice through experiments, everyday phenomena and problem solving: All five student teachers emphasized the importance of the different practical experiments as a way to connect theory to practice. However, the experiments had a twofold influence on the student teachers. If they succeeded doing the experiments they described that their knowledge increased. ST 2: I have always liked practical work and I have the impression of being that kind of type who learns from experimenting and I learn more from doing things than only from reading about it. I mean, if you have something that you have really done to relate to, things are easier to remember.

b. Discussing with someone with more knowledge or explaining to others The discussions during the video seminars were emphasized by all the five student teachers. They mentioned that the discussions gave them a possibility to reflect on what they actually did during the experiments and to compare each others result. They also mentioned that it was good to explain to each other as it helped them to understand their own thoughts. However, all of them emphasized the importance of having someone more knowable in the discussions to explain difficult concepts. Also the lecture that the teacher gave after each workshop was brought up as an important factor for the development of subject matter knowledge: ST 1: The seminar and the lectures were very good as we had to reflect on what we did and we discussed all the experiments. Otherwise you only do the experiments and then put it behind you. Also, I think that it is important to sit with your peers and discuss. Then you have the opportunity to explain to each other and hear each others thoughts. And you realise that normally you have the same answers even if you formulate it different. The group discussions were also good as you saw each others good things but also each others mistakes and it made me learn a lot.

2. Student teachers learning for primary teaching

c. Meaningful knowledge Almost every student teacher expressed that they became more motivated if they felt that the knowledge was meaningful to them and could be used in their future teaching. Further to this, discussions about what concepts that might be meaningful for primary children and how they could be explained were also emphasized by the student teachers. ST 2: I also consider it as important that we must be able to use the experiments in our own future teaching and that the things we do is meaningful for me as a teacher giving me insights into how I can teach it later. I mean...you have to think of that even when you study the physics subject.

d. Self-confidence To manage their teaching of primary physics all the five student teachers highlighted the aspect of self-confidence both concerning their subject matter knowledge but also confidence in their ability to teach science. ST 2 mentioned that she felt confident when they discussed the experiments in the seminar. She continued further to express that without the teachers, several things would have remained unclear. She also emphasized curiosity and self-confidence as important aspects both for developing subject matter knowledge, but also for teaching. She mentioned that the group discussion where she was supported by her peers was important for her self-confidence. While doing the experiments she became more and more interested and a lot of questions were raised: ST 2: Those questions and experiences made me more curious which I am sure influenced my motivation and helped in my learning. The curiosity and the self-confidence are really very important and my attitude has changed a bit as I have been more curious and hungry for knowledge because so much new questions arose during the workshops. The more you are going to learn, the more you wonder about.

Conclusions and discussion This study of primary science student teachers has used a range of methods to gain insights into student teachers' development of subject matter knowledge that became meaningful for themselves in order to teach primary physics. As a consequence, and as the data and analysis above illustrates, the student teachers came to see that different factors were crucial for this development to occur. In many ways, the study highlights the importance of helping student teachers to uncover and make explicit their own thinking about their learning about teaching. It is reasonable to suggest that perceptions about, and attitudes towards, science and the teaching of science to young children will also influence the knowledge development among primary student teachers. The student teachers in the present study were stimulated to learn physics in different ways and all of them expressed that their attitudes

towards the subject had become more positive. In the process of learning they emphasized that it was important to become aware of what you know and what you don't know, but also why you know. The subject matter knowledge was not considered by the student teachers to be something you get and then deliver in the classroom. The development of subject matter knowledge was rather explained as a dynamic process depending on several different factors. To develop high quality science teaching in pre- and primary schools, and for teacher preparation to serve an important role in that process, student teachers need to be encouraged to recognize factors that they consider as important for developing subject matter knowledge but also for their learning to teach science in an appropriate way to primary students. Implications The results of the present study concern both student teachers' development of subject matter knowledge but also other particular aspects of the knowledge base for teaching (Shulman, 1986, 1987) that they consider as important in order to teach primary physics. As the data and analysis above illustrates, the student teachers participating in this study came to see that also self-confidence and the meaningfulness of knowledge became important aspects in their own thinking about how to teach primary physics. Almost all the student teachers stressed the importance of confidence in their ability to teach science. An important issue for the pedagogy of teacher education (Loughran, 2006) might then be to cultivate a more positive attitude by developing student teachers confidence to teach science effectively.

References

- References Appleton, K. (1995). Student teachers' confidence to teach science: Is more science knowledge necessary to improve self-confidence? *International Journal of Science Education*, 19, 357-369.
- Appleton, K. (2002) Science Activities That Work: Perceptions of Primary School Teachers. *Research in Science Education*, 32, 393-410.
- Appleton, K. (2003). How Do Beginning Primary School Teachers Cope with Science? Toward an Understanding of Science Teaching Practice. *Research in Science Education*, 33, 1-25
- Appleton, K. (2006). Science Pedagogical Content Knowledge and Elementary School Teachers. In K. Appleton (Ed.), *Elementary Science Teacher Education* (pp. 31-54). New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.
- Cochran, K.F., & Jones, L.L. (1998). The Subject Matter Knowledge of Preservice Science Teachers. In B.J. Fraser, & K.G. Tobin (Eds.). *International Handbook of Science Education* (pp. 707-718). Dordrecht: Kluwer Academic Publishers.
- Cohen, L., Manion, L., & Morrison, K. (2000). *Research Methods in Education*. London: Routledge Falmer.
- Gergen, M.M. (1988). Narrative structures in social explanation. In C. Antaki (Ed.), *Analyzing social explanation* (pp. 94-112). London: Sage.
- Harlen, W., & Holroyd, C. (1997). Primary teachers' understanding of concepts of science: Impact on confidence and teaching. *International Journal of Science Education*, 19, 93-105.
- Jarvis, T., & Pell, A. (2006). The relationship between primary Teachers' attitudes and cognition during a two year science in-service programme. In K. Boersma, M. Goedhart, O. De Jong & H. Eijkelhof. (Eds.), *Research and The Quality of Science Education* (pp. 157-168). Dordrecht: Springer
- Loughran, J.J. (2006). *Developing a Pedagogy of Teacher Education: Understanding teaching and learning about teaching*. London: Routledge
- Osborne, J. & Simon, S. (1996). Primary science: Past and future directions. *Studies in Science Education*, 26, 99-147.
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15, 4-14.

- Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57, 1-22.
- Zeidler, D.L. (2002). Dancing with Maggots and Saints: Visions for Subject Matter Knowledge, Pedagogical Knowledge and Pedagogical Content Knowledge in Science Teacher Education Reform. *Journal of Science Teacher Education*, 13(1), 27-42.

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