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Teaching together and learning together – Primary science student teachers' and their mentors' joint teaching and learning in the primary classroom

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ABSTRACT

This paper focuses on what and how primary science student teachers and their mentors learn from planning and reflecting together on each other's science lessons for pupils aged 7–9. The student teachers had had training in scientific knowledge, but only brief experience of teaching. The mentors were well experienced in the pedagogy of teaching and mentoring, but did not feel confident about their science content knowledge and the teaching of science. Throughout the process of teaching and reflecting together the student teachers and the mentors expressed several specific examples of their joint learning.

1. Introduction

There is little doubt that the complexity of teaching highlights the need for more extensive research into the relationships between the different elements that constitute teacher knowledge, and how these are developed during pre-service teacher education. The learning opportunities that arise for student teachers during their school-based practice have long been investigated and acknowledged. As outlined in the research on experts' and novices' relations (e.g., Berliner, 1986, 2004), expert teachers and novice teachers differ in the ways they interpret classroom life. In this context, mentoring and the development of pedagogical content knowledge (PCK; Shulman, 1986, 1987) are well explored in the research literature. However, there are currently few studies that directly investigate the guidance given between mentors and novice teachers and those that do are not specific to science teaching (Bradbury & Koballa, 2007). Further to this there are few connections in the literature between research on mentoring and research on science PCK. Hence, there is a need for an increased communication between teacher education programs and school-based mentors (Van Driel, De Jong, & Verloop, 2002; Bradbury & Koballa, 2007).

In the field of primary school science, there is a lack of substantive analysis of the ways in which cooperating teachers frame and reframe their advisory practices (Clarke, 2006). This leads to the question of how school-based experiences can be used to stimulate professional reasoning on science teaching for student teachers *and* their supervising mentors. In this study we explored the knowledge student teachers and their mentors develop while working together in a primary school context. We used Shulman's (1986, 1987) notion of the knowledge base of teaching as a framework to articulate what elements of knowledge impact on the student teachers' and their mentors' teaching. We highlighted the importance of providing student teachers with opportunities to observe and interact with mentors in school-based pre-service teacher education in order to enable them to critically examine their own and their mentors' teaching experiences. The aim of this project was to investigate the interaction between mentors and student teachers and to gain insight into their joint learning processes in order to improve their science teaching and accordingly develop their pedagogical content knowledge. The project was guided by the following research questions:

1. What knowledge do student teachers develop from their mentors while jointly planning and reflecting on each other's science lessons?
2. What knowledge do mentors develop from student teachers while jointly planning and reflecting on each other's science lessons?
3. What knowledge do student teachers and mentors develop through interaction with students?

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2. Conceptual framework

2.1. The knowledge base of teaching primary school science

The theoretical background framing this study is teachers' professional knowledge, which characterizes teaching as a complex cognitive skill. Van Driel, Beijaard, and Verloop (2001) highlighted that teachers' craft knowledge consists of teachers' knowledge and beliefs about their own teaching practice and refers to the integrated set of knowledge, conceptions beliefs and values that teachers develop in the teaching situation. Shulman (1986, 1987) introduced the term pedagogical content knowledge (PCK) to draw attention to the value of the special amalgam of content knowledge and knowledge of general pedagogy that a teacher needs to be the best possible teacher. Various scholars have further developed conceptualizations of PCK (e.g. Appleton, 2003, 2006; Bradbury & Koballa, 2007; Gess-Newsome, 1999; Hashweh, 2005; Loughran, Mulhall, & Berry, 2004; Nilsson, 2008; Van Driel, et al., 1998) as an academic construct representing specialist knowledge of practice. As such, PCK has become a way of understanding the complex relationship between teaching and content through the use of specific teaching approaches (Van Driel et al., 1998).

Although there is no universally accepted conceptualization of PCK there seems to be consensus that PCK is to be distinguished from subject-matter knowledge (SMK), on the one hand, and from general pedagogical knowledge, on the other. It is reasonable to suggest that PCK goes beyond SMK as it refers not only to the subject matter but to the *teaching* of a subject in ways that promote pupils' understandings. Hence, a teacher needs to have a deep knowledge of content (SMK), as well as an orientation towards teaching content to pupils in a specific context.

The interface between SMK and PCK raises several interesting questions, mainly concerning the relationship between the quality of teachers' understanding of subject matter and the consequence of their understandings and beliefs for their development of PCK. Magnusson, Krajcik, and Borko (1999) developed a model of PCK for science teaching in which "orientations towards science teaching" impacted on what PCK might be. The authors emphasized that PCK was the result of a *transformation* of knowledge from other domains. They used the term "orientation" to represent a general way of viewing, or conceptualizing, science teaching. Knowledge and beliefs in this area guide a teacher's instructional decisions about the organization of activities, the content of pupils' assignments, the use of textbooks and curricular materials, and the evaluation of pupils' learning. As these components may interact in very complex ways, teachers need to develop knowledge of all aspects of pedagogical content knowledge (Magnusson et al., 1999).

Research on primary student teachers' learning to teach (Appleton, 2006; Nilsson, 2008; Skamp, 1997), emphasize the importance of primary school science student teachers' framing and reframing of their practice (Schön, 1983, 1987) in order to gain new insights into *what* and *how* they teach. We also know from research that primary school teachers have limited science knowledge, resulting in low confidence about teaching science (Appleton, 2003, 2006; Harlen, 1997). Osborne and Simon (1996) found that primary teachers' lack of ability, confidence, and enthusiasm for science resulted in the use of less stimulating teaching, and that the teachers did not respond effectively to pupils' questions. Carlsen (1991) found that the less the teacher knew, the more often classroom discussions appeared to be dominated by the teacher. Further to this, the less competent the teachers were in the specific area, the more difficult it was for them to follow the pupils' lead and to explore their ideas. Therefore, when teachers' knowledge of content in a particular area was low, the classroom discourse was limited.

As Van Driel et al. (1998) stated, PCK refers to teachers' interpretations and transformations of subject-matter knowledge in the context of teaching. PCK is, then, a fruitful tool to understand what knowledge is embedded in teaching practice. Magnusson et al. (1999) stressed that the development of PCK is determined by the content to be taught, the context in which the content is taught, and the way the teacher makes sense of his/her teaching experiences. Korthagen (1993) defined reflection as people's learning to subject their personal beliefs of teaching and learning to a critical analysis, and thus take more responsibility for their actions. Reflection on practice, therefore, emerges as another important element for student teachers in developing expertise in their practice, and is central to them accepting more responsibility for their actions (e.g. Calderhead, 1981; Loughran, 2002).

2.2. The role of mentoring in teacher education

School-based teacher education requires mentors to share their expertise with student teachers. Normally, the mentor's role is that of an experienced teacher proposing instructional approaches to the student teachers and encouraging their professional growth (i.e. their development of PCK) through reflection on the process. In exploring the conversations between mentors and novice teachers Bradbury and Koballa (2007) showed that the domain of science subject-matter knowledge was absent in the conversations. Specifically, there was little to no advices related to the topics of inquiry, the nature of science, or the development of scientific literacy. On the other hand, much of the guidance given by the mentors centred on issues concerning general pedagogical knowledge dealing with general classroom management (Bradbury & Koballa, 2007). The mentoring process is generally described in terms of roles (e.g. trainer, partner assessor and adviser; Jones, 2001). Halai (2006) identified the multiple roles of mentors as those of expert-coach, subject specialist, critical friend, and learner. Grimmett and Ratzlaff (1986) explored mentors' expectations of their work as cooperating teachers helping the student teachers to orientate themselves in the school, providing a source of instructional strategies, and providing feedback and evaluation were emphasized. Carroll (2005) highlighted that, by discussing and modelling his or her own teaching, the mentor helped the beginner to learn about certain important aspects, such as planning appropriate learning activities and considering pupils' prior knowledge and experiences of the topic.

Reports from studies on mentors' and beginning teachers' relationships imply that this relationship can also enhance the professional development of the experienced teacher. Clarke (2006) reported on a study of cooperating teachers who were provided with the opportunity to reflect on their advisory practice. In a stimulated-recall approach, the teachers had the opportunity to reflect on what was important about their practice, providing an authentic account of the ways in which they reflected upon their work as school-based teacher educators. Tauer (1998) reported on a study in which both the mentors and the student teachers spoke of benefits of the mentoring process, such as professional and personal growth and reinforcement of existing beliefs and practices. Book (1996) noted that "supervisors have begun to realize that their role in supervising student teachers has enabled them to learn more about teaching because in helping novices improve, they articulate more explicitly what they know and believe about teaching" (Book, 1996, p. 202). In a similar fashion, Lazarus (2000) referred to a study in which mentors stated that the mentoring had a positive effect on their own teaching and gave an opportunity to re-evaluate their teaching. In short, the presence of student teachers as observers made the mentors more aware of what they were doing in the lessons.