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Scaffolding primary teachers in designing and enacting language-oriented science lessons: Is handing over to independence a fata morgana?

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ABSTRACT

The purpose of the design-based research reported here is to show – as a proof of principle – how the idea of scaffolding can be used to support primary teachers in a professional development programme (PDP) to design and enact language-oriented science lessons. The PDP consisted of six sessions of 2.5 h each in which twelve primary school teachers took part over a period of six months. It centralised the language support that pupils need to reason during science lessons. In line with the idea of scaffolding, the structure of the PDP targeted teachers' gradual independence in designing lessons. The first research question is how scaffolding was enacted during the PDP. The analysis of video recordings, field notes, researcher and teacher logs, and teacher design assignments focused on the enactment of three scaffolding characteristics: diagnosis, responsiveness and handover to independence. The second research question concerns what teachers learned from the participation in the PDP that followed a scaffolding approach. The data analysis illustrates that these teachers had learned much in terms of designing and enacting language-oriented science lessons. In terms of diagnosis and responsiveness, our PDP approach was successful, but we problematise the ideal of scaffolding approaches focused on handover to independence.

1. Introduction

Anyone with the ambition to design, on the basis of research, a professional development programme (PDP) for new learning goals faces several challenges (cf. Borko, 2004). The literature provides many pieces of advice on what to focus on in PDPs, but the advice is often of a very general nature. For example, it is important to stimulate reflection and provide opportunities to link what is learned during a PDP with classroom instruction (Borko et al., 2010, p. 549; Van Veen, Zwart, & Meirink, 2012). At the same time, it is acknowledged that teacher learning is situated and that a PDP has to be adaptive to local needs (NSTA, 2006; Putnam & Borko, 2000). Applying such research to improve PDP is, as Paul Cobb says, a matter of "fighting our way up to the level of concrete practice" (Qvortrup, Wiberg, Christensen, & Hansbøl, 2016, p. 276) — a saying that aligns with the sociocultural adage of ascending from the abstract to the concrete (Ilyenkov, 1960/2008).

In a design research project we drew on several bodies of literature (language-oriented science education, scaffolding, genre

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pedagogy — summarised in the next section) to help teachers design and enact language-oriented science lessons for primary education, a relatively new learning goal for a PDP. Scaffolding, in short, can be characterised as temporary adaptive support with learners' independence as the ultimate aim (Van de Pol, Volman, & Beishuizen, 2010; Wood, Bruner, & Ross, 1976). It is considered a form of excellent teaching (Maybin, Mercer, & Stierer, 1992; Van de Pol, 2012) and is here applied to teachers rather than pupils. Our approach to language-oriented subject education is informed by content-based language instruction (e.g., Brinton, Snow, & Wesche, 2003; Gibbons, 2002), in which teachers scaffold pupils in the genres relevant to the specific topic that is being taught (e.g., reasoning about floating and sinking). Scaffolding thus operates at two levels in this study – to promote teachers' learning during a PDP and to promote pupils' learning of scientific genres – but our focus is on the adaptive support to teachers, provided by researchers-educators.

The purpose of the study reported here is to contribute to knowledge about how teachers can be scaffolded within a PDP with the aforementioned learning goal. As the first question we ask:

RQ1: How was the idea of scaffolding enacted in the professional development programme with the aim to design and enact language-oriented science lessons for primary education?

An answer to this question is necessary to give the reader a sense of the scaffolding approach as an intervention and to check how well the idea of scaffolding was implemented. Next we ask what teachers learned from this approach:

RQ2: What have teachers learned from their participation in the professional development programme in which a scaffolding approach was taken?

2. Theoretical background

Given the intention of our research to support teachers in primary education to integrate language in their science lessons, this section first elaborates on this goal. Next we formulate the overall idea of scaffolding to shape the PDP as well as the learning activities used to facilitate teacher learning. We also highlight the theoretical ideas from the genre literature that we had to transform (simplify or concretise) so as to make them productive in the PDP which had to be adaptive.

2.1. Goal of the PDP: supporting teachers to integrate language in science education

Teaching science in primary classrooms is a challenge for teachers worldwide. This can be explained by many primary teachers lacking background knowledge in science and technology, their limited pedagogical content knowledge, inadequate understanding of problem-solving skills, and low self-efficacy (Traianou, 2006; Van Aalderen-Smeets, Walma van der Molen, & Asma, 2012).

It has been argued that centralizing language while teaching science may be a potential solution to challenges primary teachers face (Howes, Campos, & Lim, 2004) and beneficial for learning both science and language (Romance & Vitale, 1992; Vars, 1996). Firstly, primary teachers are generalists, teaching all subjects, often with a particular strength in language arts (Appleton, 2007). For them, science appears to be more attractive when it integrates other aspects of the curriculum (Appleton, 2002). Integration with language also increases (preservice) teachers' comfort in teaching science (Akerson & Flanigan, 2000). Secondly, many scholars have advocated integration from a conceptual point of view by pointing to the close relationship between language and science (cf. Vygotsky, 1962; Zwiep, Straits, Stone, Beltran, & Furtado, 2011). Language learning is a vital component of learning science (Haug & Ødegaard, 2014). In particular, pupils' participation in the science classroom is dependent on teacher-pupil discourse, in which language functions as a mediating tool (cf. Vygotsky, 1962, 1978). Access to specialised science language is crucial for reasoning about scientific phenomena (Mercer, Dawes, Wegerif, & Sams, 2004). Some even go so far as to state that learning science implies learning the language of science (Braund, 2009; Lemke, 1990).

The primary science teacher's role is thus hybrid by nature: It requires understanding scientific phenomena related to pupils' explanations and argumentation, as well as the ability to provide pupils access to the specialised language needed to do so. To realise the latter, approaches of content-based language instruction (e.g., Brinton et al., 2003; Gibbons, 2002) have advocated ample opportunities for pupils to produce language themselves. This allows so-called bridging discourses to occur (Gibbons, 2002): interactional patterns in which teachers can support pupils' language development from everyday, spoken-like language to subject-specific, written-like registers. During such teacher-student interaction teachers are to pose higher-order questions and employ interactional skills that invite pupils to contribute to classroom discourse (e.g., Mercer et al., 2004; Mercer, Dawes, & Kleine Staarman, 2009; Scott, 1998). Furthermore, teachers need to explicitly attend to how specialised language is organised in a particular science domain, as each topic within the discipline of science requires its own language usage (Halliday, 1978; Stoddart, Pinal, Latzke, & Canaday, 2002). To do so, the formulation of language learning goals, in addition to content-specific learning goals, has been advocated in lesson planning (Smit, 2013). Furthermore, several researchers (e.g., Gibbons, 2002; Smit, Van Eerde, & Bakker, 2013) have advocated the deliberate enactment of scaffolding strategies in teacher-pupil interaction (e.g., reformulating, repeating correct utterances, or asking for more precise language) so as to promote pupils' development of the required language.

One of the pitfalls we knew to watch out for is the tendency of teachers using language-oriented approaches to focus on vocabulary (e.g., Haug & Ødegaard, 2014; Henrichs & Leseman, 2014). To promote pupil reasoning, attention also needs to be paid to formulations, or even genres (recurring text types in school and society, such as reports and recounts; Gibbons, 2002). However, in a previous PDP inspired by genre pedagogy (Hyland, 2004) teachers strongly advised us to no longer mention genres in PDP as these were considered too abstract, but instead speak of “reasoning steps” which were spelled out in targeted language. This is an example of a local term that functioned better than the official concepts from research: on the one hand scientific reasoning and on the other the abstract notion of genre. As researchers we came to appreciate the term reasoning steps as a bridge between a focus on language and on science. It helped teachers learn to specify learning goals in intermediate reasoning goals that included targeted language

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