Teaching and Teacher Education 66 (2017) 158–170

Contents lists available at ScienceDirect

Teaching and Teacher Education

journal homepage: www.elsevier.com/locate/tate

Teachers' professional vision, pedagogical content knowledge and beliefs: On its relation and differences between pre-service and in-service teachers

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HIGHLIGHTS

- Professional vision and pedagogical content knowledge are substantially interrelated.
- Professional vision and beliefs are substantially interrelated.
- Especially transmissive beliefs hinder professional vision.
- Correlations do not differ across in-service teachers and master students.
- This suggests a consistent structure of teacher cognition across the groups.

ARTICLE INFO

Article history:
Received 6 September 2016
Accepted 20 April 2017
Available online 6 May 2017

Keywords:
Teacher education
Pedagogical content knowledge
Beliefs
Video-based assessment
Professional vision

ABSTRACT

This study explores the structure of teacher cognition by investigating the relation of teachers' professional vision with pedagogical content knowledge and beliefs in the domain of elementary science education. An investigation using a video-based assessment approach on professional vision revealed that all three constructs are substantially associated but still separable. Latent correlations did not differ across master students ($n = 113$) and in-service teachers ($n = 110$) though in-service teachers had greater professional vision, pedagogical content knowledge and less transmissive beliefs. This suggests a stable structure of teacher cognition. Moreover, results indicate that especially transmissive beliefs hinder observing classroom situations in a professional way.

1. Introduction

Teachers are considered to play a leading role in creating meaningful learning environments and thus substantially influencing instructional quality and students' learning success (Kunter et al., 2013). In the last decades, research on teacher competence mainly focused on teachers' professional knowledge as one of the most important cognitive elements of competence. This led to beneficial insights into the structure and significance of professional knowledge. Shulman's (1987) theoretical distinction between content knowledge, pedagogical content knowledge and general pedagogical knowledge could be confirmed by the use of standardized tests in a variety of domains and the effectiveness of professional knowledge for teaching practice and student learning was shown (Baumert et al., 2010; Blömeke et al., 2009; Hill, Rowan, & Ball, 2005).

Building on these findings, recent studies and also theoretical definitions of competence emphasize the need to further investigate cognitive aspects of teacher competence that reflect the situated and contextualized nature of teaching demands (Blömeke, Gustafsson, & Shavelson, 2015; Borko, 2004; Kersting et al., 2016; Santagata & Yeh, 2016). Professional vision is regarded as such an aspect which describes teachers' ability to notice and interpret classroom events that are relevant to the process of

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http://dx.doi.org/10.1016/j.tate.2017.04.010
0742-051X/

learning (van Es & Sherin, 2002). According to Blömeke et al.'s (2015) model of competence as continuum, situation-specific skills like perception (noticing) and interpreting can be seen as an essential mediator between teachers' cognitive dispositions such as professional knowledge and beliefs on the one hand, and their performance in teaching practice on the other hand. Following this assumption, professional knowledge has "to be integrated, perhaps to be transformed and/or restructured through practical experience" (Blömeke et al., 2015, p. 7) for sophisticated noticing and interpreting of classroom situations which in turn is supposed to be relevant for teaching quality. At the same time, beliefs - as well as professional knowledge - are supposed to serve as filters for professional vision (Borko & Putnam, 1996).

Still, it is not yet clear how professional knowledge, beliefs and professional vision interrelate. Few existing studies do suggest an interrelation between professional vision and professional knowledge, but don't give a clear picture concerning its strength (Blömeke, Busse, Kaiser, König, & Suhl, 2016; Kersting, 2008; König et al., 2014). Moreover, to our knowledge studies on the relation between beliefs and professional vision are still missing.

Thus, the current study aims to contribute to this lack of research addressing the relationship between 1) professional vision with a focus on instructional support (assessed by a video-based test), 2) pedagogical content knowledge as a knowledge category which is essential for instructional quality and proved high predictive power for student progress (Baumert et al., 2010; assessed by a paper-pencil test) and 3) beliefs (assessed by a questionnaire) in the domain of elementary science education. The study was administered to a sample of master teacher students as well as experienced in-service teachers to investigate whether the interrelations differ between teachers with different levels of expertise. Findings of these analyses will provide greater insight into the construct of professional vision and teachers' cognitive dispositions as well as the development of competence and thus, have implications for the design of teacher education.

To situate this work we begin with a short overview of the three relevant constructs including empirical findings on differences between pre-service and in-service teachers. We then focus on the state of research regarding the relation of the three constructs before we describe the context of the study and our data analysis procedures, followed by the results.

1.1. Teacher beliefs on teaching and learning

Referring to Richardson (1996) beliefs can be defined as understandings or premises that are personally felt to be true. In teacher education research, authors often distinguish between two underlying beliefs on teaching and learning (Pajares, 1992; Staub & Stern, 2002). According to a more traditional, also called transmissive view teachers are expected to simply transmit correct knowledge to students who passively receive this knowledge (cf. Kleickmann, Tröbst, Jonen, Vehmeyer, & Möller, 2016; Voss, Kleickmann, Kunter, & Hachfeld, 2013). In contrast, the constructivist view implies that students take an active role by individually processing and constructing new knowledge (Staub & Stern, 2002). In the domain of science teaching focused on in our study, a constructivist view also includes a conceptual change-orientated belief, that is, the belief that students construct individual explanations of natural phenomena that are often not consistent with scientific views and that can only be modified in a long-term process (for details see Kleickmann et al., 2016). Research shows that compared to teachers holding a transmissive view, teachers with constructivist beliefs tend to provide better learning support, more challenging tasks and problems which consequently led to higher student outcomes (Staub & Stern, 2002; Stipek, Givvin, Salmon, & MacGyvers, 2001; Voss et al., 2013). However, the two orientations are not regarded as the ends of only one dimension but as two distinct beliefs that are negatively correlated, that is, teachers can hold transmissive and constructivist beliefs simultaneously (Voss et al., 2013).

Research examining changes in teachers' beliefs during teacher education is still scarce and ambiguous. On the one hand, there are first results indicating that in-service teachers hold more constructivist and less transmissive beliefs than pre-service teachers (Felbrich & Müller, 2007; Meyer, 2004; Schmeisser, Krauss, Bruckmaier, Ufer, & Blum, 2013). On the other hand, Lui and Bonner (2016), who compared in-service and pre-service teachers' beliefs about teaching and learning, found more constructivist than transmissive beliefs in both groups and an even higher score on constructivist beliefs for pre-service teachers compared to in-service teachers.

1.2. (Science teachers') pedagogical content knowledge (PCK)

In contrast to beliefs which are based on personal judgement and values, professional knowledge is supposed to have higher epistemic status (Fenstermacher, 1994; Richardson, 1996). It has to be justified and requires "general or group consensus regarding its validity and appropriateness" (Pajares, 1992, p. 311).

Among the three core knowledge categories defined by Shulman (1987), pedagogical content knowledge (PCK) "identifies the distinctive bodies of knowledge for teaching" (p.8). It means knowing the content in pedagogically useful ways and making it accessible to students. As it is the knowledge category which proved high predictive power for teachers' instructional practice and student progress (Baumert et al., 2010; Hill, Ball, & Schilling, 2008; Hill et al., 2005), it is of special interest in the present study.

Despite varying definitions, research has identified two core aspects of PCK: knowledge of students' understanding and knowledge of instructional strategies (Berry, Friedrichsen, & Loughran, 2015; Borko & Putnam, 1996; Jüttner, Boone, Park, & Neuhaus, 2013; Magnusson, Krajcik, & Borko, 1999; Park & Oliver, 2008). In science education, knowledge of students' understanding refers to knowledge of areas of student difficulty and typical misconceptions as well as requirements for learning specific scientific knowledge (Magnusson et al., 1999). The second core aspect includes knowledge of strengths and weaknesses of instructional strategies, of representations like analogies, examples or models and activities like experiments or observations.

Findings on pre-service and in-service teachers' science-specific PCK are still rare (e.g., Groβschedl, Harms, Kleickmann, & Glowinski, 2015). Results from other domains indicate an increase in knowledge during teacher education; however, mainly in the university-based and induction phase (Blömeke et al., 2008; Krauss, Baumert, & Blum, 2008). Moreover, Kleickmann et al. (2013) found that experienced teachers have slightly higher PCK than pre-service teachers at the end of their studies.

To date, research on professional knowledge is mainly based on paper-pencil assessments. These allow measuring knowledge which is cognitively represented in a declarative mode, focusing on rather factual and decontextualized knowledge (Anderson & Krathwohl, 2001).

By contrast, there is a call for additional research on more situation-specific aspects of teacher competence which reflect how teachers are able to activate their knowledge in a classroom situation (Blömeke et al., 2015; Kersting et al., 2016). Professional vision is considered to be such an aspect as it accounts for the challenge to use knowledge in the complexity of teaching (Seidel & Stürmer, 2014; Sherin & van Es, 2009).