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The concept of *practices* in mathematics teachers' competence: A theoretical exploration

Christine Luise Hirsch¹ and Nils Buchholtz²

¹University of Cologne, Germany; hirsch.christine@uni-koeln.de

²University of Hamburg, Germany

Various research disciplines investigate teachers' practices but only a few studies define that term. Therefore, the aim of this integrated review study is to identify and synthesize theoretical conceptualizations on teachers' practices in order to understand this term as an expression of teachers' professional competence. Our theoretical exploration reveals how teachers' cognitive and affective dispositions as well as situation-specific skills are involved in applying and developing practices to cope with specific recurring requirement situations in teaching.

Keywords: Practices, teachers' professional competence, situation-specific skills, teacher knowledge, beliefs.

Introduction

In research on mathematics teachers' competence, the significance and the use of the term of teachers' "practices" has increased over the last few years as the focus of research shifted slightly to more situative aspects of teacher competence, e.g. when analyzing teachers' performance in classroom situations or studying instructional quality (Even et al., 2017). However, the concept of practice or practices "has many meanings, little consistency exists in how it is used, and explicit definitions rarely accompany the term" (Charalambous & Delaney, 2020, p. 359). This lack of definitional agreement can lead to difficulties in research for example, when discussing different types of teachers' practices. As a result, the true meaning or understanding of this term often remains unknown in the research literature. Furthermore, teachers' practices are often described in the context of teachers' expertise, whereby these can be identified and reconstructed, f. e. through (repeated) classroom observations (Stigler & Miller, 2018). However, a connection of the concept of practices to teacher competence research is largely missing, which can be partly due to the ambiguous relationship between expertise and competence (Krauss et al., 2020). Therefore, the aim of this study is to identify potentially relevant understandings about mathematics teachers' practices in order to develop a theoretical model for this concept. This model can be used to better understand teachers' practices, to describe them in detail and to understand what they are drawing upon in their utterances and actions. Another aim of this study is to further describe practices as an expression of mathematics teachers' professional competence. We thus formulated the following research questions:

RQ1) How are mathematics teachers' practices theoretically described and what are their constitutive elements?

RQ2) How can practices be understood from the perspective of research on mathematics teachers' competence?

In order to answer these questions, we shortly describe our methodology, then present our results and conclude with a theoretical model for practices in our conclusion.

Method

In this study we conducted an integrative review, which serves the purpose of investigating a research topic that is conceptualized differently in different research disciplines. It is about the evaluation, critique, and synthesis of the literature on a research topic in order to yield new theoretical models and perspectives or to identify direct areas of application in practice (Snyder, 2019; Sturma et al., 2016). The review follows a goal-oriented strategy and includes quantitative and qualitative empirical as well as theoretical works (Sturma et al., 2016).

First, databases and search terms were selected for the literature search, then certain criteria for the inclusion and exclusion of literature were determined (Snyder, 2019). We used *Google Scholar* and the *Web of Science* as databases, since both are extensive and provide international literature. They were searched using the search terms “practice” and “practices” (also with the addition of “teaching-”) and their German equivalents. Similar terms that are quasi-synonyms for one or another meaning of practices (such as competencies or techniques) were excluded because they reinforce the definitional vagueness of the concept (Charalambous & Delaney, 2020). Moreover, we consulted relevant publications from the last two decades, including international handbooks, book series and the most important journals of mathematics education, as well as proceedings of selected recent mathematics education congresses. In addition, we identified additional articles or papers of interest to the topic by looking at the reference lists. This resulted in a capture of approximately 10,200 articles that mentioned the search terms. To reduce this huge amount of literature, for each the abstract was analysed to determine whether practices were explicitly defined in terms of RQ1) and/or described in terms of RQ2). This was only the case for 21 contributions.

Exploratory results

From the reviewed literature, potentially relevant information about practices were extracted. Moreover, the term was located in research on mathematics teachers’ competence and expertise.

RQ1) Theoretical description and constitutive elements of practices

The term “practice(s)” has many meanings in relation to teaching, is used inconsistently and is rarely defined in the literature. Charalambous and Delaney (2020) suggest to refer to Lampert (2010), who distinguished four conceptions of practice: The first states that practice “involves implementing an idea in a context and is different to having the idea; this is the commonly made distinction between theory and practice” (Charalambous & Delaney, 2020, p. 359 f.). The “second conception of practice is something that is done repeatedly in order to improve performance in it” (p. 360). In this case, to practice means something like to rehearse. The third conception states that “the practice of teaching includes people who have adopted ‘the identity of a teacher’ who have been ‘accepted as a teacher’ and who have taken ‘on the common values, language, and tools of teaching’” (p. 360). Therefore, practice depends a. o. on cultural aspects (Lampert, 2010). Last but not least a “fourth meaning of practice, which is typically used in the plural form, practices, relates to routines that are done ‘constantly and habitually’ in the classroom” (Charalambous & Delaney, 2020, p. 360). Thereby, teaching is understood as a collection of practices (Lampert, 2010). Although the same terminology is not always used, this fourth meaning of practice is often used in research on mathematics teachers’ practices (e. g. Prediger, 2019; Prediger & Buró, 2020).

Prediger (2019) defines practices “as the recurrent patterns of teachers’ utterances and actions for coping with [...] jobs” which in turn are understood as “the typical, often complex situational demands of subject-matter teaching” (p. 370). Similarly, the idea of practices as recurrent patterns of utterances and actions of teachers is also mentioned by Häsel-Weide and Nührenbörger (2021) who characterize practices from a sociological point of view as cross-situational analytic units of jointly produced interpretations of “the ways of doing and saying” that can be distinguished from one another, ordered, and characterized more precisely in terms of their specific interactive function for the joint process of understanding between teacher and students in the classroom. Likewise, Kolbe et al. (2008) understand practices “as rule-governed, typified and routinized recurring activities” with a “communicative structure” (p. 131 f.). The basis for practices here is assumed to be a practical implicit knowledge of actors contained in routines of action. Here as well, practices are understood as part of a sociocultural context, which means that practices always correspond to specific requirements and social interactions in the classroom and are determined f. e. by the students, the school or the mathematical content (s. a. Moschkovich, 2004).

Furthermore, Prediger (2019) characterises practices “by the underlying categories, pedagogical tools, and orientations upon which the teachers’ actions implicitly or explicitly draw” (p. 370). Thereby categories are “conceptional [...] knowledge elements that filter and focus the categorical perception and the thinking of the teacher that usually stem from knowledge on the classroom content, pedagogical content knowledge [...] or from generic pedagogical knowledge”. At this point, the understanding of practices can be linked to the situation-specific application of professional teacher knowledge, i. e., the categories of knowledge described by Shulman (1987), including CK, PCK, and GPK, that are seen as an integral part of practices and that become specifically relevant in certain situations in teaching. However, because practices are an expression of teachers’ situative performance and describe routinized patterns of action that can also be articulated and reflected on, this integral part contains both tacit and explicit knowledge components (Polanyi, 1966; Bromme 1992).

By using the term of orientations, Prediger refers “to content-related and more general beliefs that implicitly or explicitly guide teachers’ perceptions and prioritisations of jobs” (Prediger, 2019, p. 370). Content-related beliefs, so called attitudes, are ways of acting, feeling, or thinking that express a person's disposition. They are like ideas and assumptions about an object that contain an evaluative component or professional judgement. More general beliefs are psychologically based perceptions, premises, or statements about the world that are believed to be true and guide action. They are more cognitive in nature compared to attitudes, but differ from professional knowledge (Philipp, 2007). The relevance of teachers’ specific knowledge and beliefs for practices is also mentioned by other researchers, such as Breidenstein (2021), Ball and Forzani (2009) as well as Kolbe et al. (2008).

Last but not least, Prediger (2019) defines pedagogical tools as “concrete, visible tools applied to coping with the job (e.g. tasks, facilitation moves, activity structures, and didactical artefacts)” (p. 370). In this context Breidenstein (2021) draws “attention to the fact that it is precisely the artefacts that often provide the affective charge of the practices” (p. 937). Moreover, he mentions an interdependent relationship between the human body and practices. Accordingly, practices contain a performative moment. This idea is also mentioned by Kolbe et al. (2008).

Widely used in research on mathematics teachers' practice(s) are the terms of core and high leverage practices (Charalambous & Delaney, 2020; Lampert, 2010), whereby high leverage practices can be understood as a special kind of core practices (Grossman, 2018). These practices "are conceived with an explicit focus on supporting prospective teachers in learning to teach" (Charalambous & Delaney, 2020, p. 361). Therefore, they are important for developing teachers' professional competencies.

RQ2) Practices in research on mathematics teachers' professional competence

Prediger's (2019) framework is grounded on the ideas of teachers' expertise explicated by Bromme (1992). His professional-theoretical framework generally understands teachers as experts "who have to cope with professional tasks for which a long training and practical experience are required and who successfully solve these tasks" (Bromme, 1992, p. 7). These tasks relate to three basic requirements of teaching: Organizing and maintaining a structure of teacher and student activities, developing and unpacking the content in the classroom, and organizing instructional time. In order to cope with the demands, teachers resort to implicit knowledge, which Bromme (1992) understood as a specific perspective that expert teachers take on these tasks and that is the prerequisite for effective pedagogical actions.

As a teachers' practice is on the one hand performative in its nature, practices can be described in the context of research on teacher expertise. Practices can therefore be methodically observed in a teacher's performance. However, research on teachers' expertise points to difficulties both in defining expert performance and in measuring indicators of expertise (Stigler & Miller, 2018). Due to the complexity of classroom teaching and its cultural dependency, expert teachers are not defined as those who employ a set of best practices. Instead, by using deliberate practice, expert teachers "assess students' current knowledge state both prior and during instruction, formulate clear learning goals, consider a large number of instructional strategies and routines in their repertoire, make good judgements about which strategies are most appropriate in any given situation, and are able to create learning opportunities for students" (p. 440).

Since practices are on the other hand also cognitive in nature, they can be described from the perspective of research on teachers' professional competence as well. In the discourse on teachers' professional competencies, sustained successful and confident professional practice is taken as a measure of performance (Bromme, 1992; Krauss et al., 2020). At this point, the approaches of expertise research can be linked with Blömeke et al.'s (2015) idea of competence as a continuum, where situation-specific skills, namely "perception", "interpretation" and "decision-making" (PID, p.7), serve as mediators between dispositions such as teachers' knowledge and beliefs and observable teaching behavior. This idea has shaped research on teachers' professional competence and was revisited in other theoretical works.

Competency-based approaches that mediate between teachers' dispositions and their performance are currently also experiencing an uptake in the discourse on professional teacher knowledge in the field of science education. The so-called "Refined Consensus Model of Pedagogical Content Knowledge", shortly named RCM of PCK (Carlson et al., 2020) „describes the complex layers of knowledge and experiences that shape and inform teacher's science practice through their professional journey and, in turn, mediate student outcomes“ (p. 84). One of these layers is the so-called "enacted Pedagogical

Content Knowledge” (ePCK) „that a teacher draws on to engage in pedagogical reasoning during the planning of, teaching of, and reflecting on a lesson“ (p. 84). The term refers to

the specific knowledge and skills utilised by an individual teacher in a particular setting, a with a particular student or group of students, with a goal for those students to learn a particular concept, collection of concepts or a particular aspect of the discipline. It is important to note that enactment in this model not only applies to the knowledge of and reasoning behind the act of teaching when interacting directly with students (reflection *in* action), but also to the aspects of planning instruction and reflection on instruction and student outcomes (reflection *on* action). (p. 85)

Therefore, ePCK plays a central role in teachers’ situative performance. The understanding of ePCK is closely based on Shulman's definition of PCK but its character is more tacit. The starting point for the discussion of expanding Shulman's terminology was the criticism that previous approaches to describe teachers’ knowledge base did not sufficiently address the process of pedagogical reasoning in situational teaching practice. The RCM of PCK therefore takes up the approaches of “reflection-in-action” and “reflection-on-action” (Schön, 1983) among others, which includes adaptive planning, enacting and reflecting a pedagogical decision in a teaching situation. Due to the situation-specific character of a recurring requirement situation, a teacher needs to make small adjustments of a corresponding routinized action in each recurring situation by pedagogical reasoning. Over time, practices emerge as deliberate actions become more internalized and tacit. Therefore, practices develop and change over a long-term period based on the experiences of a teacher.

Conclusion

Based on this theoretical exploration of practices we understand practices in the following way: Practices are routinized recurrent patterns of utterances and actions of teachers for coping with specific requirement situations in a specific teaching context. They are learned through deliberate practice and internalization and relate to the adaptive planning, enacting, and the reflection of pedagogical decisions. Constitutive elements of practices are teachers’ affective and cognitive dispositions and situation-specific skills. For the performance of practices, a teacher draws on his or her own body and appropriate pedagogical tools. The complex interplay of the components of practices, their relation to teachers’ professional competence and their development as part of teachers’ expertise can be displayed by the following conceptual model (see Figure 1):

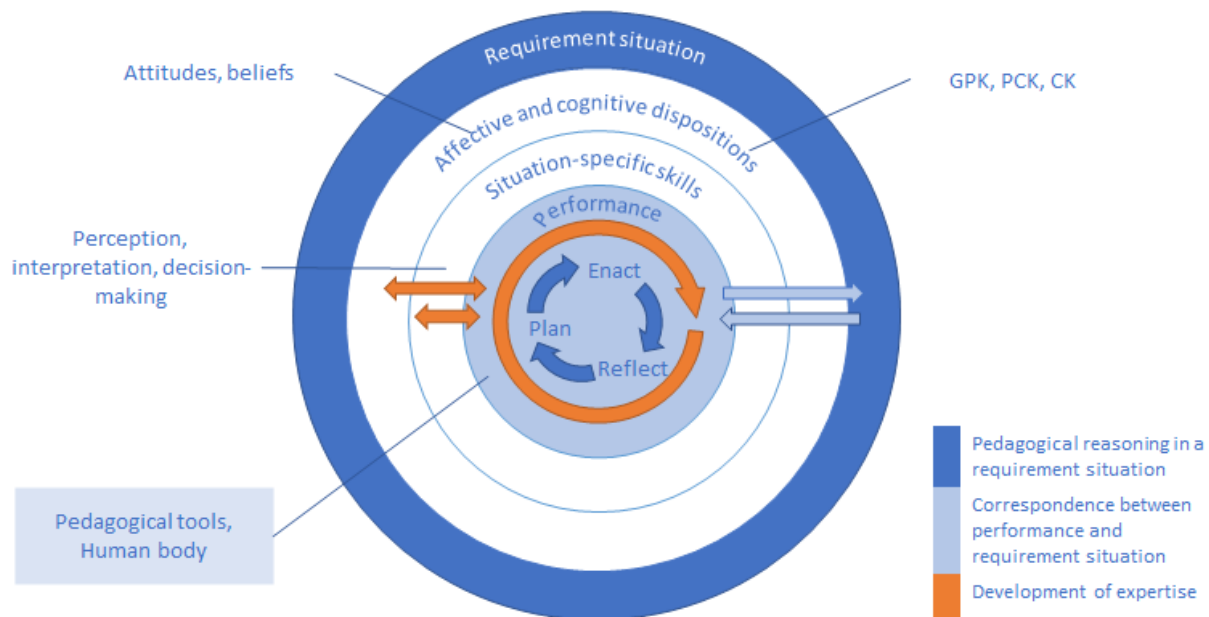


Figure 1: Theoretical model of practices

In the following, this theoretical model of practices is explained from the outside to the inside.

Requirement situation and its correspondence on teachers' performance

The requirement situation in the outer ring is based on the idea that practices are corresponding to a specific teaching context (Moschkovich, 2004). With his or her situation-specific skills, a teacher perceives a specific event in the classroom as a requirement situation (light blue arrows) and he or she draws back on affective and cognitive dispositions to interpret the event. Subsequently, the teacher decides to plan an utterance or action in order to cope with the requirement situation (which is subsequently enacted). The reflection on the effect of this initial performance in the context of the requirement situation is again mediated by his or her dispositions and situation-specific skills.

Affective and cognitive dispositions and situation-specific skills

The affective dispositions of a teacher encompass attitudes and beliefs (Philipp, 2007). These guide teachers' perceptions and their prioritisations of various requirement situations (Prediger, 2019). The term of cognitive dispositions denotes, among other things, the professional knowledge of a teacher, namely CK, GPK and PCK (Shulman, 1987). In accordance with Blömeke et al. (2015), we understand situation-specific skills as perception, interpretation and decision-making in a specific requirement situation. Thereby, decision-making also includes professional judgement (McDonald et al., 2013; Stigler & Miller, 2018). The affective and cognitive dispositions of a teacher correspond with his or her situation-specific skills as knowledge and beliefs filter and focus perception, interpretation and decision-making processes. Via these skills an utterance or action in performance is planned, enacted and later reflected on. When teachers encounter recurrent requirement situations in practice, both their situation-specific skills and their affective and cognitive dispositions develop further as a result of repeated performance over a longer period of time (orange arrows). This occurs, for example, through constant internalization of actions, reflection and the development of tacit knowledge, whereby their practices emerge and continually evolve.

Performance

In their performance, the behaviour of a teacher becomes visible and therefore observable (Blömeke et al., 2015). Thereby, only these utterances and actions are practices that appear recurrently and cope with a specific requirement situation (for this reason, requirement situation and performance are directly related). The performative character of practices is reflected in repeated pedagogical reasoning (dark blue arrows), whereby adapted pedagogical decisions are made in recurring requirement situations (orange circle arrow). Furthermore, the observable performance of teachers also includes their use of the human body and pedagogical tools.

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