

Chapter 2

The COACTIV Model of Teachers' Professional Competence

Jürgen Baumert and Mareike Kunter

Teachers are the most important element of the education system. Their education and qualification can therefore play a decisive role in optimizing educational processes (Cochran-Smith and Zeichner 2005; Darling-Hammond and Bransford 2005; Kennedy et al. 2008). However, review of the literature on teacher qualification and professionalization (e.g., Cochran-Smith and Zeichner 2005; Zeichner 2005) reveals that terms such as “qualification,” “professionalism,” “expertise,” and “competence” are often imprecisely defined and that their use by different authors is inconsistent. Moreover, overarching theoretical structures that would allow relevant research questions to be translated into empirically testable hypotheses are lacking. As a result, there are few empirically sound research findings to back up the abundance of theorizing on the subject or the many recommendations for practice. It is here that COACTIV comes in: The aim of the COACTIV research program is to make a theoretical *and* empirical contribution to clarifying central concepts and to furthering the discussion on the professionalization of teachers.

Empirical educational research has investigated various aspects of the teaching profession from different theoretical perspectives with the aim of identifying effective means of improving teacher recruitment and training. Our aim in COACTIV was to integrate these approaches within an overarching model combining findings from the various research perspectives and to test that model empirically. This chapter

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J. Baumert (✉)

Center for Educational Research, Max Planck Institute for Human Development,
Lentzeallee 94, 14195 Berlin, Germany
e-mail: sekbaumert@mpib-berlin.mpg.de

M. Kunter

Institute of Psychology, Goethe University Frankfurt, PEG, Grüneburgplatz 1,
60323 Frankfurt, Germany
e-mail: kunter@paed.psych.uni-frankfurt.de

presents the theoretical model of teachers' professional competence developed in COACTIV that provides the basis for all our empirical work. The guiding idea was to develop a generic model of teachers' professional competence that could then be specified for mathematics teachers. After outlining the theoretical principles of this model in section "Generic Structural Model of Teachers' Professional Competence," we describe in the subsequent sections the individual aspects of competence that it contains. In Chaps. 8 to 15, which constitute the main empirical part of this book, we investigate each of these aspects separately.

2.1 Generic Structural Model of Teachers' Professional Competence

The theoretical objective of COACTIV was to identify the qualities that teachers need in order to meet the demands of their profession, with the main focus of interest being on classroom instruction. As preparing and implementing instruction can be seen as the key challenge of the teaching profession (Woolfolk Hoy et al. 2006), the success of teaching practice can be measured in terms of teachers' ability to initiate and support learning processes that enable students to achieve specific pedagogical objectives. Yet the outcomes of teaching are uncertain in two respects. First, instruction can be planned only to a certain extent. Given the interactive structure of the classroom and the unpredictability of student behavior, classroom discourse and the teaching provided will always be situation dependent, even with careful planning. Second, as learning is essentially an idiosyncratic mental process (Shuell 1996), there is no guarantee for the product of instruction—that is, for successful student learning outcomes (McCaffrey et al. 2004). Against this background, we conceptualize teaching in terms of a model of instructional provision and uptake characterized by dual uncertainty (Fend 2008; Helmke 2009). According to this model, teachers are responsible, in interaction with their students, for creating learning opportunities that make insightful learning processes possible (see also Chap. 6). Their professional practice is characterized by a lack of standardization and the uncertainty of success (Floden and Buchmann 1993); however, it does not follow that the individual characteristics needed to succeed in this situation cannot be described or that these characteristics are not learnable or teachable.

If creating effective teaching and learning situations in the classroom and enabling students to achieve their learning objectives are regarded as the key tasks of any teacher, it follows that research attention should focus on those teacher characteristics that are necessary conditions for achieving these outcomes. Identifying these characteristics calls for a profession-specific approach that focuses on the core business of teaching, namely, on classroom instruction. The theoretical works of Shulman (1986, 1987) and Bromme (1992, 1997) offer useful approaches here: Shulman proposed several categories of teacher knowledge that are required for effective teaching, and Bromme later extended this categorization system. Like Grossman and Stodolsky (1995), both authors emphasized the relevance of the subject matter for

teachers' thinking, knowledge, and behavior. From this perspective, in which successful teaching practice is seen as dependent on a well-organized and comprehensive base of domain-specific knowledge that can be conveyed in the context of structured pre- and in-service teacher education, teaching can be regarded as a profession—that is, as an occupational field characterized by, for example, an intensive and specialized education, independent practice in nonroutine situations, a shared theoretical knowledge base and specialist skills, and systematic quality assurance and continuous development of knowledge in the field (Hoyle 2001; Shulman 1998).

Shulman investigated the topic of teacher professionalization in the context of a systematic comparison of professions initiated by the Carnegie Foundation for the Advancement of Teaching and identified six attributes characteristic of all professions (Shulman 1998, p. 516):

- The obligations of *service* to others, as in a “calling”
- *Understanding* of a scholarly or theoretical kind
- A domain of skilled performance or *practice*
- The exercise of *judgment* under conditions of unavoidable uncertainty
- The need for *learning from experience* as theory and practice interact
- A professional *community* to monitor quality and aggregate knowledge

A combination of analyses of the concrete demands of teaching practice and a general model of professional practice also provided the theoretical basis for the standards formulated by the US National Board for Professional Teaching Standards (NBPTS 2002). Likewise, it is the basis on which Bransford et al. (2005, p. 11) developed their theoretical model of teacher qualification—which distinguishes three main dimensions: knowledge of learners and their development in social contexts, knowledge of subject matter and curriculum goals, and knowledge of teaching—within the context of a normative vision of professional practice that is anchored in a professional community.

Profession-specific approaches of this kind are needed to determine the concrete demands teachers face in their work. At the same time, the literature on teacher professionalism has also repeatedly highlighted the need to refer to generic models of professionalization and professional development in order to further theoretical development in the field (Bromme 1997; Cochran-Smith and Zeichner 2005). Against this background, the COACTIV research team proposed a model of teachers' professional competence that is theoretically rooted in the teacher-specific literature on professional knowledge (Bransford et al. 2005; Bromme 1992, 1997; Shulman 1986, 1987) but that integrates the insights gained from this approach with the literature on professional competence and its assessment (e.g., Weinert 2001a, b).

The term “competence” describes the personal capacity to cope with specific situational demands. Competence is, by definition, learnable and teachable (Klieme et al. 2008; Weinert 2001a). The term “professional competence” was coined by Weinert (2001b), who applied the concept to the specific ability to cope with work-related demands:

The theoretical construct of action competence comprehensively combines those intellectual abilities, content-specific knowledge, cognitive skills, domain-specific strategies, routines

and subroutines, motivational tendencies, volitional control systems, personal value orientations, and social behaviors into a complex system. Together, this system specifies the prerequisites required to fulfill the demands of a particular professional position. (Weinert 2001a, p. 51; see also Weinert 2001b, p. 27f.)

The use of the term “competence” has theoretical implications that extend previous approaches to teachers’ professionalism in important ways. In the strict sense, the term refers to cognitive aspects only (Weinert 2001a). Seen from this perspective, competencies are context-dependent cognitive achievement dispositions that are acquired through learning and are needed to cope with describable demands in specific domains (Klieme et al. 2008; Mayer 2003; Simonton 2003). A broader understanding of the term also includes motivational, metacognitive, and self-regulatory characteristics, which are considered decisive for the willingness to act (Connell et al. 2003; Epstein and Hundert 2002; Kane 1992; Weinert 2001b). Within the “competence” framework, these characteristics are also conceived to be learnable and malleable—an assumption that is not made explicit in most models of the teaching profession (Klieme et al. 2008).

The COACTIV model of teachers’ professional competence thus integrates theorizing on professionalism with the competence literature. From this perspective, professional practice is seen as resulting from an interplay of various factors:

- Specific declarative and procedural knowledge (competence in the narrow sense: knowledge and skills)
- Professional values, beliefs, and goals
- Motivational orientations
- Professional self-regulation skills

This nonhierarchical model of professional competence is a generic structural model that needs to be specified for the context of teaching (Brunner et al. 2006; Krauss et al. 2008). The model specified in COACTIV is presented in Fig. 2.1. We distinguish between four *aspects* of competence (knowledge, beliefs, motivation, and self-regulation), each of which comprises more specific *domains* derived from the available research literature. These domains are further differentiated into *facets*, which are operationalized by concrete indicators. In the following sections, we describe how the individual aspects of teacher competence were theoretically specified in COACTIV.

2.2 The Core of Professionalism: Knowledge

There is broad consensus that knowledge—that is, declarative, procedural, and strategic knowledge—is a key component of teachers’ professional competence. However, there is far less agreement about the structure of this knowledge, the different types of knowledge and their epistemological status, or the development and mental representation of professional knowledge and skills (Ball et al. 2001; Fenstermacher 1994; Sternberg and Horvath 1995).

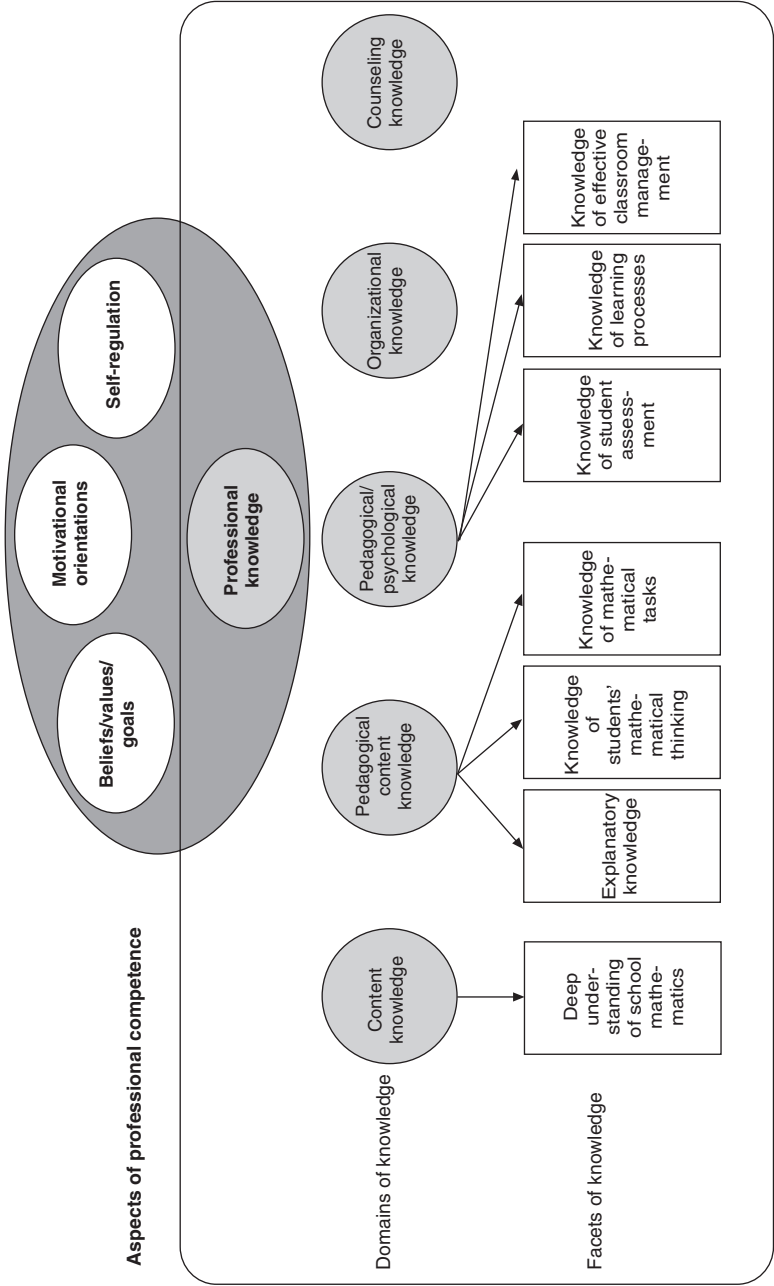


Fig. 2.1 The COACTIV model of professional competence, with the aspect of professional knowledge specified for the context of teaching

2.2.1 *Dimensions of Professional Knowledge in the Teaching Profession*

Shulman's (1986) approach to the structure of teachers' knowledge has gained widespread acceptance. Having first distinguished between *general pedagogical knowledge*, *subject matter content knowledge*, *pedagogical content knowledge*, and *curricular knowledge*, he later extended this typology to include *knowledge of learners*, *knowledge of educational context*, and *knowledge of the philosophical and historical aims of education* (Shulman 1987). The distinction between general pedagogical knowledge (PK), content knowledge (CK), and pedagogical content knowledge (PCK) has proved practically useful and has been implemented in numerous studies (e.g., Borko 2004; Borko and Putnam 1996; Blömeke et al. 2011b; Munby et al. 2001). The COACTIV model of teachers' professional competence adopts these three core dimensions of teachers' knowledge—CK, PCK, and (broadening Shulman's original definition) general pedagogical/psychological knowledge (PPK)—and supplements them by two further dimensions: *organizational knowledge* (Shulman 1987) and the *counseling knowledge* that professionals need in their communication with laypeople (Bromme and Rambow 2001; Hertel 2009; Hertel et al. 2009; Rambow and Bromme 2000).¹

2.2.2 *Types of Knowledge and Their Mental Representation*

Given the lack of previous research explicitly examining the types and forms of representation of *teachers'* professional knowledge, we instead draw on generic expertise research and its application to the professions (Bromme 2001, 2004; Cianciolo et al. 2006; Schmidt and Boshuizen 1992; Sternberg and Horvath 1995). Empirical findings from this research area provide some important insights that are substantiated and further elaborated by findings from teacher research itself. In this context, the perspective of peak performance and striving for perfection that guides expertise research (Ericsson 2006) is abandoned (Hatano and Inagaki 1986; Krauss 2010). Instead, the focus is on the difference between the content knowledge of laypeople and professionals. Key results presented by Berliner (1994, 2001), Bromme (2001, 2004), and Palmer et al. (2005) can be summarized as follows:

- Professional knowledge is domain specific and dependent on education and training (competence in the narrow sense).
- Professional knowledge is well organized and hierarchically structured.

¹Although organizational and counseling knowledge are included in the theoretical model of teacher competence, they have not yet been empirically assessed within the COACTIV framework.

- In professional domains, important content knowledge and practical knowledge are arranged around key concepts and a limited number of event schemata, onto which individual cases, episodic units, or sequences of episodes (scripts) are docked.
- Professional knowledge integrates different contexts of application and thus allows a rich variety of adaptive behaviors in problem situations.
- Basic procedures are automatized, but can nevertheless be flexibly adapted to the specifics of a given case or context (Hatano and Inagaki 1986; Neuweg 2001).

Several dimensions of professional knowledge can be differentiated. Fenstermacher (1994) distinguished between formal (theoretical) and practical knowledge. The formal component of teacher knowledge primarily includes CK but also elements of PCK and generic PPK. It is generally assumed that this type of knowledge has a propositional mental representation and can be represented with semantic networks.

However, broad areas of teacher practice—especially those relating to communicative behavior in the class or the school—draw on practical knowledge (knowledge in action). Although anchored in academic knowledge, this knowledge is experience based, embedded in specific contexts, and related to concrete problems. It is reflected in the quality of professional practice. Although this knowledge generally remains implicit in the rapid pace of classroom events, Fenstermacher (1994) argued that it can in principle be justified in practical discourse by the professional teacher (Hiebert et al. 2002; Munby et al. 2001; Neuweg 2005, p. 215f.).

Some elements of practical knowledge can also be assumed to have a propositional mental representation. This applies to the act of lesson preparation and probably also to the categorization of perceived situations and typical sequences of events. This type of knowledge is complemented by knowledge with a strong practical focus that is tied to specific cases, episodes, and scripts; is integrated in routines; but is nevertheless flexible enough to allow for intuitive fine-tuning on the job (Neuweg 2001). It is this fine-tuning—the intuitive interpretation of specific situations—that enables teachers to do the “right thing” at the right time and in a socially and morally acceptable manner (Elliott et al. 2008; Gigerenzer and Brighton 2007; Helsper 2007).

The assessment instruments developed in COACTIV and the follow-up project COACTIV-R within this theoretical framework focused primarily on teachers' theoretical, formal knowledge; our main objective was to assess their conceptual understanding of mathematics. In the domains of PCK and generic PPK, however, we also sought to assess elements of practical knowledge—specifically, those generally associated with cases, episodes, and scripts. To this end, we used a vignette approach based on written descriptions of learning situations or on video examples of critical classroom incidents (see Chaps. 9 and 11).

2.2.3 Content Knowledge and Pedagogical Content Knowledge

There can be little dispute that domain-specific knowledge—that is, knowledge of the content and teaching of a subject—is a core element of teachers' professional

competence. Indeed, the school subject is the teacher's primary field of professional activity (Goodson et al. 1999; Tenorth 2006). The assessment of teachers' CK and PCK therefore requires a theory of the subject in question and of the forms and structures of its knowledge. There is broad consensus that these two components of professional knowledge cannot simply be equated with a command of the material taught. Nevertheless, theory-driven approaches to the assessment of teachers' CK and PCK remain few and far between.

Some conceptions have, however, been developed and empirically tested for the subject of mathematics. The research group surrounding Ball, Bass, Hill, and Rowan at the University of Michigan has developed a theoretical framework and empirical measures to assess the professional competence of elementary school mathematics teachers (Ball 2003; Ball et al. 2005; Hill et al. 2004). Ball's research group sees mathematics teachers' professional content knowledge as the mathematics they need to know in order to teach effectively. Their frame of reference is therefore *not* university-level knowledge, but the mathematics behind the institutionalized curriculum of elementary school mathematics. On this basis, Ball et al. (2005) and Hill et al. (2004) distinguish the everyday mathematical knowledge that every educated adult should have (*common knowledge of content*) from the specialist knowledge acquired through professional training and classroom experience (*specialized knowledge of content*). They further identify a third dimension of mathematical knowledge, which links mathematical content with student cognitions (including misconceptions and strategies), namely, *knowledge of students and content*. At the same time, the research group distinguishes three content areas of elementary school mathematics: numbers and operations, patterns and functions, and algebra. The group has used a matrix of these content areas and knowledge dimensions as a theoretical structure for the development of test items, with items being allocated to the individual cells of the matrix on the basis of a priori theoretical considerations. Hill et al. (2004) tested this theoretical model in a large pilot sample of teachers. The empirical data did not support the complex model structure, however, as the two dimensions of common knowledge and specialized knowledge were not empirically separable. A hierarchical confirmatory factor analysis with nested factors revealed the presence of a strong *g* factor, but the specific knowledge factors also accounted for substantial proportions of the variance. Whether the *g* factor indeed reflects common knowledge of content, as the authors suggested, remains an open question. On the basis of these analyses, the Michigan group developed an overall test based on item response theory (IRT) assessing elementary school teachers' *mathematical knowledge for teaching*. Hill et al. (2005) tested the validity of the IRT total score to predict elementary students' learning gains (see Chap. 9 for results).

Another theoretical conceptualization of mathematics teachers' CK and PCK has been developed and corresponding measurement instruments constructed in the context of the IEA's Teacher Education and Development Study in Mathematics (TEDS-M; Blömeke et al. 2008a, 2011; Schmidt et al. 2007). This study defines mathematical CK as covering a broad spectrum of mathematical concepts and methods, ranging from an operative command of the mathematical content covered at

lower and upper secondary level to a conceptual understanding of the mathematics underlying this content (elementary mathematics from a higher standpoint) and to an understanding of university-level mathematics. Two dimensions of PCK are conceptualized, with a distinction being drawn between teaching-related aspects (e.g., those relating to the curriculum and lesson planning), on the one hand, and learning process-related aspects (e.g., those relating to teachers' actual instructional practice), on the other. The learning process-related aspects center on the didactic analysis of student responses. Items have been developed to tap teachers' knowledge of the content and teaching of mathematics in the domains of arithmetic, algebra, functions, geometry, and statistics (see also Blömeke et al. 2008b; Blömeke et al. 2010a, b). In the dimensional analyses conducted in the German sample, both a three-factor model distinguishing CK and the two postulated dimensions of PCK and a higher dimensional model distinguishing between mathematical content and activities provided an adequate fit to the data. In addition, the tests of both CK and PCK proved to be sensitive to the type of teacher education program attended.

COACTIV shares a common theoretical approach with Ball's group and the IEA group, to the extent that the focus of assessment is on the mathematical knowledge needed for comprehension-oriented instruction. However, COACTIV takes a different approach to the theoretical modeling of the knowledge components. In COACTIV, four forms of mathematical knowledge are theoretically distinguished, each reflecting different levels of understanding of the material taught: (1) academic research knowledge, (2) a profound mathematical understanding of the mathematics taught at school, (3) a command of the school mathematics covered at the level taught, and (4) the mathematical everyday knowledge that all adults should have after leaving school. We conceptualize the CK needed for teaching as knowledge of the second type: a profound mathematical understanding of the content of the secondary school mathematics curriculum. This knowledge is rooted in the academic reference discipline but is a domain of knowledge in its own right that is defined by the curriculum and continuously developed on the basis of feedback from instructional practice. It incorporates a firm command of the material covered in the mathematics classroom, but neither this school knowledge nor (much less) everyday mathematical knowledge can properly equip teachers to cope with the mathematical challenges facing them in the preparation and implementation of instruction.

CK is theoretically distinguished from—and generally regarded as a necessary condition for the development of—PCK. COACTIV distinguishes three dimensions of PCK:

- Knowledge of the didactic and diagnostic potential of tasks, their cognitive demands and the prior knowledge they implicitly require, their effective orchestration in the classroom, and the long-term sequencing of learning content in the curriculum
- Knowledge of student cognitions (misconceptions, typical errors, strategies) and ways of assessing student knowledge and comprehension processes
- Knowledge of explanations and multiple representations

The COACTIV test of CK focuses on teachers' understanding of the mathematical concepts underlying the content taught in middle school. A separate test assesses the three dimensions of PCK: tasks, student cognitions, and representations and explanations. The tasks used in both tests are open ended; some are administered by computer. We decided against using multiple choice items. The test construction process and structural analyses testing the dimensionality of teachers' professional knowledge are described in detail in Chap. 8. A one-dimensional, two-parameter IRT model has been shown to yield a good fit to the data provided by each test. Findings from both the COACTIV main study and other data sources have confirmed the theoretically predicted structure: a multidimensional model of knowledge comprising two correlating factors (CK and PCK), each with the specified subdimensions (see Chaps. 9 and 10).

2.2.4 *Generic Pedagogical Knowledge and Skills*

In addition to their domain-specific knowledge, teachers also need domain-general knowledge of how best to shape processes of teaching and learning—that is, of aspects covered primarily by the *general pedagogical knowledge* component (but also the *knowledge of learners* component) of Shulman's taxonomy. In constructing the Praxis Principles of Learning and Teaching tests (ETS 2006, 2007), which were designed to tap teachers' general pedagogical knowledge at the end of their university education, the Educational Testing Service (ETS) in Princeton analyzed the practice of teachers in different grade levels and surveyed experts on the competence profiles needed to succeed in the teaching profession. There was high level of agreement among experts and teachers with respect to the competencies that teachers need to have developed by the end of their preservice education (Reynolds et al. 1992; Rosenfeld and Tannenbaum 1991). Particular emphasis was given to the following general pedagogical competencies: classroom management and orchestration of the learning process, general knowledge of student development and learning, diagnostic skills and assessment of student performance, and professional behavior in the school context. These are the dimensions covered by the Praxis II test of teachers' PK. They are also largely congruent with Shulman's (1987) extended catalog, with one exception: Shulman additionally considers teachers' central repertoire of professional knowledge to include knowledge of the *philosophical and historical aims of education*—that is, knowledge of educational philosophy, educational theory, school theory, and the sociology and history of education. Darling-Hammond and Bransford (2005) and Terhart (2002) have developed similar competence profiles.

Table 2.1 systematizes the proposed facets of general PK on which there is broad consensus. As this overview clearly shows, the facets differ in their proximity to teachers' professional and instructional practice. It is likely to become increasingly difficult to demonstrate the relevance of general PK for teaching practice as the distance from instruction and its context increases. In particular, knowledge of the

Table 2.1 Facets of general PK

1. Conceptual knowledge of the <i>foundations</i> of education
– Educational philosophy, educational theory, and the historical foundations of schooling and instruction
– Theory of institutions
– The psychology of human development, learning, and motivation
2. General pedagogical knowledge of instructional planning
– Metatheoretical models of lesson planning
– Domain-general principles of lesson planning
– Instructional methods in the broad sense
3. Knowledge of classroom management and orchestration of learning opportunities
– Patterns of instructional practice
– Variation of social forms and methods of learning
– Rules and routines of effective classroom management
– Creating a constructive and supportive learning environment
4. Knowledge of domain-general principles of diagnostic testing and assessment
– Learning and achievement: basic diagnostic skills
– Assessment and evaluation of learning processes
– Feedback
– Summative testing and assessment
5. Basic knowledge of the methods of empirical social research

foundations of education can be expected to have only indirect effects on teaching practice.

The recent literature has highlighted the need for valid and reliable *proximal* assessment of teacher competence, and there is general agreement that research efforts should be concentrated in this area (Cochran-Smith and Zeichner 2005). In terms of assessing teachers' conceptual knowledge in domains such as the foundations of education, lesson planning, or general principles of student testing and assessment, the path to be taken is relatively clear. However, considerable difficulties arise when combinations of knowledge and practical skills need to be assessed (e.g., in the context of classroom management or the orchestration of learning opportunities). In COACTIV-R, the theoretical framework of teachers' generic PPK—as a constitutive element of their general pedagogical knowledge and skills—was specified by the dimensions of knowledge of classroom management, knowledge of teaching methods, knowledge of classroom assessment, knowledge of students' learning processes, and knowledge of individual student characteristics (Voss et al. 2011; see Chap. 10).

2.2.5 *Counseling and Organizational Knowledge*

A further dimension of teachers' professional knowledge identified in the COACTIV model is the counseling knowledge that professionals need to communicate

effectively with laypeople (Bromme and Rambow 2001; Hertel 2009; Hertel et al. 2009; Rambow and Bromme 2000). In the COACTIV model of teachers' professional knowledge, we distinguish counseling knowledge from general PK, on the one hand, and from CK and PCK, on the other. This approach was motivated by the theoretical assumption that counseling knowledge is a socially distributed and largely nonsubject-specific form of knowledge that has to be bundled and interpreted for specific addressees in a given counseling situation. In the school context, these addressees may be individual students or small groups of students or parents/families. Common reasons for counseling include upcoming decisions at critical points in students' educational careers, learning difficulties, and behavioral problems (Hertel 2009; Hertel et al. 2009). Counseling situations tend to address people's experiences and behaviors in various areas, beyond a single school subject, and thus require the experiences and diagnostic skills of several adults—both teachers and parents—to be activated. They are thematically and socially complex in terms of their preparation, the counseling process itself, and any follow-up measures required. They often also involve decisions on whether or not other institutional partners should be consulted (e.g., psychological or remedial services, child guidance centers, or social services). In COACTIV and COACTIV-R, we decided against assessing this dimension of knowledge for reasons of research economy: The validation of a corresponding measurement instrument would have exceeded the scope of the study (e.g., see Bruder et al. 2010; Hertel 2009).

Finally, organizational knowledge on the functioning and effectiveness of the education system and its individual institutions is also conceptualized as a separate domain of teachers' professional knowledge. Organizational knowledge can include knowledge of (1) the education system and its institutional framework; (2) management, governance, and transparency; (3) the organization and ecology of the school; the legal form of schools; the rights and responsibilities of students, parents, and teachers; and the role of school management; (4) school quality and effectiveness; and (5) theories of schooling (Altrichter et al. 2007; Böttcher et al. 2008; Fend 2008; Woolfolk Hoy et al. 2006). Here again, validating a corresponding measurement instrument would require an institution-based study design that could not be provided in the context of COACTIV and COACTIV-R. This gap in the research is to be closed by the BilWiss study on "Broad Educational Knowledge and the Acquisition of Professional Competence in Teacher Candidates" (see Chap. 6). The label "broad educational knowledge" is used to cover generic pedagogical knowledge and skills—including PPK—as well as counseling knowledge and organizational knowledge (see Chap. 1).

In sum, teachers' professional knowledge comprises several domains that differ in their proximity to classroom practice. In empirically testing the COACTIV model of teacher competence, we focused on the three domains with direct relevance to teachers' instructional practice, namely, CK, PCK, and PPK. Our research was guided by the theoretical assumptions that a well-established body of CK is a necessary condition for the development of PCK and that PCK and PPK are directly reflected in teachers' classroom practice. Whereas PPK was expected to be particularly important for general classroom management and individual learning support, PCK was hypothesized

to be the key factor determining the potential for cognitive activation. The empirical testing of these hypotheses was and remains one of the main objectives of the COACTIV research program and is addressed in Chaps. 10 and 11.

2.3 Values and Beliefs

In the generic model of teachers' professional competence proposed in COACTIV, teachers' knowledge and skills, on the one hand, and value commitments and beliefs, on the other, are conceived as two separate categories of teacher competence. Knowledge and beliefs have different epistemological statuses, although the transitions between the two are blurred. In teacher research, however, this distinction is not maintained and is often deliberately abandoned. In these cases, "knowledge" is used as an umbrella term that is applied to a wide variety of mental representations without consideration of their epistemological status. Fenstermacher (1994), keenly aware of the philosophical difficulties of drawing strict boundaries between knowledge and beliefs, emphasized the categorical difference between the two, which he saw as rooted in the respective requirements for justification.

In his review article, Pajares (1992) made a first attempt to "clean up" the conceptualization of teachers' belief systems in educational research. Ten years later, Op't Eynde et al. (2002) defined *students'* mathematics-related beliefs as "the implicitly or explicitly held subjective conceptions students hold to be true about mathematics education, about themselves as mathematicians, and about the mathematics class context" (p. 27). In contrast to knowledge, beliefs do not have to satisfy the criterion of consistency, neither is it necessary for beliefs to be justified when challenged. It suffices for the individual in question to judge them to be correct. Focusing on the context of mathematics, these authors distinguished between:

- *Epistemological beliefs*, which relate to the structure, development, and validation of bodies of knowledge.
- Beliefs about learning in a school subject area—in the following, we refer to *subjective theories of learning*.
- *Subjective theories* about the *teaching* of the subject.
- Beliefs about the self in the context of the learning and teaching of that subject—in the following, these beliefs are termed *self-related ability cognitions*.

These distinctions also offer a useful conceptual system for the classification of *teachers'* beliefs, if expanded to include value commitments (or professional ethos), on the one hand, and the goal systems that guide teachers' practice, on the other (see also Woolfolk Hoy et al. 2006). The inclusion in this system of self-related cognitions, which are typically addressed in the context of theories of motivation, merits particular note. In COACTIV, we also assign self-related cognitions to this aspect of teachers' professional competence (see Chap. 13). Within the dimension of values and beliefs, we thus distinguish value commitments, epistemological beliefs (world views), subjective theories of teaching and learning, and goal systems.

In COACTIV and COACTIV-R, we focus on epistemological beliefs, subjective theories of teaching and learning, and instructional goals in mathematics—that is, on the domains of teacher competence that are directly relevant to instruction. Key analyses have been conducted from a structural perspective, asking whether it is possible to empirically distinguish belief systems rooted in different theoretical orientations toward learning and, from an impact perspective, testing whether and to what extent belief systems influence the quality of instruction and students' learning gains (see Chap. 12).

2.4 Motivational Orientations and Self-Regulation

Motivational orientations and self-regulatory abilities are responsible for the psychological dynamics of behavior, the maintenance of intentions, and the monitoring and regulation of occupational practice over an extended period. Both aspects are thus key characteristics of psychological functioning. Two closely related strands of research on teachers' motivational orientations and professional self-regulation can be distinguished. The first examines teachers' self-related cognitions—especially control beliefs and self-efficacy beliefs (e.g., Tschannen-Moran and Woolfolk Hoy 2001; Schmitz and Schwarzer 2000)—and intrinsic motivation (e.g., Pelletier et al. 2002; Roth et al. 2007). The second addresses experience of strain and sources of resilience in the teaching profession from the perspective of self-regulation (e.g., Buchwald and Hobfoll 2004; Hakanen et al. 2006; Hillert and Schmitz 2004; Kyriacou 2001; Vandenberghe and Huberman 1999).

2.4.1 *Control Beliefs and Self-Efficacy Beliefs*

Teachers' self-efficacy beliefs are seen as an important aspect of professional competence (Klassen et al. 2011). Various studies have shown that teachers with higher self-efficacy beliefs show greater enthusiasm for teaching, have a stronger normative commitment to their teaching practice, and are more likely to stay in the profession (Tschannen-Moran et al. 1998). Self-efficacy beliefs have also been found to be linked to the preparation and delivery of instruction, especially the provision of constructive support (Ashton and Webb 1986; Gibson and Dembo 1984; Podell and Soodak 1993). Furthermore, strong self-efficacy beliefs can be a resilience factor helping people to cope with occupational stress and strain over the long term: High self-efficacy beliefs are associated with higher levels of occupational engagement and higher job satisfaction (Schmitz 2001; Schmitz and Schwarzer 2000).

Less is known about the development of self-efficacy beliefs over the course of teacher education and during teaching practice. Tschannen-Moran et al. (1998) reported that self-efficacy beliefs decrease during the periods of university education

in which teacher candidates gain practical classroom experience. Malmberg (2006) reported similar findings for control beliefs. Hoy and Spero (2005) observed a comparable phenomenon among beginning teachers (Dann et al. 1981).

In sum, self-efficacy beliefs seem to be an important component of teachers' ability to regulate their psychological experience in the professional context (Tschannen-Moran and Woolfolk Hoy 2001). More recent longitudinal research with a strong theoretical and methodological basis provides particularly compelling support for this conclusion (Schmitz and Schwarzer 2000). The development of teachers' self-efficacy also seems to depend on the stage of their career and on the social context of the school and its teaching staff (Goddard et al. 2004).

In COACTIV and COACTIV-R, we assessed self-efficacy beliefs relating to instruction and other school-specific demands (see Chap. 12). As a convincing body of empirical research based on well-established research instruments is already available, however, self-efficacy beliefs were given only peripheral attention in our empirical testing of the competence model. Instead, we focused on a second domain that has seen much theoretical debate, but relatively little empirical research, namely, teachers' intrinsic motivational orientations.

2.4.2 *Intrinsic Motivational Orientations: Teacher Enthusiasm*

Since the seminal research report by Brophy and Good (1986), enthusiasm has been regarded as an important element of teacher competence (see also Long and Hoy 2006). Enthusiasm is typically understood to be a classroom behavior serving to enhance student motivation that may be more or less instrumental or strategic (Shuell 1996). The assumption is that observable teacher engagement in the classroom provides a positive model for student behavior. The evidence for this assumption is limited, however (Brigham et al. 1992; Frenzel et al. 2009; Patrick et al. 2000).

In contrast to this instrumental conception of teacher enthusiasm as a form of classroom engagement, COACTIV conceptualizes enthusiasm as an individual teacher characteristic (Kunter et al. 2008). Based on the extended expectancy-value theory (Wigfield and Eccles 2000), the theory of individual interest (Krapp 2000), and self-determination theory (Deci and Ryan 2000), we see teacher enthusiasm as the component of intrinsic motivational orientation that all three theories describe as the *emotional* factor of motivation. Teacher enthusiasm thus reflects the degree of positive emotion experienced during the activity of teaching. Drawing on Schiefele (1998), Kunter et al. (2008) have further distinguished topic-related from activity-related teacher enthusiasm, that is, enthusiasm for the topic of instruction—usually the subject taught—versus enthusiasm for the activity of teaching itself.

In COACTIV, we examined the extent to which teachers' enthusiasm for teaching was positively associated with the quality of classroom management, with students' experience of individual learning support, and with the level of cognitive activation in the classroom (see Chap. 13).

2.4.3 Professional Self-Regulation: Engagement and the Ability to Maintain a Healthy Distance

Self-regulatory skills—in particular, the ability to responsibly manage one’s personal resources—are another important component of teachers’ general professional competence. Research on the experience of strain and effective coping with the challenges of work situations is of direct relevance here (Maslach et al. 2001). The subjective experience of strain seems not only to be an important predictor of retention in the profession (Rudow 1999) but also to impact the quality of professional practice and of instruction (Maslach and Leiter 1999).

Hobfoll’s (1989) conservation of resources theory provides a useful model to explain the emergence of symptoms of strain and stress in teachers—and to identify individual characteristics capable of mitigating or preventing these negative occupational outcomes. According to this theory, effective management of personal resources is characterized by both the investment of resources and the ability to protect and conserve resources. This idea is reflected in the work of Hallsten (1993), who introduced the concept of balanced commitment as an adaptive behavioral style that helps to reduce work-related strain. Based on these theoretical ideas and on the work of Schaarschmidt and Fischer (1997), we used the dimensions of work engagement (as a strategy of resource investment) and resilience (as a strategy of resource conservation) to identify four self-regulatory types, whose abilities to manage their resources effectively differed systematically. Schaarschmidt and Fischer (1997) have developed an instrument to assess patterns of strain in the teaching profession, which postulates three primary factors of psychological regulation: work engagement, resilience, and work-related emotions. Based on their analysis of profile patterns, Schaarschmidt et al. (1999) identified four self-regulatory types, each with distinctive patterns of work engagement and distancing (Schaarschmidt 2002).

The assessment of self-regulatory skills in COACTIV draws on the work of Schaarschmidt et al. (1999), on the one hand, and on research on the experience of strain and coping with the challenges of work-related situations (Maslach et al. 2001), on the other. In COACTIV, we examined the extent to which teachers’ self-regulatory ability is reflected in both their occupational well-being and their instructional practice (see Chap. 15).

2.5 Conclusion: Professional Competence as a Multidimensional Construct

In this chapter, we drew on the teacher-specific literature on professional knowledge as well as on the research literature on competence as a precondition for adaptive and effective professional practice to derive a generic model of teachers’ professional competence, and we showed how this model was specified to apply to mathematics teachers in the context of COACTIV. This specification provides the

basis for the empirical testing of the competence model described in later chapters of this book. We conclude this chapter by returning to the problem of the inconsistent use of terms and theoretical approaches in research on the teaching profession that we noted at the beginning of this chapter and by describing where our competence model fits in.

The model of teachers' professional competence developed in COACTIV draws on various research traditions that have examined the characteristics of a successful teacher from different perspectives. By emphasizing knowledge as a key dimension of teacher competence, the COACTIV model builds on the expertise research on the teaching profession conducted by Berliner (1994, 2001), Bromme (1992, 1997), and Leinhardt and Greeno (1986). Research on teachers' beliefs also has a long tradition (Calderhead 1996; Pajares 1992). Both research strands share a focus on teachers' cognitive characteristics that—despite differing in their requirements for justification—nevertheless have much in common: Both knowledge and beliefs are mental representations constructed by teachers in explicit and implicit learning processes. For example, the idea that knowledge and belief systems become better differentiated with increasing teaching experience and that more differentiated schemata are associated with the ability to act adaptively and flexibly applies equally to both knowledge and beliefs, prompting some researchers to subsume both aspects under the label “expertise” (Shulman 1986; see also Woolfolk Hoy et al. 2006). The emphasis on these cognitive characteristics, which are subject to processes of learning and change, clearly runs counter to the traditional understanding of the teaching profession as an “art and craft” (Lieberman and Miller 1992), which emphasizes talent or inborn dispositions. The COACTIV model of teachers' professional competence also assumes that the individual competencies are, in principle, teachable and learnable and subject to processes of change. However, the COACTIV model also takes noncognitive characteristics such as motivational orientations and self-regulatory skills into account—and thus goes beyond the conventional understanding of expertise.

To date, research taking a psychological perspective on the teaching profession has paid far more attention to teachers' motivational and self-regulatory characteristics than to their cognitive characteristics. However, most of these studies have taken a nonprofession-specific approach, taking little account of the specifics of the teaching profession in their analyses of how these characteristics relate to, for example, general work-related behavior (e.g., career decisions, general work engagement), occupational well-being, or the experience of strain (e.g., Butler 2007; Schaarschmidt et al. 1999; Vandenberghe and Huberman 1999; Watt and Richardson 2007). In COACTIV, we draw on the constructs established in this research framework but reinterpret them by explicitly examining their relevance to the core business of teachers, namely, teaching, as a criterion for the ability to cope successfully with the demands of the profession.

A key premise of the theoretical approach taken in COACTIV is that individual attributes in both areas—cognitive characteristics such as knowledge and beliefs as well as motivational/self-regulatory characteristics—provide the necessary basis for effective teaching practice over the long term. We do not see these characteristics as innate or immutable, but as the products of processes of professional development

that begin with teacher education and continue throughout the teaching career (Terhart 2001; see also Chap. 4). With its emphasis on the teachability and learnability of aspects of professional competence, the COACTIV framework model thus builds on teacher education research and on the literature on professionalization in the teaching profession (Cochran-Smith and Zeichner 2005; Darling-Hammond and Bransford 2005; Kennedy et al. 2008). However, whereas the primary goal of research on professionalization and qualification is to describe normative criteria or standards and structures for the attainment of these standards, COACTIV takes a more differential perspective. Our main objective is to specify more precisely the determinants and consequences of interindividual differences in teacher competence.

In sum, the COACTIV model of teachers' professional competence describes the qualities needed to succeed in the teaching profession from a multidimensional perspective. The term "professional competence" seems particularly appropriate in this context, as it is generally used to describe precisely this multidimensionality and the interplay of cognitive and motivational/self-regulatory characteristics needed to cope with work-related demands (Epstein and Hundert 2002; Kane 1992; Weinert 2001a). The use of this term therefore has theoretical implications that extend previous approaches to teacher expertise or professionalism in important respects. Professional competence refers to the individual's ability to cope with specific occupational situations, and thus goes beyond more global approaches such as the personality paradigm in teacher research (Bromme 2001). Moreover, competence encompasses both the ability and the willingness to act (Connell et al. 2003) and thus describes a broader spectrum of personal characteristics than the primarily knowledge-based concept of teacher expertise (Bromme 1997, 2001). Finally, a key premise of our approach is that professional competence is malleable—and thus teachable and learnable in the context of professional development. This assumption has direct implications for quality assurance, as it places a much stronger focus on pre- and in-service training than on selection to the profession. Chapter 4 examines these processes of change in more detail.

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