Professional Competence of Teachers: Effects on Instructional Quality and Student Development

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This study investigates teachers' pedagogical content knowledge, professional beliefs, work-related motivation, and self-regulation as aspects of their professional competence. Specifically, it examines how these aspects impact instruction and, in turn, student outcomes. In a nationally representative sample of 194 German secondary school mathematics classes, multiple measures were used to assess teacher competence, instructional quality, and students' achievement and motivation. The effect of teachers' professional competence on student outcomes was estimated in a 1-year repeated-measures design. Two-level structural equation models revealed positive effects of teachers' pedagogical content knowledge, enthusiasm for teaching, and self-regulatory skills on instructional quality, which in turn affected student outcomes. In contrast, teachers' general academic ability did not affect their instruction. The multidimensional model of teachers' professional competence introduced in this article seems suited to stimulate further research on the personal indicators of teacher quality.

Keywords: teacher quality, instruction, student achievement, student motivation

Recent years have seen an upsurge of research investigating the characteristics that predict teachers' effectiveness and, in particular, how well they succeed in providing high-quality instruction that fosters student learning (Kennedy, Ahn, & Choi, 2008; Zumwalt & Craig, 2005). The focus of these discussions is often on characteristics such as general cognitive abilities or personality factors (e.g., Wayne & Youngs, 2003; Yeh, 2009; Zumwalt & Craig, 2005). This suggests that recruiting candidates who show high levels of these characteristics into teaching can improve the profession. In this article, we argue that it is necessary to take account of the specific processes that determine the mastery of teaching in the conceptualization of teacher quality. We introduce a multidimensional model of teachers' professional competence that includes cognitive aspects (e.g., professional knowledge), beliefs related to learning, and motivational and self-regulatory variables, which we hypothesize to be the foundations of successful teaching. We then present results from a study in which the professional competence of secondary school mathematics teachers was measured by a battery of tests and questionnaires. The study investigates the link between teachers' professional competence, their instructional practice, and the impact of those behaviors on student learning.

Research on Teacher Quality

Teacher quality refers to all teacher-related characteristics that produce favorable educational outcomes (Cochran-Smith & Fries, 2005) such as student performance on standardized tests or supervisor ratings (D'Agostino & Powers, 2009). Discussions about how to improve teacher quality tend to follow one of two lines of argumentation. The first line proposes that good teachers show certain stable cognitive characteristics, making careful recruitment

and selection into the teaching profession crucial (e.g., Wayne & Youngs, 2003; Yeh, 2009; Zumwalt & Craig, 2005). We call this argument the Bright Person Hypothesis (BPH), after a suggestion by Kennedy et al. (2008). The second argument is that attention should focus on the profession-specific knowledge acquired during teacher education (e.g., Anderson et al., 1995; Shulman, 1998). We call this argument the Knowledgeable Teacher Hypothesis (KTH). As we discuss in the following section, the empirical evidence for both suggestions is mixed.

The Bright Person Hypothesis

Kennedy et al. (2008) introduced the "Bright Person Hypothesis"[1] (BPH) as the idea that "the best teachers are *bright, well-educated* [italics added] people who are smart enough and thoughtful enough to figure out the nuances of teaching in the process of doing it" (p. 1248). In other words, the cognitive capabilities with which people *enter* the teaching career are seen as crucial for determining teacher quality. This argument is based on the idea that teaching is a highly demanding, complex, and inherently unpredictable task that requires high cognitive flexibility and a capacity for quick problem solving (Feldon, 2007).

The BPH is widely endorsed in the public discussion and among policy makers (Organisation for Economic Co-operation and Development [OECD], 2005). Its practical implications are obvious: If the best teachers are characterized by their high intelligence, then a focus needs to be placed on recruiting these individuals into teaching. It would therefore be necessary to establish innovative recruitment programs or entrance tests (Yeh, 2009). Moreover, since a high proportion of teachers leave the career after a few years, new incentive systems would need to be enacted to keep high-potential teachers in the profession (OECD, 2005).

Research in vocational psychology has provided empirical evidence in support of the BPH, showing that cognitive abilities (as measured by standardized tests) and academic abilities (as indicated by high school grade point average, GPA) strongly predict professional success (Hunter, 1983; Kuncel, Hezlett, & Ones, 2004). These findings span many vocations and professions, but teachers are rarely included in the samples. Empirical evidence for the teaching domain is mixed. Although some studies have found a positive association between teachers' general cognitive ability and student performance, others have reported zero correlations (Aloe & Becker, 2009; Kuncel et al., 2004; Yeh, 2009; Zumwalt & Craig, 2005). One conceptual difficulty of the BPH is its unclear stance as regards high cognitive abilities: Are they prerequisites of mastering the teaching job at all, or are they needed only to perform at very high levels (see Sternberg & Horvath, 1995)? With their tests for linear correlations between teachers' cognitive ability and their performance, most studies address the first question, indicating that within the regular range of teaching successes, cognitive ability is not an important predictor.

The Knowledgeable Teacher Hypothesis

A second explanation of teachers' success views teaching as a profession whose members are autonomous practitioners that exercise knowledge-based skills in nonroutine contexts (Anderson et al., 1995; Shulman, 1998). The Knowledgeable Teacher Hypothesis (KTH) thus sees profession-specific knowledge as a key factor

in teacher success (Shulman, 1987). This type of knowledge is not everyday knowledge; rather, it is highly specialized knowledge that is shared among a community of professionals. It is acquired in formal, profession-specific learning environments and refined in discourse with other experts. Drawing on Shulman (1986, 1987) and Bromme (2001), research distinguishes between teachers' subject-specific content knowledge, subject-specific pedagogical content knowledge, and subject-unspecific psychological–pedagogical knowledge. Content knowledge is conceptualized as a deep understanding of the content to be taught (Baumert et al., 2010; Krauss et al., 2008), pedagogical content knowledge (PCK) is defined as the knowledge necessary to make this content accessible to students (Hill, Rowan, & Ball, 2005; Krauss et al., 2008), and psychological–pedagogical knowledge is defined as the generic, cross-curricular knowledge needed to create and optimize teaching and learning situations (Voss, Kunter, & Baumert, 2011).

There is ample evidence that teacher education is important and that quality control through teacher education and certification contributes to teachers' success (Brouwer & Korthagen, 2005; Darling-Hammond, Holtzman, Gatlin, & Vasquez Heilig, 2005; Kennedy et al., 2008). However, exactly which types of courses or contents matter most remains an open question (D'Agostino & Powers, 2009; Goodman, Arbona, & Dominguez de Rameriz, 2008; Kennedy et al., 2008). Studies using proximal approaches to measure teacher knowledge have produced more consistent results, showing teacher knowledge is associated with higher quality instruction, which in turn has a positive effect on student learning (e.g., Hill, Ball, Blunk, Goffney, & Rowan, 2007; Ma, 1999).

The idea that first-class teachers are, above all, knowledgeable educators is also featured prominently in studies on teachers' expertise (Berliner, 1992; Borko et al., 1992). These studies typically compare novices (before or at the beginning of their teaching career) and expert teachers (who have completed teacher education and have substantial teaching experience). They show that a profound and differentiated knowledge base on student characteristics, the teaching matter, and/or possible instructional interactions enables "expert teachers" to perceive and interpret teaching situations more adequately, resulting in the enactment of better instructional strategies (e.g., Borko et al., 1992; Sabers, Cushing, & Berliner, 1991). This indicates that a large part of this expert knowledge is attained through the formal learning opportunities of teacher education. There is also evidence that professional development courses or self-initiated learning activities contribute to the growth of teachers' professional knowledge (Desimone, 2009; Dunn & Shriner, 1999).

Overall, these studies attest to the value of a profound profession-specific knowledge base, as developed in professional education. However, most of this research has focused exclusively on teacher knowledge and neglected the possibility that other factors may be equally important in predicting success in the teaching profession (Goodman et al., 2008).

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[1] Kennedy et al. (2008) considered both personal qualities and a degree from a prestigious university as potential determining factors of teacher success. In this sense, "well-educated" is not specific to the teaching profession but is a proxy for generally high cognitive abilities.

More Than Knowledge: The Concept of Professional Competence

The concept of professional competence may offer a third route to understanding teacher success. Based on definitions from several domains, competence can be defined as the skills, knowledge, attitudes, and motivational variables that form the basis for mastery of specific situations (see Epstein & Hundert, 2002; Kane, 1992; Klieme, Hartig, & Rauch, 2008). According to this approach, skills, knowledge, attitudes, and motivational characteristics are not innate, but learnable and thus teachable. The term "professional competence" is the application of the concept to working life, particularly in highly complex and demanding professions, in which mastery of situations is especially dependent on the interplay of knowledge, skills, attitudes, and motivation (Epstein & Hundert, 2002; Kane, 1992; Weinert, 2001).

Several researchers have suggested that the concept of professional competence may be fruitfully applied to the teaching profession (Goodman et al., 2008; Oser, Achtenhagen, & Renold, 2006; Tannenbaum & Rosenfeld, 1994) and that the multidimensional concept of professional competence makes it possible to integrate several strands of empirical research on the necessary characteristics of teachers. There is ample evidence that aspects beyond knowledge may be important in determining teacher success. These aspects include teachers' beliefs, work-related motivation, and ability for professional self-regulation.

Beliefs. Teachers' beliefs are implicit or explicit conceptions about school- and learning-related matters that influence their perceptions of the environment and their behaviors (Pajares, 1992; Richardson, 1996). Theoretical distinctions have been drawn between professional values, epistemological beliefs, and beliefs about learning content and instructional practice (e.g., Pajares, 1992; Woolfolk Hoy, Davis, & Pape, 2006). For instance, two sets of beliefs concerning the teaching and learning of mathematics have been described (Dubberke, Kunter, McElvany, Brunner, & Baumert, 2008; Staub & Stern, 2002): A "transmission view" that draws on traditional learning theories and tends to see students as passive receivers of information, and a "constructivist view" that endorses the principles of active and constructive learning in a social context. Studies show that teachers who endorse less transmissive or more constructivist views provide better learning support and select more demanding tasks, resulting in better student learning outcomes (Dubberke et al., 2008; Staub & Stern, 2002).

Motivational orientations and self-regulation skills. The teaching profession is characterized by a relative lack of external constraints on teachers' behavior (Lortie, 1975). The typical career path offers few direct incentives or rewards to enhance occupational commitment. At the same time, the profession makes high demands on teachers' attention, energy, and tolerance for frustration. Motivational research has identified interindividual differences in motivational orientations and shown that these differences are manifested in the quality and persistence of behavior (Pintrich, 2003). Thus, adaptive motivational orientations are vital for teachers to succeed in their profession in the long term (Alexander, 2008; Woolfolk Hoy, 2008). More specifically, prior research has demonstrated a systematic link between high self-efficacy beliefs and more effective and innovative teaching behaviors (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). Furthermore, studies of intrinsic motivation indicate that teachers who experience their job as enjoyable and intrinsically rewarding provide more support to students, which in turn has a favorable impact on their students' motivation (Frenzel, Goetz, Lüdtke, Pekrun, & Sutton, 2009; Kunter et al., 2008; Roth, Assor, Kanat-Maymon, & Kaplan, 2007).

Teaching is not only a cognitive challenge; it is also socially and emotionally demanding (Jennings & Greenberg, 2009). In order to meet these challenges over extended periods of time, teachers need to regulate their engagement and to develop ways of coping with the constant demands of their work. Empirical research has found that a combination of high engagement and a lack of stress management skills comprise a risk factor for reduced well-being and performance (Hobfoll & Freedy, 1993; Maslach & Leiter, 1999). Teachers therefore need to develop self-regulation skills in order to maintain their occupational commitment over time and to preclude unfavorable motivational and emotional outcomes. Note that "self-regulation" has a specific meaning in this context. In contrast to the use of the phrase with respect to student learning, "self-regulation" in this context indicates the ability to engage oneself while simultaneously monitoring one's own behavior and, in stressful situations, finding ways to cope adaptively (Klusmann, Kunter, Trautwein, Lüdtke, & Baumert, 2008).

The Good Teacher: Bright, Knowledgeable, or Competent?

In summary, three approaches can be distinguished in the research on teacher quality. The BPH suggests that stable and generic cognitive abilities that exist *prior* to entering the teaching career are a decisive factor in determining teachers' success (e.g., Aloe & Becker, 2009; Yeh, 2009). In contrast, the KTH suggests that profession-specific knowledge acquired *in the course* of teacher education and the later career is the decisive factor (e.g., Brouwer & Korthagen, 2005; Darling-Hammond et al., 2005). Against the backdrop of the available empirical evidence, we also suggested the concept of *professional competence* as a third approach to explain differences in teachers' performance. The concept of professional competence acknowledges the importance of *profession-specific* teacher attributes (as pointed out in the KTH) rather than generic attributes (as in the BPH) but suggests that in addition to knowledge, beliefs, motivation, and self-regulation represent key aspects that determine teachers' success. To date, little is known about the specific contribution that these aspects make to different outcomes.

The Present Investigation

We conclude that teachers' professional competence comprises in-depth PCK, constructivist beliefs, an intrinsic disposition toward their work, and self-regulatory abilities. Empirical research has shown that these teacher variables predict better mastery of the instructional situation and seem to produce positive effects in students. However, the competence approach implies certain additional theoretical assumptions that have not yet been addressed empirically and that guide our research questions in the present investigation.

Specific Contribution of Teachers' Knowledge, Beliefs, Motivation, and Self-Regulation

To date, researchers from different fields of expertise have investigated teachers' knowledge, beliefs, motivation, and self-regulation separately and in isolation, meaning that the specific contribution that each aspect makes to predicting successful teaching remains unclear. In the present investigation, we are therefore interested in identifying the specific role that teachers' knowledge, beliefs, motivation, and self-regulation play in explaining differences in the quality of the instruction they provide. We thus examined the effects of all variables simultaneously.

Instructional Quality as a Mediator of the Teacher Effect

Most studies to date link teacher variables directly with student outcomes, mainly student achievement (Kennedy et al., 2008; McCaffrey, Lockwood, Koretz, Louis, & Hamilton, 2004). In our study, we are interested in the processes underlying this relationship, and we thus investigated whether the effect of teachers' competence on students' progress is mediated by differences in teachers' quality of instruction. Three components have consistently emerged as crucial in the initiation and maintenance of insightful learning processes in mathematics lessons (Lipowsky et al., 2009; Pianta & Hamre, 2009; Rakoczy et al., 2007): the degree of cognitive challenge and activation offered to students, the degree of learning support provided through individual monitoring of the learning process, and efficient classroom management. We expected that different aspects of teachers' professional competence would be differentially predictive of these three dimensions of instructional quality.

First, regarding the level of cognitive challenge, we expected teachers' PCK to be the prime predictor (e.g., Baumert et al., 2010; Hill et al., 2007), as a thorough command of subject-specific knowledge seems to be a necessary condition for the appropriate selection and implementation of mathematical tasks in the classroom. In addition, we expected teachers' beliefs to co-vary with the level of challenge in the classroom, as teachers who endorse a constructivist view of learning can be expected to select more tasks that facilitate independent student thinking.

Second, support of individual learning is characterized by forms of student-centered instruction in which teachers monitor the learning process, provide individual feedback, show empathy for students' problems, and adapt their instruction accordingly (Cornelius-White, 2007). We expected teachers with constructivist beliefs to give this aspect of instruction particular emphasis. It can also be expected that a certain basis of PCK is a necessary condition for teachers to respond appropriately to students' instructional needs (Baumert et al., 2010; Hill et al., 2007). In addition, studies have shown that teachers' motivation and self-regulation skills are important predictors of the provision of learning support (e.g., Klusmann et al., 2008; Kunter et al., 2008; Roth et al., 2007). It thus may be that in order to provide caring instruction, teachers need a certain level of enthusiasm and engagement but that overcommitment to the job may reduce their patience and ease in social interactions with students (Jennings & Greenberg, 2009).

Third, classroom management involves strategies that reduce interpersonal conflicts and disruptions during teaching time. To date, very few studies have empirically investigated which teacher variables predict effective classroom management (see Jennings & Greenberg, 2009; Woolfolk Hoy & Weinstein, 2006). Prior studies have shown that teachers' enthusiasm for teaching is closely linked to their classroom management but that their PCK and self-regulatory styles are not (Baumert et al., 2010; Klusmann et al., 2008; Kunter et al., 2008). The role of a constructivist orientation in classroom management is of particular interest, as a focus on order and rules is considered detrimental to constructivist learning principles, and the possible disadvantages of imposing too many regulations on students have been discussed (McCaslin & Good, 1992; Woolfolk Hoy & Weinstein, 2006).

Benchmarks for Teacher Success: Multiple Student Outcomes

The most common approach to quantifying teachers' success is in terms of their students' academic achievement (e.g., McCaffrey et al., 2004). However, it also seems important to acknowledge teachers' roles as facilitators of independent and motivated learning. Yet multivariate approaches investigating teachers' effects on both student learning and motivation are rare. We therefore investigated the impact of teachers' professional competence on their students' domain-specific learning *and* motivation. We expected that teachers' domain-specific knowledge and beliefs would predict students' learning in that domain and that teachers' motivation (i.e., their enthusiasm) and self-regulation would predict students' motivation.

Distinguishing Professional Competence From General Cognitive Ability

One of the core assumptions of the competence literature is that competence develops through learning situations and can be distinguished from stable, trait-like characteristics, such as cognitive ability or personality. We therefore investigated how aspects of knowledge, beliefs, motivation, and self-regulation are related to teachers' general academic ability and to what degree teachers' academic ability features as an additional predictor for teachers' success.

Summary of Research Questions and Hypotheses

1. Effects of professional competence on student achievement and motivation. We expected that high levels of teacher knowledge, constructivist beliefs, intrinsic motivational orientations, and self-regulation would explain differences in their students' mathematics related achievement and motivation. More specifically, we expected teachers' knowledge and beliefs to be more predictive of their students' achievement, and teachers' motivation and self-regulation to be more predictive of their students' motivation.

2. Diverse aspects of professional competence predict different aspects of instructional quality and hence student outcomes. We expected instructional quality to mediate the link between teacher variables and student outcomes. On the one hand, we expected that high levels of PCK would enhance teachers'

ability to provide students with cognitively activating tasks and with adequate learning support. On the other hand, we expected that over and above knowledge, high levels of constructivist beliefs, high enthusiasm for teaching, and adequate self-regulatory skills would additionally predict higher instructional quality. Specifically, we expected positive effects of constructivist beliefs on cognitive activation and learning support, of enthusiasm on cognitive activation, learning support, and classroom management, and of self-regulation on learning support.

3. Greater effects for profession-specific aspects than for general cognitive ability. Drawing on the inconsistent findings on teachers' generic ability, we expected that aspects of profession-specific competence (knowledge, beliefs, motivation, and self-regulation) would be more predictive of student outcomes and instructional quality than teachers' general academic ability.

While all these hypotheses are based on the literature review outlined above, some of our more specific hypotheses are based on earlier studies that were carried out with the same data set used for the current study. In particular, studies with univariate designs have found that teachers' PCK predicts students' achievement via higher cognitive activation (Baumert et al., 2010), that higher teaching enthusiasm predicts all three aspects of instruction (Kunter et al., 2008), and that better self-regulation predicts student support and cognitive activation (Klusmann et al., 2008). However, we know of no studies in which all four aspects of competence were considered simultaneously, and neither student motivation nor teachers' general ability have been investigated in prior studies. The current study thus presents a comprehensive model of the effects of diverse aspects of teacher competence.

Method

The study draws on data from the COACTIV study, which was conducted in Germany from 2003 to 2004 (COACTIV: Professional Competence of Teachers, **Co**gnitively **Acti**vating Instruction, and the Development of Students' Mathematical Literacy; Kunter et al., 2007, in press). In a 1-year repeated-measurement design, COACTIV surveyed a nationally representative sample of Grade 10 classes and their mathematics teachers. The study investigated the implications of teachers' professional competence for processes of learning and instruction in secondary-level mathematics.

Study Design and Sample

COACTIV was embedded in the German extension to the 2003 cycle of the OECD's Programme for International Student Assessment (PISA; OECD, 2004). In this national extension, the international cross-sectional design involving an age-based sample of 15-year-olds was extended to a grade-based study spanning a 1-year period from the end of Grade 9 to the end of Grade 10 (Prenzel, Carstensen, Schöps, & Maurischat, 2006). In PISA, a nationally representative sample of Grade 9 students was drawn. A subsample of these students and their teachers took part in the additional longitudinal component that forms the basis for our investigation.[2] Participation in the study was voluntary; participating teachers received a financial acknowledgment. Students in the PISA classes were administered achievement tests as well as questionnaires assessing background data and aspects of their

mathematics instruction at the end of grades 9 and 10. Within the framework of COACTIV, the mathematics teachers of these PISA classes were administered tests and questionnaires on aspects of their professional knowledge, instructional quality, and professional background (Kunter et al., 2007).

The current study implements a quasi-experimental design with the purpose of explaining differences in students' achievement and motivation in Grade 10 (dependent variables) by differences in teacher variables (independent variables) that work via differences in instructional quality (mediator variables). To make such an interpretation possible, we include covariates (prior student achievement and motivation levels at Grade 9) that allow us to assume similarity across classes in the dependent variables. Thus, most of the variables in our study are drawn from the Grade 10 measurement (plus student achievement and motivation from the Grade 9 measurement).

At the teacher level, participation rates in the first and second wave of assessment were 94% and 84%, respectively. A total of 181 teachers with 194 classes and 4,353 students participated in the longitudinal study (13 of the participating teachers taught parallel classes in the same school). These 181 teachers (48% female) had a mean age of 48 years ($SD = 8$) and had been teachers for on average 22 years ($SD = 10$). All teachers had studied mathematics at university level, and they were licensed to teach the subject. The mean age of the students (57% female) was 15.7 years, and the mean class size was 24 students. The German secondary education system is characterized by selective tracking, with one academic track that qualifies students for university entrance and—depending on the state—one to three other tracks. In the present sample, 43% of the classes were from academic-track schools.

Analysis of sampling bias at the student level showed that the longitudinal sample can be considered representative of Grade 10 in Germany, which does not include vocational-track students (Prenzel et al., 2006). Likewise, findings on teacher effects can be generalized to the population of mathematics teachers teaching in Grade 10 classrooms in Germany.

Instruments

In order to minimize measurement error, we applied a latent modeling approach and modeled constructs on the basis of multiple manifest indicators wherever applicable.

Teacher variables. Teachers' mathematical *PCK* was assessed by a newly constructed test that tapped their knowledge of mathematical tasks, of student thinking, and of explanations and representations. For example, teachers had to predict typical student errors in a task requiring the area of a parallelogram to be calculated or to list as many explanations as possible for the fact that minus one times minus one equals plus one. The test comprised 23 open-ended items that were independently coded by two raters using a standardized coding system. The mean interrater reliability (proportion of variance that results from differences

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[2] In Germany's tracked and federal secondary school system, some states require vocational-track students to complete 9 years of secondary schooling, whereas other states require them to complete 10 years. Only school types that implement a 10th grade nationwide were included in the longitudinal extension (78% of the original sample).

between items in relation to the proportion of variance that results from differences between raters) across categories was $\rho = .81$ (see Krauss et al., 2008). The reliability as measured by internal consistency of the total test was Cronbach's $\alpha = .78$. As part of the multiple indicator approach, we formed three item parcels reflecting the subdimensions knowledge of tasks (4 items), knowledge of student thinking (7 items), and knowledge of explanations (12 items; see Krauss et al., 2008, for a detailed description of the PCK test).

We assessed *teachers' constructivist beliefs* using three subscales of a teacher belief inventory used in previous studies (Dubberke et al., 2008; Voss, Kleickmann, Kunter, & Hachfeld, in press). The subscales measured the degree to which teachers understood mathematics knowledge to be a process (4 items, e.g., "In mathematics, there are lots of things you can find out and try out by yourself," $\alpha = .65$), favored independent and insightful discursive learning (12 items, e.g., "In applied problems, students should be given the opportunity to explain their approach in detail," $\alpha = .88$), and thought it important to foster students' mathematical independence (5 items, e.g., "Given suitable material, students can develop computation procedures by themselves," $\alpha = .86$). Teachers indicated their agreement with all items on a 4-point Likert scale. Prior analyses showed that these three scales can be reliably subsumed into one factor representing a constructivist orientation (as opposed to a more transmissive orientation; see Voss et al., in press).

Teachers' enthusiasm for teaching was assessed by a short scale that was newly constructed within COACTIV and consisted of two items tapping teachers' enjoyment of the activity of teaching (responses were given on a 4-point Likert scale; $\alpha = .93$). Prior analyses have shown that the two items form a distinct dimension that can be distinguished from enthusiasm for the subject taught and that student ratings on this scale predicted their instructional quality (Kunter, Frenzel, Nagy, Baumert, & Pekrun, 2011; Kunter et al., 2008).

We tapped *teachers' self-regulatory style* using a procedure developed by Klusmann et al. (2008) based on eight subscales from the Occupational Stress and Coping Inventory (Kieschke & Schaarschmidt, 2008). The questionnaire measures teachers' work engagement and resilience using four subscales each (engagement: subjective significance of work, career ambitions, exertion, and perfectionism; resilience: emotional distancing, low tendency to give up after failure, active coping, and mental stability; 32 items). Teachers indicated their agreement with each item on a 5-point Likert scale. All scales demonstrated good to high reliability (α ranged from .79 to .82). Since adaptive self-regulation is defined as a combination of high engagement and high resilience, we used a latent profile approach to identify teachers with this particular combination. In these latent profile analyses, persons were categorized into different categories based on their scores on the eight scales, with different solutions that varied in the number of categories being formed. An advantage of latent profile analysis is that different categorization solutions can be compared with statistical fit indices and that once a solution is selected, the category into which each person most likely falls can be determined based on probability scores. Prior latent profile analysis favored a four-category solution in which four self-regulatory patterns were distinguished (high engagement and high resilience: 30% of the present sample; high engagement and low resilience: 17%; low

engagement and high resilience: 23%; low engagement and low resilience: 31%; see Klusmann et al., 2008, for details). The overall fit of this solution was good (Akaike's Information Criterion AIC = 29184.12, Bayes Information Criterion BIC = 29551.91, Lo-Mendell-Rubin likelihood ratio test for n versus n − 1 classes $p > .05$, see Klusmann et al., 2008). This four-category solution was the basis for our present analysis. We were particularly interested in the adaptive category characterized by high engagement and high resilience, and for each teacher in the sample we have statistical information whether he or she falls into this category or not. Prior analyses have shown that teachers belonging in this category show better instructional quality and higher student motivation (Klusmann et al., 2008). We therefore used membership of the adaptive self-regulatory category as a dummy variable (coded 0 = no and 1 = yes) in the present analyses (membership of the other categories was not included in the analyses, see Klusmann et al., 2008, for details).

As a non-profession specific indicator of *teachers' general academic ability*, we drew on teachers' self-reported grade point average (GPA) at school.[3]

Instructional variables. We drew on three different sources of information for instructional quality: student ratings, teachers' self-reports, and an analysis of the tasks set in the participating classes. Again, we used multiple indicators to reduce measurement error.

We assessed the provision of *cognitively activating learning opportunities* by reconstructing learning situations at the task level. To this end, teachers were asked to submit all tests and examinations they had used in the school year in the participating classes. The tasks were categorized by raters, who used a standardized classification scheme (Jordan et al., 2006) to code the type of mathematical task (three levels: purely technical, computational modeling, conceptual modeling), the level of mathematical argumentation required (four levels: no argumentation required, low, intermediate, high level of argumentation), and translation processes within mathematics (four levels: no translation required, low, intermediate, high level of translation). The interrater reliability for the categories was high ($\rho = .81, .93, .64$). On average, each teacher submitted 53 tasks. For the analysis, we summarized the ratings in each of the three dimensions for all tasks per teacher; the three resulting scales then formed the indicators of a latent factor "cognitively activating learning opportunities."

Learning support was operationalized by six student rating scales, each comprising three to four items, all answered on a 4-point Likert scale. The scales tapped the degree to which teachers provided adaptive explanations and responded constructively and patiently to errors, whether students perceived the pacing as adequate, and whether the teacher–student interaction was respectful and caring. The intraclass correlation coefficient taking into account the number of student raters per class (ICC_r) was used as a reliability measure (Lüdtke, Trautwein, Kunter, & Baumert, 2006). All coefficients were above .82, indicating good reliability of the student responses aggregated at class level (see Baumert et

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[3] Our sample included 42 teachers who themselves went to school in the former German Democratic Republic, where the grading system was very different. These 42 teachers were therefore excluded from all analyses including GPA.

al., 2010, for details of the scales). Thus, for each teacher, the ratings of his/her students in each scale were averaged to form six class means; these six scales then formed the indicators of a teacher's latent factor "learning support."

Classroom management was operationalized by scales tapping both student and teacher perceptions. First, two student rating scales assessed classroom management from the students' perspective (prevention of disruption, $ICC_r = .89$; effective use of time, $ICC_r = .90$, each comprising three items). Individual student scores in the scales were averaged per teacher. Second, one teacher scale assessed classroom management from the teacher's perspective (general disciplinary climate, $\alpha = .82$, eight items). Agreement between teacher and student judgments was high (Kunter & Baumert, 2006). For our analyses, the three scales form the multiple indicators for a teacher's classroom management. An advantage of this combination of student and teacher scales in one factor is that it reduces the common method bias.

Student variables. *Students' mathematics achievement* at the end of Grade 10 was assessed by a test covering the standard content of the federal states' curricula for Grade 10 mathematics ($\alpha = .79$). Students' mathematical literacy as measured in Grade 9 as part of the international PISA assessment was included in the models as a control variable ($\alpha = .93$). The tests were scaled using Rasch analysis and the weighted likelihood estimates were used as person parameters. For mathematics achievement in Grade 10, two test halves, representing the manifest indicators of the latent factor, were scaled separately. For mathematical literacy in Grade 9, only one test score was available.

Students' mathematics enjoyment was assessed at the end of Grades 9 and 10 by identical scales. The scales consisted of six items tapping students' positive emotions toward the subject of mathematics (Pekrun, Goetz, & Frenzel, 2005; e.g., "I find the material so exciting that mathematics lessons are real fun, " $\alpha = .91$ in both grades). The questionnaire scales were scaled using Rasch analysis and the weighted likelihood estimates were used as person parameters. Unfortunately, only one test score was available at each measurement point; therefore, these scales could not be modeled with multiple indicators.

Analyses

Our data have a hierarchical structure in which teachers' competence, the task indicators, and teachers classroom management ratings are measured at the class level, whereas students' achievement and motivation as well as all measures based on the student questionnaire are measured at the individual level but can be conceptualized at both individual and class level (class means). For our research questions, the unit of interest is the class (teacher) level. All variables measured at the individual level were modeled simultaneously at the individual and class level, but results are reported for the class level only (with the exception of the two control variables achievement and enjoyment at Grade 9, which were specified as group-centered individual-level variables only).

To investigate our research questions we ran a series of multilevel structural equation models (SEM). We started with a two-level measurement model (M1) that included all variables and in which all latent constructs were allowed to correlate freely. With a few exceptions, all variables were modeled as latent factors with multiple indicators. The exceptions are

teacher's self-regulation and students' achievement and enjoyment (both, Grades 9 and 10) because no multiple indicators were available for these variables. In the SEM, we specified these variables as latent factors with single indicators. In a second step, we specified a series of two-level models (M2a-d) to test the univariate effect of each competence aspect on students' achievement and enjoyment. In these models, the dependent variables were students' achievement and enjoyment in Grade 10; the predictor was one of the four teacher competence aspects (PCK, beliefs, enthusiasm, self-regulation, respectively). In these analyses, we followed a quasi-experimental logic, investigating the effect of varying levels of the teacher competence aspects on students' achievement and motivation. In order to control a priori differences between students and thus be able to interpret between-class differences in achievement and motivation as effects of teacher differences, we added prior achievement and prior enjoyment as control variables at the individual student level. School track (academic track vs. all others) was entered as an additional control variable at class level because previous analyses had shown that teachers and students vary across tracks (see Baumert et al., 2010). In a third step, all four competence aspects were entered as simultaneous predictors to investigate their effects on students' achievement and motivation in a multivariate approach (M3). We call models 2a-d and 3 "black box" models because they investigate the net effect of teacher variables on students without taking the mediating processes into account (referring to our first set of hypotheses). In a fourth step, we expanded these black box models and included all three instructional variables as mediating variables (M4; second set of hypotheses). Finally, we were interested in comparing the effect of the profession-specific competence aspects with those of GPA as a generic teacher variable (third set of hypotheses). We tested this by first running a model that uses GPA as the only predictor for the three instruction variables that then predicted student outcomes (M5a) and then a model in which all four competence aspects and GPA are simultaneous predictors for instruction and student outcomes (M5b).

We conducted all analyses with the Mplus 5.1 software (Muthén & Muthén, 1998–2007), using the full information maximum likelihood algorithm to estimate missing values. Model fit was evaluated by means of the comparative fit index (CFI), the root-mean-square error of approximation (RMSEA), and the standardized root-mean-square residual (SRMR), which was calculated separately for the within- and between-class covariance matrices ($SRMR_{within}$, $SRMR_{between}$). CFI values above .9, RMSEA values below .05, and SRMR values below .08 are considered indicative of a satisfactory to good model fit (Hu & Bentler, 1998). All significance testing was performed at the .05 level.

Results

Table 1 provides an overview of all manifest indicators with means and standard deviations. The full measurement model (M1), in which all latent constructs were allowed to correlate freely, fit the data well, $\chi^2_{[285]} = 1334.06$, $p < .05$; CFI = .921, RMSEA

Table 1

Descriptive Data for All Variables (Manifest Indicators)

Variable	N	M	SD
Class level			
Teacher variables			
Pedagogical content knowledge			
Tasks (TT)	170	0.03	0.97
Student cognitions (TT)	184	0.05	0.95
Explanations (TT)	184	0.06	0.93
Constructivist beliefs			
Mathematics as process (T)	185	3.28	0.44
Insightful/discursive learning (T)	185	3.32	0.40
Mathematical independence (T)	184	2.89	0.59
Teaching enthusiasm			
Item A (T)	179	2.97	0.69
Item B (T)	180	3.01	0.66
Adaptive self-regulation			
Percentage cluster type (T)[a]	187	0.34	0.48
Academic ability			
Teachers' GPA (T)	140	2.33	0.48
Instructional variables			
Cognitive level of tasks			
Type of mathematical task (E)	169	0.43	0.31
Level of mathematical argumentation (E)	169	0.07	0.10
Inner mathematical translation (E)	169	1.60	0.26
Learning support			
Adaptive explanations (S)	194	2.82	0.43
Constructive response to errors (S)	194	2.94	0.44
Patience (S)	194	2.76	0.53
Adaptive pacing (S)	194	2.20	0.44
Respectful treatment of students (S)	194	3.25	0.49
Caring ethos (S)	194	2.66	0.49
Classroom management			
Prevention of disruption (S)	194	2.47	0.62
Effective use of time (S)	194	2.34	0.58
Disciplinary climate (T)	184	2.00	0.65
Student variables (class average)			
Mathematics achievement Grade 9 (ST)	194	0.25	0.52
Mathematics achievement Grade 10 (ST)	194	572.00	49.48
Mathematics enjoyment Grade 9 (S)	192	2.18	0.29
Mathematics enjoyment Grade 10 (S)	194	2.13	0.25
Student level			
Mathematics achievement Grade 9 (ST)	4,325	0.28	0.87
Mathematics achievement Grade 10 (ST)	4,157	575.30	79.45
Mathematics enjoyment Grade 9 (S)	4,236	2.18	0.77
Mathematics enjoyment Grade 10 (S)	4,119	2.13	0.76

Note. TT = teacher test; T = teacher reports; E = tasks implemented in written examinations and tests; S = student reports; ST = student test; GPA = grade point average.
[a] Membership of the adaptive self-regulatory type was coded as a dummy variable (0 = no, 1 = yes).

.029, SRMR$_{within}$ = .035, SRMR$_{between}$ = .071.[4] Table 2 lists the zero-order latent correlations between all variables conceptualized at class level. These correlations provide several insights with respect to our main research question: the impact of teachers' professional competence on instructional quality and student progress. First, intercorrelations between most of the competence aspects (knowledge, beliefs, motivation, and self-regulation) were zero, small, or moderate in size, indicating that teachers can have distinct competence profiles with particular strengths and weaknesses in different aspects. Second, most competence aspects were positively related to one or both student outcomes and to at least one dimension of instructional quality. Third, instructional quality was associated with student outcomes. Thus, the conditions for testing the proposed impact of teacher competence on student

progress are met. However, as prior levels of achievement and enjoyment are not taken into account in these bivariate correlations, these results can provide only a first indication of the possible effects of teachers' competence.

Effects of Professional Competence on Student Achievement and Motivation

To test the effect of teachers' professional competence on student outcomes, we first ran a set of black box models in which each aspect of competence predicted students' mathematics

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[4] A table listing all factor loadings in the measurement model can be obtained from Mareike Kunter.

Table 2

Intercorrelations Between All Class-Level Variables

Variable	1	2	3	4	5	6	7	8	9	10
Teacher variables										
1. Pedagogical content knowledge	—	.32*	.04	.06	.63*	.14	.20*	.27*	.05	−.26*
2. Constructivist beliefs		—	.16*	.02	.17*	.07	.03	.13	−.17	.08
3. Teaching enthusiasm			—	.14	.19*	.43*	.07	.43*	.45*	−.03
4. Adaptive self-regulation				—	−.02	.14	.00	.23*	.08	.11
Student variables										
5. Mathematics achievement					—	.04	.25*	.15*	.21*	−.11
6. Mathematics enjoyment						—	.00	.80*	.43*	−.13
Instructional variables										
7. Cognitive level of tasks							—	.01	.06	−.05
8. Learning support								—	.31*	−.13
9. Classroom management									—	.06
10. Academic ability										—

* $p < .05$.

achievement and enjoyment in Grade 10 (M2a-d). In addition, students' mathematics achievement and enjoyment in Grade 9 were entered as predictors. As a consequence, any significant regression coefficients of teacher competence can be interpreted as effects on students' learning and motivation, given similar entry levels. As shown in Table 3, the regression models indicated that teachers' competence affected students' achievement and enjoyment: Classes in which the teacher had higher PCK, more constructivist beliefs, or more enthusiasm for teaching showed higher achievement. In addition, classes in which the teacher had higher enthusiasm showed an increase in mathematics enjoyment. Teachers' self-regulation had no direct effect on student outcomes. To understand more about the specific effects of the different aspects

Table 3

Predicting Mathematics Achievement and Mathematics Enjoyment at the End of Grade 10 From Teachers' Professional Competence

Model	Mathematics achievement Grade 10[a]	Mathematics enjoyment Grade 10[b]
2a		
PCK	.62*	−.03
2b		
Constructivist beliefs	.18*	.04
2c		
Teaching enthusiasm	.20*	.38*
2d		
Adaptive self-regulation	−.05	.09
3		
PCK	.38*	−.05
Constructivist beliefs	−.03	−.01
Teaching enthusiasm	.20*	.37*
Adaptive self-regulation	−.07	.04

Note. PCK = pedagogical content knowledge.
[a] The regression models included mathematics achievement at Grade 9 as a student-level predictor to control for prior achievement levels and school track as a control variable at the class level. [b] The regression models included mathematics enjoyment at Grade 9 as a student-level predictor to control for prior enjoyment levels and school track as a control variable at the class level.
* $p < .05$.

of competence, we included all four simultaneously in one model (M3). For most of the predictors, the coefficients remained stable, indicating that the four competence aspects operate independently of each other. However, the regression coefficients for PCK and constructivist beliefs predicting student achievement decreased significantly (even below the threshold of statistical significance for the belief coefficient), indicating that these two aspects share a substantial amount of variance (see Table 3, fit indices for this model: $\chi^2_{[40]} = 243.84$, $p < .05$; CFI = .955, RMSEA .023, SRMR$_{within}$ = .023, SRMR$_{between}$ = .053).

Professional Competence Predicting Instructional Quality and Student Outcomes

In our the next step, we expanded the black box model to a mediation model in which teacher competence predicted instructional quality, which in turn predicted student outcomes. More specifically, all four aspects of teacher competence predicted the three instructional variables, which then predicted student achievement and enjoyment (M4). As in the black box models, prior levels of achievement and enjoyment were controlled at the individual level, and school type was entered as a control variable at the class level. The model fit the data well ($\chi^2_{[284]} = 1547.86$, $p < .05$; CFI = .900, RMSEA .032, SRMR$_{within}$ = .033, SRMR$_{between}$ = .099). The results are shown in Figure 1 and Table 4. All aspects of teachers' professional competence made a specific contribution to the prediction of instructional quality. As expected, higher levels of pedagogical content knowledge were linked to higher levels of cognitive activation and better learning support for students. Higher levels of teaching enthusiasm were associated with better learning support and better classroom management, and adaptive self-regulation was linked to better learning support. However, teachers' constructivist beliefs were negatively related to instruction: Although unrelated to cognitive activation and learning support, more constructivist beliefs were associated with less effective classroom management. All other competence aspects being equal, teachers who endorse constructivist views of learning thus seem to have more problems with classroom discipline than do other teachers.

The effect of instructional quality on students' development is reflected in the regression coefficients in which instruction
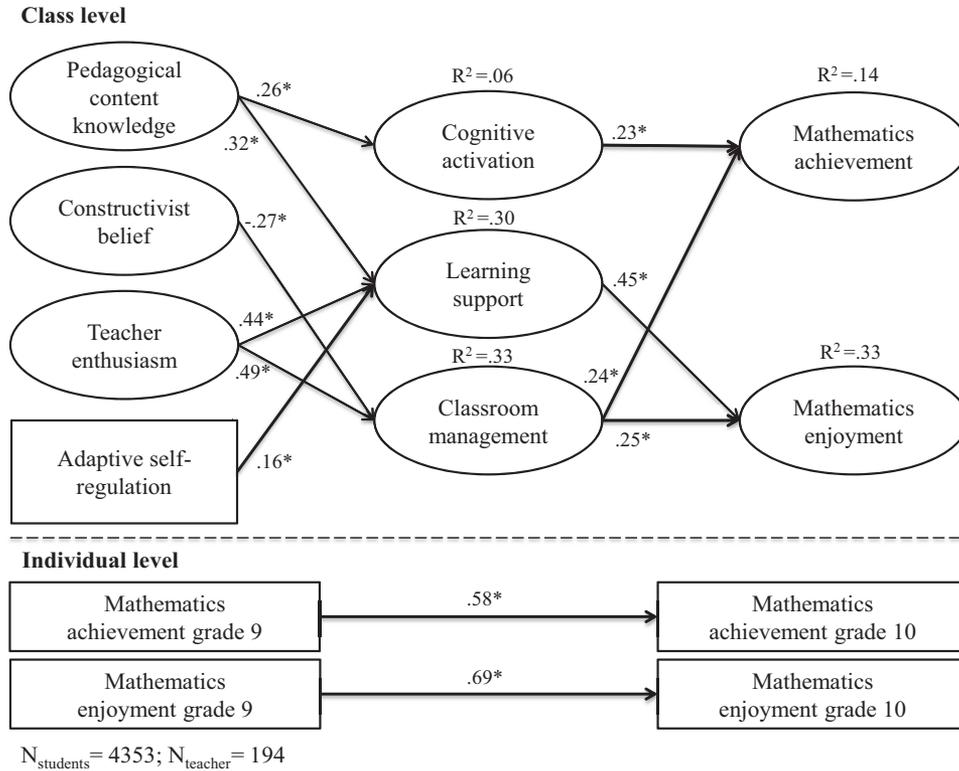
Figure 1. Full mediation model of teachers' professional competence predicting instructional quality and student outcomes. Variables depicted as ellipses indicate that they are based on multiple indicators; variables depicted as boxes indicate that they are based on single indicators. $^*p < .05$.

predicts student outcomes. High levels of cognitive activation and efficient classroom management predicted greater achievement gains, and high levels of learning support and efficient classroom management predicted gains in students' enjoyment of mathematics. In Grade 10, 14% of the variance in mathematics achievement and 33% of the variance in enjoyment were explained by instructional practice and (indirectly) by teachers' competence.

Table 4
Predicting Mathematics Achievement and Mathematics Enjoyment at the End of Grade 10 by Instructional Quality and Teachers' Professional Competence (Two-Level Mediation Model)

Class/teacher level	Mediator variables			Dependent variables	
	Cognitive activation	Learning support	Classroom management	Mathematics achievement Grade 10	Mathematics enjoyment Grade 10
Teacher variables					
Pedagogical content knowledge	.26[*][a]	.32*	.16		
Constructivist beliefs	−.02	.00	−.27*		
Teaching enthusiasm	.06	.44*	.49*		
Adaptive self-regulation	−.02	.16*	.01		
Instructional variables					
Cognitive activation				.23*	−.01
Learning support				.10	.45*
Classroom management				.24*	.25*
Student level					
Mathematics achievement Grade 9				.58*	
Mathematics enjoyment Grade 9					.69*
R^2	.06	.30	.33	.14	.33

Note. School track was included as a predictor of the teacher variables and instructional variables.
$^*p < .05$.

What Matters More: Professional Competence or General Academic Ability?

Our results thus far show that all theoretically identified aspects of teachers' competence can have distinct effects on teachers' instructional behavior. However, what remains to be shown is that these profession-specific aspects of competence are of greater relevance than are teacher characteristics that are not specific to the profession, such as general academic ability. As shown by the zero-order correlations in Table 2, teachers' GPA was not systematically linked to teachers' competence or instructional quality or to students' mathematics achievement or enjoyment. The only exception was teachers' PCK, which was significantly correlated with their GPA ($r = .26$). To further investigate whether the teacher effects found in the meditation analyses were really attributable to profession-specific attributes, we ran an additional mediation model in which teachers' GPA was specified as a predictor of instructional quality in place of the competence aspects (M4a). This model did not fit the data very well, $\chi^2_{[147]}, = 1234.90, p < .05$; CFI $= .89$, RMSEA $= .05$, SRMR$_{within} = 0.049$, SRMR$_{between} = .143$, and the regression coefficients for the prediction of instructional quality were small to zero and not statistically significant ($\beta_{cognitive\ activation} = 0.08$, $\beta_{learning\ support} = -.11$, $\beta_{classroom\ management} = .05$). Moreover, the proportion of variance in dimensions of instructional quality explained by GPA was minimal ($R^2_{cognitive\ activation} = .01$, $R^2_{learning\ support} = .01$, $R^2_{classroom\ management} = .00$). To further substantiate these findings, we estimated another model in which we combined GPA and the four competence aspects in one model (M4b). Again, the coefficients for GPA were small to zero and not statistically significant ($\beta_{cognitive\ activation} = -0.10$, $\beta_{learning\ support}, = -.05$, $\beta_{classroom\ management} = .06$). The coefficients for the other teacher variables were almost identical to the coefficients in the model without GPA (maximum change in betas $= .01$; overall model fit $\chi^2_{[304]}, = 1471.50, p < .05$, CFI $= .903$, RMSEA $= .030$, SRMR$_{within} = 0.032$, SRMR$_{between} = .098$.

Summary and Discussion

In the discussion about teacher quality, two competing hypotheses are often brought into play. Following the BPH, the most important determinant of teacher success is general cognitive ability, a personal attribute that is situation unspecific and formed long before individuals enter teacher education. Following the KTH, what matters most for teaching success is the profession-specific expertise that is formed and expanded as part of professional training. In our study, we proposed that neither of the two hypotheses describes teachers' essential prerequisites fully, suggesting a model of professional competence that includes professional knowledge, beliefs, motivation, and self-regulation as the determining factors of teachers' success. An important assumption of our model is its domain specificity, favoring *profession-specific* over generic attributes (as suggested in the BPH). While this brings us close to the KTH, we argued that knowledge alone does not sufficiently explain differences in teachers' behavior and success and that aspects such as beliefs, motivation, and self-regulation need to be further taken into account. When testing these assumptions, we were guided by two objectives. First, we took a multi-criterion approach in determining teacher success and investigated teacher effects not only on their students' achievement but also on students' motivation, an aspect that is often overlooked in teacher quality research. Second, we were interested not only in the net effects of teachers but in the mediating variables, that is, the specific teaching behaviors teachers display and that seem to be a reason for different student outcomes.

Effects of Professional Competence on Student Achievement and Motivation and on Instructional Quality

Empirically, our study was based on a comprehensive data set that had already been used to investigate some aspects of teacher quality, namely the link between professional knowledge and instruction and student achievement (Baumert et al., 2010), and between beliefs and instruction (Dubberke et al., 2008), motivation and instruction (Kunter et al., 2008), and self-regulation and instruction (Klusmann et al., 2008). All prior analyses had considered single competence aspects in univariate analyses. What is new in the current study is the test of a comprehensive model of teacher competence that combines all four aspects in one analysis and tests the relative importance of these variables in a joint model. Moreover, while prior work has mainly regarded teacher effects on students' achievement (Baumert et al., 2010), the current study adds student motivation as an additional student outcome (see also Klusmann et al., 2008). Finally, another new aspect is the juxtaposition of teachers' knowledge, beliefs, motivation, and self-regulation and their general, profession unspecific cognitive ability, which to our knowledge has not yet been empirically investigated.

Effects on students. In our first research question, we examined the effects of teachers' knowledge, beliefs, motivation, and self-regulation on students' achievement and motivation. Our findings indicate that students whose teachers had better PCK, endorsed constructivist beliefs, and were enthusiastic about teaching showed higher achievement gains. In addition, students whose teachers were enthusiastic about teaching showed a significant increase in mathematics enjoyment.

Effects on instruction. As suggested in our second research question, this effect was explained by differences in the instruction provided. Teachers who scored highly on PCK provided more cognitively activating instruction and better learning support, with the former showing positive effects on student achievement and the latter on student motivation. This finding confirms earlier research (Baumert et al., 2010; Hill et al., 2007), underscoring the importance of profession-specific knowledge for fostering students' learning processes. Yet as a new insight, our study also showed that teachers' PCK affects not only students' achievement but also their motivation, specifically their enjoyment of the subject, and that this effect operates through better provision of support, as suggested by motivational theories (e.g., Turner et al., 1998).

While these findings thus seem to support the KTH, additional findings from our study show that there is more to successful teaching than a solid knowledge base. Enthusiastic teachers provided better learning support and classroom management, which in turn had positive effects on students' motivation. Although teach-

ers' self-regulatory style did not affect student outcomes directly, there was an indirect effect, linking adaptive self-regulation to better learning support. These findings corroborate earlier univariate findings (Klusmann et al., 2008; Kunter et al., 2008) and previous research from others (e.g., Jennings & Greenberg, 2009; Roth et al., 2007) on the beneficial effects of adaptive motivation and self-regulation on teachers' ability to create constructive and supportive learning environments. These findings also suggest that it may be worthwhile to define teacher success based on multiple outcomes and not only on student achievement.

Constructivist beliefs and instructional quality. Our study also revealed an interesting effect of teachers' constructivist beliefs. While our univariate analysis was able to confirm the positive effect of constructivist beliefs on student achievement, in line with previous studies (e.g., Dubberke et al., 2008; Staub & Stern, 2002), this effect was not found in the present multivariate models. In fact, all other teacher attributes being equal, teachers who endorsed constructivist beliefs showed no advantage in cognitive activation or student support, and even scored lower on classroom management.

From a methodological viewpoint, it needs to be pointed out that constructivist beliefs and PCK were positively correlated. Considering both variables together in one analysis, as done in the multivariate mediation models, may therefore have led to a suppression effect as the unique effect of constructivist beliefs was obviously smaller than the shared effect of both variables. From a theoretical viewpoint, however, the phenomenon that more disturbances occur and less time is spent on tasks in classrooms whose teachers endorse constructivist views remains to be discussed.

One explanation may be that classroom management and constructivism represent mutually exclusive paradigms of instruction (see Brophy, 1999). While in the classroom literature, teachers are typically seen as leaders who monitor and direct students' behavior (e.g., Kounin, 1970), constructivist theories emphasize the active and self-directed role of learners (e.g., Tobias & Duffy, 2009), suggesting a possible role conflict for teachers who might have difficulties combining the two approaches. In fact, studies show that teachers often associate classroom management with aspects such as control and punishment and see this in contrast to a more caring, student-centered approach to teaching, thus feeling the need to choose one approach to the exclusion of the other (Woolfolk Hoy & Weinstein, 2006).

An alternative explanation may be that classroom management is more difficult to endorse in constructivist learning settings. In constructivist classrooms, too, teachers need to structure the learning activities in a way that prevents disturbances and maintains order (Evertson & Harris, 1999). However, given the student-centered methods typically endorsed in constructivist approaches, this may be a more challenging task than in teacher-centered learning settings (Evertson & Harris, 1999). It is beyond the scope of our large-scale study to investigate this issue further; however, we refer to the growing literature on classroom management in learner-centered classrooms. The literature suggests that generally, active student participation and effective classroom management can be successfully combined (Evertson & Harris, 1999; Weinstein, 1999).

No Effects for General Cognitive Ability

In contrast to the BPH, we found that teachers' general cognitive ability was unrelated to teachers' instructional behaviors. These results indicate that simply being a smart student does not make somebody a good teacher—it is the profession-specific aspects of competence that matter. At the same time, however, it needs to be pointed out that because our study was embedded in a large-scale assessment, we were only able to implement a distal measure of teachers' cognitive ability, namely their GPA instead of more proximal measures such as scores in standardized ability tests. As GPA was assessed retrospectively and indicates academic ability at a timepoint much earlier than our study, we cannot rule out the possibility that we underestimated the effect of general cognitive ability using GPA. We still see significance in our results as our findings mirror other null-findings where standardized test scores are used (e.g., Aloe & Becker, 2009) and, practically because in many education systems, it is applicants' GPA on which admission into the teaching career is based (Wang, Coleman, Coley, Phelps, & Educational Testing Service, 2003).

Study Strengths and Limitations

By design, our study complements existing findings on teacher quality in three ways. First, we measured teaching success on a variety of criteria by going beyond the performance criterion of student achievement and additionally examining students' motivation and instructional practice. Second, we combined profession-specific predictors with general academic ability as a profession-unspecific predictor, making it possible to examine the relative contribution of each approach. Third, we used proximal measures to tap teachers' competence (i.e., test and questionnaires). To make these aspects empirically accessible, we specified them for secondary school mathematics teachers and linked them to mathematics-specific aspects of instruction and to mathematics-related student outcomes.

Of course, this approach considerably limits the generalizability of our findings, and studies assessing teachers' professional competence in other domains are required. Even within the domain of mathematics, however, additional studies with teachers from different school systems and different training backgrounds are needed before final interpretations can be made. While several studies have highlighted the role of teachers' professional knowledge and beliefs (e.g., Hill et al., 2005; Staub & Stern, 2002; Woolfolk Hoy et al., 2006), empirical evidence on the role of teachers' motivation and self-regulation in determining the quality of their instruction is still limited. More studies combining different aspects of competence are thus needed to provide further insights into the differential effects found in our study.

Another limitation concerns the proposed advantage of profession-specific aspects of teacher competence over profession-unspecific traits as predictors of instructional and learning outcomes. We considered only GPA as one possible profession-unspecific trait in the present study. Other traits, such as personality factors or cognitive ability as measured by standardized tests, were not considered. Moreover, the teachers in our sample had been teaching on average for 22 years; it is therefore difficult to distinguish between general traits and profession-specific attributes that have developed over the course of the career. An ideal approach to this question would involve prospec-

tive long-term studies in which teacher candidates are tracked prior to their entry into teacher education and then throughout their professional career. Naturally, studies covering such a long time period are rare, and it is unusual for unspecific traits, aspects of professional competence, and objective outcomes to all be featured in a single study.

This leads to a third limitation, namely the unanswered question of competence development. As pointed out in the introduction, a core assumption of the competence literature is that competence develops through active engagement with one's environment (Masten & Coatsworth, 1998). Our study design, with its single measurement of teacher competence, does not allow any inferences to be drawn about the development of teachers' knowledge, beliefs, motivation, and self-regulation over the professional career. Empirical studies show that teacher education has a crucial impact on knowledge development (e.g., Brouwer & Korthagen, 2005). However, findings for beliefs and motivation, which are thought to be more stable, are less clear (e.g., Richardson, 1996). Further, to our knowledge, no empirical studies have yet investigated the development of teachers' self-regulatory styles over the course of their education and career. Thus, before we can claim that professional competence develops over teacher education and professional development, more research is needed on the developmental trajectories of different aspects of teacher competence (Brouwer, 2010; Desimone, 2009).

Finally, as a fourth issue, we consider our study a starting point for further research investigating the interplay between different aspects of professional competence and general ability in more detail. In our study, the core objective was to investigate main effects of the four aspects of competence in a comprehensive model that included instructional quality and student outcomes, but we did not have theoretical assumptions for possible interactions between the teacher variables. Exploratory analyses yielded no evidence for substantial interactions between the factors, and given the high complexity of our statistical models (multi-level SEMs with five predictors on the teacher level, including GPA) we decided to leave this avenue of research unexplored in the current article. We realize, however, that it will be an interesting next step to investigate whether other than additive effects may be observed for the different competence aspects. Ideally, these studies would start from theoretically well-founded hypotheses on expected interactions between teacher variables and would test these in designs far less complex than in our current study.

Theoretical and Practical Implications

We have introduced the competence approach as a way of consolidating different approaches to examining teacher quality. Hence, our findings contribute to the discussion on the recruitment and education of teachers (OECD, 2005).

The competence approach differs from the BPH (Kennedy et al., 2008; Yeh, 2009) in that it predicts profession-specific rather than profession-unspecific personal attributes to determine teachers' behaviors and professional outcomes. Our data thus add to the literature on trait predictors of teacher success and confirm earlier findings that cognitive ability alone does not contribute systematically to success in the teaching profession (Bromme, 2001; Getzels & Jackson, 1963; Zumwalt & Craig, 2005). Thus, selection procedures for entry into teacher education that are based solely on

this indicator may run the risk of rejecting candidates capable of developing the necessary knowledge, beliefs, motivation, and self-regulation (which we found to covary independently of general academic ability). This may pose a particular problem for education systems grappling with teacher shortages.

The competence approach is in line with the KTH (Bromme, 2001; Shulman, 1987) in that it acknowledges that profession-specific knowledge is a core condition for successful teaching. Our results emphasize the importance of high-quality teacher education that fosters the development of sound profession-specific competencies. If a profound knowledge base is an important factor determining teacher success, it follows that the best way to ensure teacher quality is to make sure that candidates learn all they need to know during their teacher education (Anderson et al., 1995; D'Agostino & Powers, 2009; Kennedy et al., 2008). Moreover, teacher quality could be maintained by ensuring that licensed teachers continue to participate in professional development activities throughout their career (Desimone, 2009). This focus on knowledge as the prime factor determining teacher success has led to many discussions about possible reforms of the teacher education curriculum, about the subjects and contents that need to be covered, and about how knowledge can best be tested (Osborn, 2006; Tittle, 2006).

Nevertheless, our study goes beyond the typical qualification argument by showing that teachers' success is also dependent on motivational and self-regulatory aspects, particularly with regard to long-term noncognitive student outcomes and teacher functioning. These outcome criteria have been overlooked in most teacher quality research to date. Only recently, Jennings and Greenberg (2009) presented a comprehensive review suggesting that teachers' socio-emotional and motivational characteristics are important factors in developing supportive teacher–student relationships and effective classroom management and that they thus foster students' learning. This suggestion is supported by our data. Thus, our results indicate that teacher educators would be ill advised to focus exclusively on the transmission of content-specific knowledge. Strategies for coping with work-related demands and to maintain engagement over the career might be important additions to the teacher education curriculum.

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