For unto every one that hath shall be given: teachers' competence profiles regarding the promotion of self-regulated learning moderate the effectiveness of short-term teacher training

Charlotte Dignath¹

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Abstract

Teachers play a major role in the effectiveness of student learning. Teacher's competence contributes to their classroom practice. We applied a generic model of teacher competence to the specific context of teachers' promotion of self-regulated learning (SRL) in the classroom, and investigated teachers' competence profiles regarding SRL (study 1) and how teachers' competence can moderate the effectiveness of teacher training (study 2). In the first step, in study 1 191 teachers were assessed according to different characteristics that have been found to be important aspects of teacher competence (knowledge, beliefs, and self-efficacy). To investigate how these characteristics co-occur in teachers we determined latent profiles of teacher competence regarding SRL. To this end, and the data were subjected to a latent profile analysis that yielded two levels of competence profile: low and high competence to promote SRL. These competence profiles were positively associated with teachers' self-reported SRL practice in the classroom. Next, to test whether these competence profiles affect teachers' competence development, we conducted a training study. In this study 2, we examined the effects of an 8-h long teacher training about SRL on the development of teachers' competence (knowledge, beliefs, self-efficacy) and on their SRL practice in the classroom with a repeated measures control group design. Forty-five teachers participated in the training, and these teachers and their 543 students evaluated the effectiveness of the training. Training effects were found on the teacher level, but not on the student level. Teachers who participated in the training outperformed the control teachers in their development of self-efficacy to foster SRL, and their perceived SRL practice. Moreover, teachers' competence profiles moderated the training effect, showing that teachers with an initially high competence benefitted more from the training. Applying a generic model of teacher competence to the context of promoting SRL seems beneficial to inspire future research on indicators of teachers' SRL practice.

Keywords Self-regulated learning · Metacognition · Teacher · Training

✉ Charlotte Dignath
dignath@dipf.de

¹ Leibniz Institute for Research and Information in Education, Rostocker Straße 6,
60323 Frankfurt am Main, Germany

There is overwhelming evidence that self-regulated learning (SRL) is highly effective for learning (e.g., Hattie, 2013; Zimmerman & Bandura, 1994). In order to develop self-regulated learners, researchers suggest that learners need both explicit instruction in self-regulation strategies as well as the opportunity to practice SRL in a constructivist learning environment (Dignath & Veenman, 2021; Paris & Paris, 2001; Pressley et al., 1992). Yet, research indicates a strong heterogeneity among teachers' effectiveness in promoting SRL in their classrooms: whereas some studies identify strong examples of teachers who engage their learners in SRL (e.g., Butler et al., 2017; Perry, 1998), others find that teachers hardly provided their learners with strategies to self-regulate their learning (e.g., Dignath & Büttner, 2018; Spruce & Bol, 2015). Why do some teachers succeed in developing self-regulated learners and others do not?

Several teacher characteristics have been found to affect their classroom practice: for example, teachers' professional knowledge, their pedagogical beliefs, and their motivational orientation have been found to explain variation in teachers' classroom practice (Kunter et al., 2013a, 2013b). Also for the field of SRL, research has shown that these characteristics are associated with teachers' SRL practice, but most researchers focused either only on cognitive characteristics (e.g., teacher knowledge [e.g., Zohar]) or on motivational-affective characteristics [e.g., teachers' self-efficacy beliefs (e.g., De Smul et al., 2018)]. In order to look at the whole set of characteristics, these cognitive and motivational-affective characteristics have been subsumed under the term "teacher competence" to indicate teachers' prerequisites that predict their classroom practice (Depaepe & König, 2018).

Drawing on research from the field of teachers' competence as well as from the field of SRL, we conducted two studies to generate new ideas about explaining variation in teachers' SRL practice and to understand how this affects teacher development in becoming effective promoters of SRL. To this end, we conducted two studies. In study 1, we examined whether cognitive and motivational-affective teacher characteristics regarding SRL (i.e., teacher competence to promote SRL) co-occur similarly in all teachers (e.g., high levels on all characteristics) or in distinct patterns (e.g., high knowledge, but low self-efficacy). For this purpose, we conducted profile analyses that investigate all cognitive and motivational-affective characteristics simultaneously and determine profiles of teacher competence. Next, we investigated whether these profiles were associated with teachers' SRL practice in the classroom. To understand the impact of such profiles of teacher competence on teachers' learning about SRL, we conducted a training study. In study 2, we investigated the moderating effect of the competence profiles discovered in study 1 on teachers' competence growth as a result of teacher training.

The following section first presents research on SRL and on pedagogical approaches to promote SRL in the classroom. Next, we introduce a generic model of teacher competence that we propose applying to the context of SRL and provide evidence from SRL research for the cognitive and motivational-affective aspects of teacher competence. This model of teacher competence will serve as the basis for (1) investigating teachers' competence profiles examined in study 1, and (2) evaluating the effectiveness of teacher training on teachers' competence growth in study 2. Finally, we present the state of the art of evidence from training studies that have been conducted to support teachers in promoting SRL, on which the development of the teacher training of study 2 is grounded. This training targets cognitive and motivational-affective aspects of teacher competence to promote SRL as well as their SRL practice.

Self-regulated learning: An interaction between cognitive, metacognitive and motivational processes

Self-regulated learning is defined as a learners' "self-generated thoughts, feelings and actions that are planned and cyclically adapted to the attainment of personal goals" (Zimmerman, 2000, p. 14). In the beginning of a learning cycle, self-regulated learners set task-specific goals that serve as a standard against which they evaluate their performance. When learners consider the result as having not met this standard, they respond to this internal feedback by adapting their approach to solve the academic task. The outcome of this self-evaluation influences the next learning phase, often involving a change in the initial strategies or even in the goal itself (Pintrich, 2000).

Within the self-regulation process, three types of strategies can be detected that a learner applies during learning (e.g., Boekaerts, 1999). *Cognitive* strategies, such as elaboration and organization, serve the information processing related to task execution and are the key cognitive processes that self-regulation acts upon in order to attain the goal. Such strategies are specific to the subject and the learning content. The self-oriented feedback loop that characterizes self-regulation processes is executed through monitoring and control processes. Such *metacognitive* processes regulate the learning process by orienting, planning, monitoring and evaluating the learning activity. Research has shown that metacognitive strategies play a major role in sustaining the self-regulation process (Corno, 2008). Metacognition is based on the idea that learners possess a control entity that builds on the ability to introspect and serves to monitor, reflect, evaluate and control. Metacognition involves metacognitive strategies, knowledge and experience. Metacognitive strategies explain how self-regulation occurs, whereas metacognitive knowledge consists of knowledge of strategy, task and person variables (Flavell, 1979). Metacognitive experience affects the learner's self-concept and the causal attributions (Efklides, 2011). Finally, *motivation* strategies, such as rewarding oneself, help to initiate and maintain learning processes. Engaging in monitoring and control requires effort that may involve an additional cognitive load to that of the academic task, and thus presupposes motivation (Efklides, 2011). Thus, motivation and self-regulation exert reciprocal effects: motivation can affect one's self-regulation and one can self-regulate one's motivation.

Cognitive and situative pedagogical approaches to develop self-regulated learners

In order to engage students in SRL, teachers apply pedagogical approaches based on their knowledge and beliefs about learning and teaching as well as on assumptions about the effectiveness of learning environments (Lawson et al., 2019; Zohar & Schwartz, 2005). Research has identified two aspects of the learning environment that enable students to self-regulate their learning, which result from different research traditions about learning: the activation of effective self-regulation strategies, and the provision of meaningful and thoughtful learning opportunities that facilitate cognitive engagement (Paris & Paris, 2001; Perry, 1998).

The activation of self-regulation strategies is based on cognitive approaches to learning. From a cognitive perspective, learning involves the acquisition and use of conceptual and cognitive structures and is understood as a constructivist process of conceptual growth, as well as growth in cognitive activity and in metacognitive processes (Anderson, 1996). Self-regulation strategies can facilitate learning by supporting the composition of knowledge structure (cognitive

strategies), by activating monitoring and control of the learning process (metacognitive strategies), and by helping to regulate motivation, volition and emotion (motivation strategies). SRL research suggests that strategy training is especially effective when the instructors explicitly address declarative, procedural, and conditional metacognitive knowledge underlying an effective strategic learning (Pressley et al., 1992) by clarifying the benefit of using self-regulation strategies and by reflecting with the students about their use of such strategies (Dignath & Büttner, 2008). The cognitive approach is based on the assumption that learners will not be able to handle learning opportunities that offer autonomy and require self-regulation without first being trained in self-regulation strategies (Bolhuis & Voeten, 2001).

Next to strategy instruction, from a situative perspective, learning is the interaction of individuals with other people as well as with physical and technological systems, and is, thus, inextricably bound in context (Resnick et al., 1991). According to this perspective, a learner will only deeply engage in learning when the context is aligned with their needs (Marks et al., 1996). This requires rich learning environments that elicit learners' intrinsic motivation and offer complex and authentic tasks, whereas superficial or low-level tasks, e.g., rote learning or worksheets, will not engage learners in thoughtful and deep learning (Greeno et al., 1996). Perry (1998), (Perry et al., 2002) identifies five characteristics of such rich learning environments that engage students in SRL. (1) First, these teachers offer complex and meaningful activities. They provide their students with opportunities (2) to take control of the level of challenge of a task by deciding, for example, about the pace or the support, and (3) to choose the content, the place or the partner for an assignment. (4) Furthermore, these teachers provide their students with criteria to evaluate their own learning and the learning of their peers. (5) Finally, they give non-threatening and mastery-oriented feedback (Perry, 1998; Perry et al., 2002).

Following the situative approach, teachers design rich learning environments that offer autonomy and complex tasks to students and that indirectly activate SRL in their students. An advantage to this approach is that students develop SRL within the learning context, i.e., strategy knowledge is not acquired as inert knowledge and will be transferable to other learning contexts. However, a purely situative approach to SRL could imply that students are exposed to learning environments that may request more SRL than they can already exert (Bolhuis & Voeten, 2001). Contrary to this, building on the cognitive approach, teachers promote procedures for SRL directly by teaching their students the use of self-regulation strategies. An advantage is that students acquire the necessary skills for handling a learning environment that requires self-regulation. However, teaching students strategies that they cannot apply if they lack learning opportunities to self-regulate their learning may lead to tacit knowledge about SRL. Moreover, many teachers, even if instructing strategies directly, do not provide their students with the conditional knowledge necessary to apply these strategies effectively (Dignath & Büttner, 2018; Zepeda et al., 2019), risking that the strategy instruction leads to inert strategy knowledge. Taking pros and cons for both research traditions together, there is an argument for bridging cognitive and situative approaches of learning in order to support learning most effectively (Vosniadou, 2007).

Teacher competence to facilitate self-regulated learning

We propose to draw on generic models of teacher competence to find causes for variation in teachers' classroom practice, and to detect potential training needs. Whereas *teaching practice* is conceptualized as the teachers' initiation and support of learning processes that

help students to achieve specific learning goals (Baumert & Kunter, 2013), *teaching competence* is considered a multidimensional construct that comprises both cognitive and motivational-affective aspects, which have been found to *predict* teaching practice (Depaepe & König, 2018): teachers' (1) professional knowledge, (2) pedagogical beliefs, and (3) motivational orientations (Kunter et al., 2013a, 2013b). Despite the growing amount of research that studied these cognitive and motivational-affective teacher characteristics simultaneously, studies relating such characteristics of teacher competence in the context of SRL are scarce. In the following, we will present the state of SRL research for each of the three aspects of teacher competence.

Teacher knowledge of promoting self-regulated learning

Teachers' professional knowledge includes subject-specific as well as generic pedagogical knowledge (Shulman, 1987) and is highly relevant for the quality of teaching practice (e.g., Depaepe & König, 2018). Teachers' knowledge of promoting SRL comprises general metacognitive knowledge, meta-strategic knowledge, and relevant pedagogical knowledge of how to engage their students in SRL (Zohar & Barzilai, 2015). Yet, many teachers lack strategic knowledge (Askell-Williams et al., 2012), or do not know the functional value of strategies (Kiewra, 2002), especially meta-cognitive strategies (Dignath & Büttner, 2018), which are most relevant for the SRL cycle (Corno, 2008). Furthermore, teachers often hold misconceptions about SRL strategies and its promotion (Glogger-Frey et al., 2018). For example, some teachers consider SRL mainly relevant for high-achieving students (Zohar & Barzilai, 2015), whereas research indicates that low-achieving students benefit especially from explicit instruction in SRL strategies (Zohar & Ben David, 2008; Zohar & Peled, 2008). Finally, many teachers dispose of limited knowledge of pedagogical concepts of promoting SRL (Zohar & Lostov, 2018) or lack pedagogical knowledge on promoting SRL effectively, despite holding positive beliefs about promoting SRL (Geduld, 2019; Zohar et al., 2001).

Teacher beliefs about promoting self-regulated learning

Teacher beliefs, as subjective claims (Pajares, 1992), have been found to predict teaching practice (Skott, 2015) and determine a teacher's willingness to take on educational innovation (Gregoire, 2003). In terms of promoting SRL, research shows that many teachers hold positive beliefs about situative approaches to activating SRL indirectly (e.g., Lombaerts et al., 2009a, 2009b), but less positive beliefs about cognitive approaches to fostering SRL directly (e.g., Dignath & Van der Werf, 2012; Lawson et al., 2019). Since the concept of SRL is inherently constructivist (Zimmerman, 2000), teachers may assume that acquiring self-regulation skills lies with the student rather than with the teacher (Dignath & Van der Werf, 2012). In this case, acquiring self-regulation skills would be the result of unsystematic experience instead of systematic instruction, and should be an implicit process rather than explicit instruction (Lawson et al., 2019).

Teacher self-efficacy to promote self-regulated learning

Teachers' self-efficacy beliefs comprise a teacher's belief in their capability of dealing with complex tasks, and is considered to be an important factor influencing human agency in general (Bandura, 1997), and teachers' instructional behavior as well as many other related outcomes in particular (Tschannen-Moran et al., 1998). A teacher's self-efficacy beliefs determine how much effort and persistence a teacher invests in reaching a certain goal (Gregoire, 2003) and, in regards to promoting SRL, refer to teachers' beliefs about being able to engage their students in SRL (De Smul et al., 2018). They thus constitute an important motivational factor for teachers' instructional behavior. Research indicates that teachers' self-efficacy to promote SRL is among the strongest predictors for teachers' self-reported SRL practice (Dignath, 2017), and teachers who do not promote SRL often feel incompetent in stimulating it (Vandevelde et al., 2012). Although many teachers hold positive views about SRL, they often feel unable to support self-regulation among their students (e.g., De Smul et al., 2018; Perry et al., 2008). Teachers' knowledge can be detrimental to the development of their self-efficacy: Teachers, who believe they have acquired essential knowledge, are more likely to develop a high sense of self-efficacy (Morris et al., 2017).

Interplay between these aspects of teacher competence and with teaching practice and student outcomes

These results suggest that the different aspects of teachers' competence—knowledge, beliefs, self-efficacy—interact. Research on generic teacher competence investigates how they are organized within each individual teacher, whether high levels of one aspect can compensate for low levels of another aspect, and whether teachers differ qualitatively in the patterns of their competence (Holzberger et al., 2021). With regard to SRL research, most studies adopt a rather variable-centered approach by examining specific aspects of teacher competence separately. Some studies, however, investigated the interplay between different competence aspects, suggesting that teachers' knowledge and their beliefs about promoting SRL are not necessarily aligned (Dignath, 2017; Spruce & Bol, 2015), whereas teachers' knowledge and their self-efficacy to promote SRL seem to be correlated (Dignath, 2017; Karlen et al., 2020).

As to associations between individual aspects of teacher competence and teachers' SRL practice, the evidence is inconsistent. Some studies reveal correlations between teachers' beliefs about SRL and their self-reported (Lombaerts et al., 2009a, 2009b; Thomas et al., 2020) and observed SRL practice (Depaepe et al., 2010; Lombaerts et al., 2009a, 2009b), but others did not (Dignath & Büttner, 2018; Pauli et al., 2003). Consistently, researchers find that teachers' self-efficacy to implement SRL predicts their self-reported SRL practice (De Smul et al., 2018; Dignath, 2017; Karlen et al., 2020). Surprisingly, this is not found for teachers' knowledge about the promotion of SRL (e.g., Dignath & Van der Werf, 2012; Karlen et al., 2020).

Next to effects of teacher competence on teachers' classroom practice, one can also expect effects on student outcomes. Research showed that the effects of teacher competence on student outcomes are mediated by teachers' classroom practice (Fauth et al., 2019). Whereas some studies in the field of SRL have examined effects of teacher competence regarding SRL on teachers' SRL practice, few studies have investigated associations between teachers' attempts to promote SRL and their students' self-regulation

or achievement (see Dignath & Veenman, 2021). Dignath et al. (2013), Kistner et al. (2010), and Zepeda et al. (2019) find teachers' observed direct promotion of SRL to be associated with students' self-reported SRL and their achievement. Yet, these studies did not assess teachers' competence to promote SRL, but establish associations directly between teachers' SRL practice and student outcomes.

Beside the question about consequences of teacher competences for instructional quality and student outcomes, researchers have been investigating what determines teacher competence (see Kunter et al., 2013a, 2013b). For the field of SRL, researchers have examined how teacher training affects teachers' competence growth regarding the promotion of SRL. In the following, we will provide an overview of findings from research on teacher training in the context of SRL, and we will derive implications to consider for the development of a teacher intervention.

Professional development to support teachers in promoting self-regulated learning

Reviewing the literature on interventions to support teachers' promotion of SRL reveals two different lines of PD programs that aim to enhance SRL practice. First, PD programs that mainly address situated approaches for SRL are based on collaborative learning in teacher communities and applied situated approaches also as a means to fostering teachers' own self-regulation. Second, PD programs that mainly address cognitive approaches for SRL are based on direct instruction to provide teachers with knowledge about the self-regulation process and with pre-structured lesson plans or exercises to support strategy instruction in the classroom. These teacher interventions differ in many characteristics, such as the length of the intervention, the participant sample, the support transfer, as well as the pedagogical approach to SRL promoted in the PD course.

The teacher interventions about situative approaches to promote SRL in the classroom were built on situative principles of teacher learning. For example, building a "community of practice" (Perry & VandeKamp, 2000) initiated cooperation among participating teachers (e.g., Butler et al., 2013; Lau, 2013) and/or with researchers (e.g., Cartier et al., 2010). These interventions aimed at engaging teachers in SRL in order to support their transfer of SRL to their own classrooms (e.g., Finsterwald et al., 2013). Most of these interventions were long-term PD programs for teachers to learn about SRL (e.g., Butler et al., 2013 and Lau, 2013: one academic year; Finsterwald et al., 2013: 3 semesters; Perry & VandeKamp, 2000: 3 years) and were evaluated using in-depth methods, such as teacher or student interviews and classroom observations, and conducted with small teacher samples (e.g., Barr & Askell-Williams, 2020: N=4; Butler et al., 2013: N=18; Cartier et al., 2010: N=6; Perry & VandeKamp, 2000: N=5). Positive training effects were found either in terms of the development of teachers' SRL practice (e.g., Perry & VandeKamp, 2000) or knowledge gain (e.g., Finsterwald et al., 2013), or on the student level (e.g., Butler et al., 2013).

In contrast, the intervention studies that focus mainly on cognitive approaches for SRL practice provide teachers with highly structured examples of strategy, or checklists and lesson plans to implement strategy instruction in their classrooms. The intervention studies reviewed in this paper yielded inconsistent results. For interventions evaluated on the student level, teachers' participation in the PD training did not affect students'

SRL or their achievement. Students' SRL only improved when they participated in the intervention themselves. Wagner et al. (2014) compare the effectiveness of interventions for teachers only, for students only and combined interventions for both groups. The teachers learned about teaching SRL strategies in the context of foreign language learning in a kick-off workshop and three following online modules that provided them with knowledge and classroom materials about the promotion of SRL. The results indicate that only students who personally participated in an intervention improved; if only the teacher participated, those students did not improve. Likewise, Perels and Otto (2009) conducted an intervention for primary school teachers and students who learned about SRL in the context of mathematics teaching. Students' SRL did not improve as a function of their teachers' participation in the PD training. Only those students who received an SRL intervention themselves increased in SRL and mathematical competence (Perels & Otto, 2009).

More promising results were found for interventions that were evaluated on the teacher level. Perels et al. (2009) find positive intervention effects on the development of kindergarten teachers' knowledge of the promotion of SRL as well as their own self-reported self-regulation. However, no significant effects were found for teachers' self-reported use of methods to promote SRL among their students. Nevertheless, in a test scenario, the students in the group, where the teacher received the intervention, showed a greater increase in suggestions for self-regulatory activities than the students whose teacher was in the control group (Perels et al., 2009). Werth et al. (2012) evaluate the effectiveness of a short-term PD training on promoting SRL in 5th grade mathematics instruction. After the intervention, the teachers of the intervention group rated their SRL practice higher than the control teachers. However, student ratings of their teachers' SRL practice did not reflect this (Werth et al., 2012). Kramarski and Revach (2009) investigate the effects of a PD course for primary school teachers aimed at fostering teachers' understanding of mathematics teaching and practicing pedagogical means. The intervention group teachers also learned to support student SRL during mathematics classes based on the *IMPROVE* method, which integrates metacognitive activities, peer interaction and systematic provision of feedback-corrective-enrichment. Classroom observations as well as analyses of lesson plans demonstrate that the intervention group implemented more SRL support than the control group (Kramarski & Revach, 2009).

Finally, two studies investigate whether aspects of the teachers' prior competence to promote SRL moderated the intervention effect. Steinbach and Stoeger (2016) examine the extent to which teachers' prior beliefs affect their implementation of SRL practice after having followed a two-day PD course on SRL. Teachers' self-reported implementation of the training materials indicate substantial variation of time spent on the promotion of SRL. The use of optional training materials varied as a function of teachers' prior beliefs about SRL (Steinbach & Stoeger, 2016). Regarding the moderating effects of teachers' prior knowledge of SRL, Venitz and Perels (2019) conduct a short PD intervention for kindergarten teachers aiming at sensitizing them to the importance of SRL and providing them with pedagogical methods to support their students' SRL development. As the results show, only teachers with limited prior knowledge improved in their self-reported SRL practice. No effects were evident for teachers with moderate or high prior knowledge.

To sum up, compared to the PD programs about situative approaches to foster SRL, the PD programs that focus on cognitive approaches provide teachers with highly structured

examples or, in some cases, even checklists and lesson plans to implement strategy instruction in the classroom. The intervention studies on cognitive approaches reveal positive effects at the teacher level; effects were only positive at the student level when the students received training themselves (Perels & Otto, 2009; Wagner et al., 2014). Researchers find effects on the development of teachers' knowledge of SRL (Perels et al., 2009) as well as on their SRL practice. Whereas some studies demonstrate training effects only for teachers' self-reported SRL practice, but not students' ratings (Werth et al., 2012), others find great effects for SRL practice observed among teachers (Kramarski & Revach, 2009). Few studies consider aspects of teachers' ability to promote SRL, instead targeting their SRL practice in the classroom. However, considering prior competence seems beneficial to investigating differential intervention effects (see Steinbach & Stoeger, 2016; Venitz & Perels, 2019), although results were inconsistent. Hence, accounting for different agents as well as measures from different perspectives when evaluating such training seems highly relevant for the intervention results.

Considerations for teacher interventions on the promotion of SRL

Directly comparing both types of interventions is difficult due to the different methodological designs—PD training about cognitive approaches applied quasi-experimental designs with larger samples and short training duration, whereas PD training about situative approaches used in-depth design with small samples and teacher case studies. The inconsistency of the findings necessitates further research to understand how an intervention that effectively promotes SRL among teachers should look. Four aspects have to be considered: (1) the content of such an intervention, (2) the didactical methods for teacher learning, (3) the length of the intervention, and (4) the outcome variables targeted by the teacher intervention.

First, drawing on research about the effectiveness of pedagogical approaches to engage learners in SRL (e.g., Dignath & Veenman, 2021), intervention studies are needed that combine situated learning and cognitive instruction (see Vosniadou, 2001) as methods of teachers' PD program. As described earlier, learners need to acquire the necessary skills to self-regulate their learning and opportunities to engage in SRL. Second, one-step workshops that apply a top-down approach to disseminating knowledge and skills that teachers are expected to translate into action have often been criticized as insufficient for inducing conceptual and long-term change in teaching practice (Butler et al., 2004). Thus, teacher interventions should include similar didactical methods to transmit knowledge and develop teaching skills. Third, several meta-analyses and review studies on the effectiveness of teacher interventions on classroom practice demonstrate that neither the length nor intensity of the intervention moderate its effect (Basma & Savage, 2018; Garrett et al., 2019; Lipowsky & Rzejak, 2015; Timperley et al., 2007). Even short workshops of a few hours produce effects (e.g., Bernacki et al., 2020). Many teachers also prefer short-term training, since it is economical and easy to incorporate into their regular teaching practice. Thus, it seems meaningful to investigate the effects that short-term workshops can have on teachers' SRL practice in order to introduce them to SRL. Furthermore, the evaluation of the PD program should be expanded to include the development of teachers' competence—their knowledge, beliefs, and self-efficacy—instead of immediately and only targeting teachers' SRL practice (see e.g., Kollmayer et al., 2020). Finally, the findings presented here suggest evaluating an intervention on the teacher and student level, and to take into account different perspectives when examining teachers' SRL practice.

Objectives and research questions of the current studies

Generic teacher research shows that multiple aspects of teacher competence explain classroom practice (Baumert & Kunter, 2013), and that interventions can help teachers to develop these competencies (e.g., Gregoire, 2003). Besides, teachers' competencies affect their learning (Fives & Buehl, 2012) and their uptake of learning opportunities (Kunter et al., 2013). However, SRL research often investigates these aspects of teacher competence separately by associating their SRL practice with their pedagogical beliefs (e.g., Kistner et al., 2015), their self-efficacy (De Smul et al., 2018), or their knowledge of promoting SRL (Spruce & Bol, 2015), but not all three simultaneously. Drawing on evidence from teaching effectiveness research, which demonstrates the impact of teacher competence on their classroom practice (Kunter et al., 2013a, 2013b), the investigation of how these aspects of teacher competence can affect teachers' SRL practice seems highly relevant for drawing conclusions about teachers' professional development.

By bridging research on both SRL and generic teacher competence, this article investigates (1) which patterns of competencies predict how teachers and students perceive teachers' promotion of SRL in the classroom, and (2) which role these competence patterns play for teachers' uptake of learning opportunities. To this end, we conduct two studies to identify patterns of teacher competence that predict teachers' SRL practice, how teacher training can impact teacher competence as well as how patterns of teacher competence can moderate the effectiveness of teacher training. As the research questions were tested in two studies, two sets of data were collected, and analyses are based on two different sub-samples of teachers and students. First, patterns (i.e., latent profiles) of teacher competence to promote SRL were empirically derived within a larger teacher sample (study 1). Second, we investigated the effects of a teacher training for a subsample of these teachers, where we tested whether their SRL competence patterns moderate the effects of this training (study 2).

We adopted a new approach for the field of SRL by (a) synchronously examining cognitive and motivational-affective aspects of teacher competence, (b) exploring patterns of teacher competence in terms of promoting SRL, (c) examining their predictive value not only for teachers' SRL practice but also for student outcomes, and (d) testing these patterns' moderating effect for teacher learning. Based on the literature, we formulated the following research questions and hypotheses.

Teachers' SRL competence profiles and associations with their promotion of SRL

Study 1 (1) investigates profiles of teacher competence to promote SRL, and (2) tests the predictive value of these competence profiles for teachers' SRL practice, and, eventually, (3) for their students' SRL.

Research question 1: Which profiles of teacher competence do we find in terms of promoting SRL, and do they differ with teachers' experience, age or gender?

First, we investigated patterns of the multiple aspects of teacher competence to promote SRL by considering multiple aspects of competence simultaneously. As we statistically determined latent *profiles* of the configuration of teachers' SRL knowledge, their beliefs about SRL, and their self-efficacy regarding the promotion of SRL, we will call these patterns *profile* in the following. In line with the distinction between (a) situative and

(b) cognitive approaches to promoting SRL and (c) a combination of both, we expected that teachers' competence in promoting SRL would follow three qualitatively different profiles. Next, we characterized the profiles. Based on the literature, we did not expect teachers' SRL competence profiles to vary systematically according to general teacher characteristics, such as age, gender or experience, since earlier studies do not find that they affect teachers' promotion of SRL (Dignath & Büttner, 2018; Lombaerts et al., 2009a, 2009b; Vandeveldel et al., 2012).

- Hypothesis 1.1 We will identify three patterns of teacher competence in terms of SRL using latent profile analysis: teachers who support situative approaches for SRL ("situative profile"), teachers who support cognitive approaches for SRL ("cognitive profile"), and teachers who support both the situative and cognitive approach ("mixed profile").
- Hypothesis 1.2 Teachers with different profiles will not differ in terms of teaching experience, age or gender.

Research question 2: Are the identified profiles associated with teachers' promotion of SRL, and with the students' self-reported SRL?

Next, we investigated whether the identified patterns of teacher competence were related to teachers' SRL practice in the classroom. To this end, we examined associations of the identified profiles with teachers' self-reported SRL practice as well as with the students' ratings of their teachers' SRL practice. Based on the evidence described earlier, we expected that teachers' knowledge, beliefs and self-efficacy will be reflected in their SRL practice. Thus, for both outcome variables, we assumed that teachers with a "situative profile" would report to/would be rated to apply more situative approaches in their SRL practice, teachers with a "cognitive profile" would report to/would be rated to apply more cognitive approaches in their SRL practice, and teachers with a "mixed profile" would report to/would be rated to apply both approaches in their SRL practice (based on teacher and student reports). We did not formulate specific hypotheses in case the profile analyses did not yield the expected qualitative differences between the profiles (e.g., if teachers differed in the levels of quantity only). We were interested in whether competence profiles would be reflected in teachers' SRL practice as well as in their students' SRL. As the literature suggests that students need learning environments that allow them to self-regulate their learning as well as strategies to handle these learning environments effectively (e.g., Dignath & Veenman, 2021; Paris & Paris, 2001), we assumed that how teachers promote SRL would affect their students' SRL.

- Hypothesis 2.1 Teachers of the identified profiles will differ in their self-reported promotion of SRL.
- Hypothesis 2.2 Teachers of the identified profiles will differ in their student-reported promotion of SRL.
- Hypothesis 2.3 Teachers of the identified profiles will differ with regard to their students' self-reported SRL.

Effectiveness of the teacher training for teachers with different SRL competence profiles

The objectives of study 2 were to investigate the effects of a teacher intervention on the promotion of SRL (1) on the development of teachers' competence to promote SRL and (2) on students' perceived SRL, as well as (3) to test for a moderating effect of teachers' competence profiles on the training effect. Based on the results of study 1, we derived hypotheses about how teachers' competence profiles may moderate the effectiveness of a short-term PD program for teachers on the development of teachers' competence, and eventually, on the development of students' perceived SRL.

Research question 1: Is the training effective for developing teachers' competence to promote SRL, their SRL practice, and their students' SRL?

First, we aimed to evaluate the general effectiveness of the teacher training. In line with research about teacher competence, we assumed that the PD training would affect the development of knowledge, beliefs and self-efficacy (Cochran-Smith, 2005; Fives & Buehl, 2016) regarding SRL promotion, and, eventually, teachers' SRL practice (Garrett et al., 2019). In the next step, we expected teachers' promotion of SRL in the classroom to improve students' SRL (Dignath & Veenman, 2021). Consequently, the effectiveness of the training was operationalized in terms of a positive development of the targeted teacher variables (teacher competence, classroom behavior) as well as the targeted student outcome (SRL).

Hypotheses 1 Teachers in the training group will outperform teachers in the control group with regard to their:

- (1) beliefs, (2) knowledge and (3) self-efficacy beliefs about the promotion of SRL.
- SRL practice based on teacher reports.
- SRL practice based on student reports.
- students' perceived SRL.

Research question 2: Do teachers' competence profiles moderate the effectiveness of the training?

Finally, based on theories on teacher beliefs (e.g., Fives & Buehl, 2012) and conceptual change of teachers (e.g., Gregoire, 2003), we expect teachers' initial beliefs and their prior knowledge and self-efficacy to moderate the effect of the PD training. This should be reflected in teachers' SRL practice and, eventually, in their students' self-regulation.

Hypotheses 2.1 The teacher competence profile will moderate the training effects on the teachers' competence growth.

Hypotheses 2.2 The teachers' prior competence profile will moderate the training effects on the teachers' promotion of SRL.

Study 1: Teachers' SRL competence profiles and associations with teachers' promotion of SRL

Method

In study 1, we empirically identified patterns of teacher competence regarding the promotion of SRL. Teachers' competence was assessed as teachers' knowledge, beliefs and self-efficacy about promoting SRL in the classroom, all measured by means of a teacher report. Based on previous research on teachers' promotion of SRL, we assumed qualitatively distinct patterns in teachers' preferences for situative, cognitive or mixed approaches to promote SRL. To this end, latent profile analyses were conducted to categorize participating teachers into sub-groups based on the patterns of associations among variables that are indicators for teacher competence. Latent profile analyses were applied since they outperform more widely used cluster analyses by providing goodness-of-fit indices for the fit of several models that can be compared in terms of their number of clusters (Hickendorff et al., 2018). Second, we examined whether the identified profiles of teachers' SRL competence differ in terms of teaching experience, age or gender, and whether these profiles can predict teachers' self-reported promotion of SRL, their students' perceived promotion of SRL, and students' perceived SRL.

Sample

One hundred and ninety one teachers from primary schools located in two different states in southwestern Germany participated in the first round of data collection. Teachers were contacted by phone and email via their school principals and were provided with a link to an online survey (88.48% female; age range: 22–63 years, $M=40.05$, $SD=11.92$). The teaching experience in the group ranged from 1 to 43 years ($M=14.57$, $SD=11.93$). At the moment of data collection, all participating teachers were teaching third or fourth grade and, for comparability, were asked to refer all questions from the survey to teaching the last two grades of primary school.¹ We decided to investigate teachers' SRL practice in third and fourth grade, as we assume that teachers may be reluctant to promote SRL among very young students in the first two school grades, who are still learning the basic skills, such as reading, writing and arithmetic. Previous research suggested that some teachers are concerned that early primary school students are too young for SRL (Dignath & Van der Werf, 2012; Vandeveldel et al., 2012). For a subsample of 38 teachers who also participated in the following training study (see study 2), we could collect additional data from their 232 students (average age: 9.05 ($SD=0.67$); 52.02% female) about their perception of their teachers' SRL practice.

Instruments

Altogether, the online survey to assess different aspects of teachers' competence in promoting SRL (knowledge, beliefs, self-efficacy) as well as teachers' self-reported SRL practice consisted of 59 items from five scales that are detailed below. Since the questionnaires applied different Likert scales, all values were z-transformed before being entered in the latent profile analyses to allow the variables to be compared.

¹ In Germany, primary school consists of four grades. Students enter primary school at the age of 6 or 7, and are promoted to secondary school 4 years later. Thus, the students participating in this study were attending their last 2 years of primary school.

Teachers' knowledge of the promotion of SRL

We used the knowledge scale of promoting SRL developed by Dignath and Van der Werf (2012), which is theoretically based on the recommendations for good strategy instruction by Pressley et al. (1992). This scale consists of seven items that measure teachers' agreement with statements about effective strategy instruction (example item: "When instructing strategies, it is important to explain explicitly how to use a strategy and to model strategy use."). Teachers rate the importance of each statement on a five-point Likert scale (0 = *not important*; 4 = *very important*). The scale showed a good internal consistency in our sample ($\alpha = 0.83$).

Teacher beliefs about SRL

We used the *Self-Regulated Learning Teacher Belief Scale (SRLTB)* by Lombaerts et al., (2009a, 2009b) to assess teacher beliefs about cognitive approaches to fostering SRL and the *Beliefs about Primary Education Scale (BPES)* by Hermans et al. (2008) to assess teachers' beliefs about situative approaches. The original *SRLTB* consists of ten items (Lombaerts et al., 2009a, 2009b), to which Dignath and Van der Werf (2012) added two more items that measure teachers' beliefs about direct strategy instruction and Dignath (2017) then translated into German (example item: "The instruction of learning strategies leads to students being better in evaluating their learning."). The *BPES* to measure teachers' beliefs about situative approaches for SRL consists of ten items to assess teachers' constructivist beliefs about learning (example item: "I find it important to have time for students to work together (in groups)."). In both scales, items had to be answered on a five-point Likert scale (0 = *strongly disagree*, 1 = *disagree*, 2 = *partly agree*, 3 = *agree*, 4 = *strongly agree*). The internal consistency for the German translation of both scales found in our sample was satisfying: Cronbach's $\alpha = 0.77$ (beliefs about situated approaches for SRL) and $\alpha = 0.74$ (beliefs about cognitive approaches for SRL).

Teacher self-efficacy about promoting SRL

To assess teachers' self-efficacy about implementing SRL practice, we used a scale by Dignath (2017), which is an adaptation of the *Teacher-Self-Efficacy Scale* by Schmitz and Schwarzer (2000), which assesses general teacher efficacy, to the context of SRL (Dignath, 2017). The original *Teacher-Self-Efficacy Scale* consists of ten items to assess teachers' self-efficacy expectations regarding job accomplishment, skill development on the job, social interaction with others, and coping with job stress (Schmitz & Schwarzer, 2000). Whereas the original scale refers to general teaching, Dignath (2017) adapted these items to an SRL context (example: original item Schmitz and Schwarzer (2000): "I am convinced that I am able to successfully teach all relevant subject content to even the most difficult students."; adapted item Dignath (2017): "I am convinced that I am able to successfully teach how to learn to even the most difficult students."). Participants were asked to rate their agreement with the ten statements on a four-point Likert scale (0 = *strongly*

disagree, 3 = *strongly agree*). For our sample, the scale's internal consistency was acceptable ($\alpha=0.77$).

Teachers' self-reported promotion of SRL

The *Self-Regulated Learning Inventory for Teachers (SRLIT)* (Lombaerts et al., 2007) was used to assess teachers' self-reported promotion of SRL in their classroom. The SRLIT is developed to measure teachers' views on their realization of SRL practices and comprises 23 items, which Dignath and Van der Werf (2012) extended by five items that measure teachers' beliefs about direct strategy instruction (example item: "I teach my students how to plan their learning."). We applied the German translation of this extended scale by Dignath (2017). Factor analysis using principal component analysis with Varimax (orthogonal) rotation of these items showed that the set of variables were adequately related for factor analysis, Bartlett's Test of Sphericity, $X^2(190)=1836.44$, $p<0.001$; $KMO=0.89$ (please refer to the appendix for a more detailed presentation of the results of the factor analysis). The two yielded factors explained a total of 48.21% of the variance. This first factor (cognitive approaches for SRL) explained 35.19% of the variance (example item: "When we review tasks in class, pupils have to say how they tackled a learning problem."); the second factor (situative approaches for SRL) 13.01% (example item: "My students can decide themselves how much time they spend on an assignment."). In order to distinguish between cognitive and situative approaches for SRL, we computed subscales across the items within each of the two factors. All statements had to be rated on a six-point Likert scale (0 = *never* to 5 = *always*). Internal consistency for the two subscales was good (cognitive approaches for SRL: $\alpha=0.84$; situative approaches for SRL: Cronbach's $\alpha=0.86$).

Students' self-regulation

In addition to the teacher questionnaires we also administered a student questionnaire to measure students' self-reported use of SRL strategies as well as their perceived promotion of SRL by their teacher (Otto, 2007). Students rated all statements on a four-point Likert scale (1 = *I do not agree*, 4 = *I totally agree*).

The *SRL student questionnaire* (Otto, 2007) assesses students' self-regulation, the theory of which is based on Zimmerman's cyclical model of SRL. This scale consists of three subscales in line with Zimmerman's three phases of the SRL cycle (Zimmerman, 2000). We included 20 items focusing on students' strategy use in the forethought phase (e.g., "If I have to do a lot of homework, I create a time plan for myself."). Thirteen items were taken from the scale measuring self-regulation in the phase of performance or volitional control in order to assess students' strategy use during learning (e.g., "I do my homework in a quiet place where nothing can disturb me."). Five items from the self-reflection and evaluation phase were included to measure strategy use after learning (e.g., "After doing my homework, I think of how I could have done better."). Students were asked to answer all questions with regard to doing their homework or working on an assignment independently. We computed an overall scale for students' strategy use that reached a good internal consistency ($\alpha=.87$).

Students' perspective of teachers' promotion of SRL

To measure students' rating of their teachers' SRL practice, we used the *SRL student questionnaire* by Otto (2007), which includes a subscale that measures students' evaluation of their teachers SRL promotion. Ten statements refer to teachers' situative approaches to activating SRL (example item: "Our teacher tells us in the beginning which assignments we should have accomplished by the end of the week."), and eight statements focus on teachers' cognitive approaches to fostering SRL (example item: "Our teacher shows us how we can improve our learning."). Both subscales produced satisfying internal consistency (teachers' situative approaches for SRL: $\alpha=0.78$; teachers' cognitive approaches for SRL: $\alpha=0.83$).

Statistical analyses

We conducted a latent profile analysis to examine which patterns of teacher competencies could be found among primary school teachers in terms of promoting self-regulated learning (Research Question 1.1). Latent profile analysis is a quantitative method to trace back heterogeneity among participants, based on a number of observed variables. Participants with similar characteristics are classified into distinct latent profiles. The profiles are formed by identifying as much similarity within a profile, and the greatest possible differences between the profiles (Lanza & Cooper, 2016). These profiles may either represent qualitatively distinct classes, or classes that express the same underlying quantitative continuum, such as low, medium and high proficiency (Bouwmeester et al., 2004).

A series of models with an increasing number of profiles was fitted to determine the a priori unknown number of latent profiles. Models were estimated using maximum likelihood estimation (Collins & Lanza, 2010). These models were then evaluated according to a combination of statistical fit measures, economy and interpretability of the model given theory (see Hickendorff et al., 2018). First, the Bayesian Information Criterion (BIC) was applied to determine which profile solution best fits the data (Nylund et al., 2007). If including more latent profiles does not improve the model fit, the more economical model with fewer profiles was selected (Tekle et al., 2016). Second, to interpret the selected model, we tested the variables in which the profiles differed. Profiles can differ in levels (overall high, medium or low across indicators), or in shape (pattern of high, medium or low scores varying across indicators) (Marsh et al., 2009). Moreover, we drew on the theory on teacher competence regarding the promotion of SRL in order to label the profiles.

After identifying the final profile solution, we investigated whether the teacher competence profiles differed in age, gender and teaching experience. To this end, each participating teacher was assigned to the profile for which their probability was highest based on their posterior profile membership probabilities, and chi-squared tests were computed to test for differences.

Finally, we investigated whether the teachers' profile membership predicted their SRL practice and, eventually, their students' SRL (Research Question 2). Here, we calculated three regression models: profile membership predicts (a) teachers' self-reported SRL promotion; (b) teachers' promotion of SRL as reported by their students; (c) students' self-reported SRL. Stata Version 15 was used for all analyses reported here (StataCorp, 2017).

Results

Research question 1: Which profiles of teacher competence do we find in terms of promoting SRL, and do they differ with teachers' experience, age or gender?

Latent profile analysis was performed using the means of the four variables that represent aspects of teacher competence to promote SRL. Table 1 displays correlations across teachers' knowledge of promoting SRL, their cognitive and their situative beliefs, and their self-efficacy beliefs about promoting SRL.

Four models were specified, starting with a one-profile model and adding a supplementary latent profile to each new model. Table 2 shows the statistical fit indices for the four latent profile models. Since adding a third latent class did not reduce the BIC substantially, a two-class model seemed statistically most appropriate. As content-oriented criteria should also be taken into account for the identification of the number of latent classes (Lubke & Muthén, 2005), the mean patterns of the different models were examined. The z scores supported the two-class model (see Fig. 1).

Hypothesis 1.1 Contrary to our assumption, the latent profile analysis suggests two teacher profiles. Profile 1 (51% of participants) was characterized by—relative to the mean of the total sample—low scores on both the beliefs about situative and cognitive approaches to activate SRL, as well as on self-efficacy, and knowledge about fostering SRL. Profile 2 (48% of participants) was characterized by high scores on all four variables (see Fig. 1). Contrary to our hypothesis, the profiles suggest that teachers did not differ qualitatively in patterns representing preferences for situative or cognitive approaches to foster SRL, but rather quantitatively in competence levels (low vs. high).

Hypothesis 1.2 We then conducted chi-squared tests to investigate whether there were any differences in teachers' background variables between the two profile groups. In line with our hypothesis, the profiles did not differ for teachers' gender, $\chi^2(1, N=191)=0.006, p=0.94$, age, $\chi^2(1, N=191)=3.85, p=0.43$, or teaching experience, $\chi^2(1, N=191)=53.33, p=0.19$. However, further regression analyses revealed that teachers differed significantly on almost all indicator variables between the two profiles, with teachers in profile 2 outperforming teachers in profile 1 on knowledge of promoting SRL, beliefs and self-efficacy. Only for teachers' self-reported situated approaches for SRL no significant difference was found (see Table 3).

Table 1 Pearson correlations across variables

Variable	N	1	2	3	4	5	6
1. Belief: situated approaches for SRL practice	189	1					
2. Belief: cognitive approaches for SRL practice	188	.63**	1				
3. Knowledge about SRL practice	185	.22**	.50**	1			
4. Self-efficacy about SRL practice	189	.43**	.45**	.25**	1		
5. Cognitive approaches for SRL practice	189	.44**	.45**	.21**	.54**	1	
6. Situated approaches for SRL practice	189	.48**	.34**	.10	.48**	.74**	1

¹ $p < .10$

* $p < .05$

** $p < .01$

Table 2 Goodness-of-fit Indices for four model solutions of teachers' SRL competence profiles

Model	<i>n</i>	<i>df</i>	AIC	BIC
One class	191	8	987.25	1013.27
Two classes	191	13	854.95	897.23
Three classes	191	18	823.99	882.53
Four classes	191	23	821.38	896.19

Research question 2: Are the identified profiles associated with teachers' promotion of SRL and with the students' self-reported SRL?

Next, we analyzed whether teachers' membership in one of the two competence profiles predict their self-reported and student-reported classroom behavior, and in terms of their students' self-reported use of self-regulation strategies. To this end, we first investigated the association between profiles and teacher-reported SRL practice within the whole teacher sample ($N=191$). Second, we tested the contribution of the teacher profiles to explain students' perception of teachers' promotion of SRL. Finally, we investigated whether teachers' competence profile predicts students' perceived SRL. The latter two analyses were conducted within the subsample that contained teacher and student data ($N=16$ classrooms).

Hypothesis 2.1 First, two regressions with robust standard errors were performed, regressing teachers' profile membership to their self-reported (a) situative and (b) cognitive approaches to fostering SRL in the classroom. The competence profile was included in the regression as a dummy-coded variable, with the low competence profile as the reference category. Teachers' competence profile significantly predicted their self-reported SRL practice in both regressions. Teachers with a high competence profile significantly outperformed teachers with a low competence profile in their direct strategy instruction (cognitive approaches to SRL) $b=0.48$, $t(191)=5.30$, $p<0.001$. A similar result was found with regard to teachers' self-reported situative approaches, $b=0.36$, $t(191)=3.90$, $p<0.001$. Competence profiles also explained a significant proportion of variance in teachers' scores for cognitive approaches to promote SRL, $R^2=0.13$, $F(1, 191)=28.10$, $p<0.001$, as well as for situative approaches, $R^2=0.07$, $F(1, 191)=15.19$, $p<0.001$.

Fig. 1 Profiles of teachers' SRL competence based on z-scores

Table 3 Descriptives by competence profile and χ^2

Indicator variable	SRL competence profile						Difference	
	Low			High				
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	χ^2	<i>p</i>
Gender: male	11			11				
Gender: female	83			86				
Gender: total	94			97			0.006	.94
Age	87	39.36	12.56	96	40.69	11.33	39.85	.43
Teaching experience	92	14.99	13.12	95	14.15	10.71	53.55	.19
Beliefs situated	93	2.42	0.37	96	3.06	.40	93.50***	< .001
Beliefs cognitive	93	2.69	0.29	97	3.34	.25	141.83***	< .001
Self-efficacy	94	1.56	0.31	97	1.95	.38	64.08***	< .001
Knowledge	91	2.98	0.49	96	3.51	.45	55.60***	< .001
Promotion situated	94	2.32	0.63	97	2.77	.67	47.08	.12
Promotion cognitive	94	2.33	0.66	97	2.94	.68	60.68***	< .001

[†] $p < .10$ * $p < .05$ ** $p < .01$

Hypothesis 2.2 Teachers may overestimate their attempts to foster SRL among their students, which could inflate the association between their SRL competence profiles and their classroom behavior if their self-report is the only source of data. Thus, we also investigated how teachers' competence profiles were associated with students' ratings of their teachers' promotion of SRL. According to our hypotheses, different competence profiles should become manifest in teachers' attempts to activate SRL in their classroom, which should be observable for students. The student sample consisted of 230 students from 16 classrooms. Of the teachers in this subsample, 68% were assigned to the low-competence profile, and 31% to the high-competence profile. Two regression analyses with robust standard errors were carried out, regressing teachers' competence profile on students' perception of their teachers' situative and cognitive attempts to foster SRL. Yet, the teachers' competence profile predicted neither their situative approaches, $b = -0.04$, $T(230) = -0.59$, $p = 0.56$, nor their cognitive approaches for promoting SRL as reported by the students, $b = 0.03$, $T(231) = 0.35$, $p = 0.72$.

Hypothesis 2.3 Third, we expected that teachers' SRL competence profiles are also predictive of students' use of self-regulation strategies. Assuming that teachers with different competence profiles showed the expected differences in their SRL practice, we expected an association between teachers' competence profile and students' self-reported SRL. A regression analysis with robust standard errors was conducted, with students' SRL score being regressed on teachers' competence profile (dummy variable), by controlling for student-reported and teacher-reported situative and cognitive attempts of teachers' SRL practice. As Table 4 shows, the results revealed an association between teachers' profile and students' SRL that was only marginally significant, $b = 0.10$, $T(229) = 1.78$, $p = 0.07$. Moreover, teachers' self-reported promotion of SRL did not predict students' SRL significantly, yet students' ratings of teachers' SRL practice did: student reports about teachers' situative approaches for SRL predicted students' SRL negatively, $b = -0.12$, $T(229) = -1.99$,

Table 4 Regression analyses on students' SRL

Variable	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>p</i>	95% <i>CI</i>
High competence profile	0.10 [†]	.06	1.78	.07	[− .01, .21]
Situated approaches for SRL (teacher report)	− 0.11	.09	− 1.27	.20	[− .28, .06]
Cognitive approaches for SRL (teacher report)	− 0.03	.07	− .45	.66	[− .16, .10]
Situated approaches for SRL (student report)	− 0.12*	.06	− 1.99	.048	[− .23, − .0009]
Cognitive approaches for SRL (student report)	0.39**	.06	6.24	<.001	[.27, .51]
<i>R</i> ²	.25				
<i>F</i>	10.25**				

[†]*p* < .10**p* < .05***p* < .01

p = 0.048, whereas student reports about teachers' cognitive approaches for SRL predicted students' SRL positively, *b* = 0.39, *T*(229) = 6.24, *p* < 0.001.

Summary

In part 1 of our study, we identified two different profiles of teachers' SRL competence. Contrary to our assumptions, teacher profiles did not represent qualitatively distinct patterns of teachers' preferences for cognitive vs. situative approaches to foster SRL. Instead, two profiles emerged that represent quantitative distinct levels of teachers' competence to promote SRL, which integrate both situative and cognitive approaches for SRL. As predicted, teachers differed significantly on all indicator variables between the two subgroups, but not on teachers' background variables. Partly in line with our hypotheses, competence profiles were significantly associated with teachers' situative and cognitive approaches to activate SRL as reported by the teachers, but not as reported by the students. A marginally significant association was found between teacher profiles and students' self-reported SRL.

Study 2: Effectiveness of the teacher training for teachers with different SRL competence profiles

In study 2, we investigated the growth in teachers' SRL competence after attending a short training and tested whether their SRL competence profile moderated the training's effectiveness.

Method

Design

In study 2, we tested the degree to which teachers' SRL competence profiles affect their professional development (PD) regarding SRL in the context of a short-term training. To this end, a subsample of the teachers from study 1 participated in an intervention study. Those teachers in

the intervention group received eight hours of training about situative and cognitive approaches to promoting SRL. Control group teachers did not receive training, but participated in the pre- and post-tests. A quasi-experimental design assessed the training's effects on teachers' knowledge of promoting SRL, changes of SRL belief, and of their self-efficacy beliefs to promote SRL.

Sample

The intervention study saw 45 teachers participate. The eight-hour workshop was accredited by the official institution for teachers' PD in the two southwestern German states where the intervention study was conducted, and teachers received credits for the PD as an incentive to participate in the study. Thirty-three teachers participated in the training, and 12 teachers served as a control group. Average teaching experience ranged from 2 to 35 years ($M = 13.38$, $SD = 8.49$) and 95.6% of the teachers were female (age range: 26–61 years, $M = 41.80$, $SD = 9.78$). The groups did not differ significantly with regard to teaching experience ($F(44,2) = 0.43$, $p = 0.51$), age ($F(44,2) = 0.007$, $p = 0.99$), or any of the variables of teacher competence regarding SRL (see Table 5). The teachers were provided with the link to the post-test survey one week after the training.

Out of the full sample of the 45 teachers that took part in the pre-post evaluation on the teacher level, a subsample of 38 teachers also participated with their classes in the evaluation on the student level. For this student sample, students could be assigned to their classes and to the training condition, but for data protection reasons, we could not relate individual teachers to the student data. These 543 students were on average 9.05 years old ($SD = 0.67$) and 52.02% were female. The student evaluation was conducted as a paper and pencil assessment. The teachers received the student questionnaires at the end of the workshop. Teachers collected the data in their classrooms 4 to 6 weeks after the PD training, and returned the student questionnaires via mail.

Out of these 38 teachers, only 16 teachers were willing to identify the association between teacher and students. Thus, we could assign the students' data to their teachers' training condition as well as to the individual teachers for the 230 students of these 16 teachers.

Teacher training

The PD training aimed to support teachers with developing conceptual frameworks for SRL and SRL practice and to provide them with practical skills on how to promote SRL

Table 5 Pre- and posttest means and standard deviation by training group

Dependent variable	Training group						Control group					
	Pretest			Posttest			Pretest			Posttest		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Beliefs situated	33	2.92	.58	33	3.60	.58	12	2.89	.55	12	3.53	.47
Beliefs cognitive	33	3.23	.46	33	3.61	.59	12	3.07	.41	12	3.44	.53
Self-efficacy	33	1.75	.39	33	1.82	.44	12	1.70	.35	12	1.62	.35
Knowledge	33	3.31	.49	33	3.42	.50	12	3.32	.43	12	3.30	.48
Promotion situated	33	2.53	.83	33	2.77	.86	12	2.46	.71	12	2.48	.70
Promotion cognitive	33	2.67	.85	33	3.02	.88	12	2.56	.84	12	2.65	.58

among their students. It also targeted teachers' beliefs about promoting SRL and raising their sense of self-efficacy for implementing SRL in their classrooms. The contents of the PD training focused on situative and cognitive approaches to activating SRL indirectly, by providing students with a learning environment that fosters SRL, and directly, via strategy instruction. Based on the literature about PD training regarding SRL, we learned from the studies that focused on situative approaches for SRL to (a) apply the same SRL principles of the training content as pedagogical methods for the PD training, (b) coach teachers in developing lesson plans for SRL classrooms, and (c) use mixed methods to triangulate the results about teachers' SRL practice. From previous intervention studies that focused on cognitive approaches for SRL, we adopted (a) providing teachers with exercises to apply in their classroom, and (b) using a quasi-experimental design to evaluate the effectiveness of the PD training.

A cyclical model of SRL strategies

The PD training started with activating teachers' prior knowledge and beliefs about SRL. To this end, teachers exchanged their ideas of what SRL entails, and their experiences with using it in the classroom. After this discussion, two conceptual frameworks of SRL were introduced: Zimmerman's (2000) process model of SRL to understand the cyclical character of self-regulation, and Boekerts' (1999) three-layer model of SRL to illustrate the different types of strategies that interact during SRL. Building on the teachers' prior knowledge about SRL strategies, they worked in small groups to collect strategies that exemplify the conceptual SRL models just presented to them. We then developed a repertoire of SRL strategies to provide teachers with concrete ideas about strategies that their students apply or do not apply yet. The strategy repertoire was used to discuss the utility, conditions and benefits of these strategies in order to stimulate teachers' metacognitive reflection.

Scaffolding to develop self-regulated learners

In the next step, the teachers developed ideas about how to integrate strategy instruction into their regular classrooms. To elicit their experience of autonomy and scaffolding, teachers were pair together to perform an exercise of guiding one another while one was blindfolded. The exercise was followed by a group discussion to reflect their experiences of providing and receiving more or less guidance and scaffolding. The trainer helped teachers to transfer their own experience to the context of scaffolding their students during SRL. This practical experience introduced the importance of situated as well as cognitive approaches for SRL.

Designing learning environments that support SRL

During a phase of collaborative learning, the teachers created a learning environment that fosters student SRL. The groups presented their lesson plans, and ideas were structured according to either Powerful Learning Environments (De Corte, 1990) as specified in the CLIA model (De Corte et al., 2004) that served as conceptual models for situated approaches for SRL. In the final hours of the PD training, the teachers developed lesson plans and teaching materials for SRL practice to facilitate the transfer of the content from the training to teachers' classrooms. To this end, a classroom scenario was presented as a problem situation to stimulate teachers in collaborating to prepare a solution to the

problem. The trainer worked as a coach during the collaborative working phase to support teachers in mobilizing their new ideas about situative and cognitive approaches in planning their classroom practice. Teachers were invited to continue collaborating beyond the PD training.

Statistical analyses

The training was evaluated in three steps. (a) For the evaluation on the teacher level, data from all 45 teachers was complete and could be used for the analyses. (b) For the evaluation on the student level, we extracted a dataset containing student data that we could assign to the intervention or control group. This made it possible to compare intervention and control group students, but we could not include information about their teachers' profiles, since we did not have the corresponding teacher data. (c) Among these classes, there was a subsample of teachers who also agreed to provide their identity in order to relate their data to their students' data. For this subsample, the teacher profile could be included into the analyses with the student data.

Teacher level

In order to investigate whether participating in the training affected teachers' development of SRL competence (Research Question 1), regression analyses were conducted with the six outcome variables at the teacher level (teachers' knowledge, situative and cognitive beliefs, self-efficacy, and self-reported situative and cognitive attempts to fostering SRL), and the three outcome variables at the student level (students' perception of their teachers' situative and cognitive attempts to foster SRL, and their self-reported SRL). Teachers' pre-test scores were used to control for pre-test differences. Furthermore, we included teachers' group membership (i.e., participation in the training or not), and their competence profile as predictors into the regression analyses. In the next step, analyses were run again separately for the two teacher profile subgroups in order to test whether teachers' competence profile affected the training effect.

To identify a potential moderating effect of teachers' competence prior to the training (Research Question 2), we added teachers' competence profile as a dummy-coded variable, as well as an interaction term between profile and training condition as predictors to the regressions. In case of a significant interaction effect, the regression was run again separately for the two subgroups of both teacher profiles in order to investigate the direction of effects.

Student level

We performed three regression analyses to analyze whether students' teachers participating in the training predicted the students' perception of their teacher's (a) situative or (b) cognitive approaches for promoting SRL, or (c) the students' self-reported use of SRL strategies. Hierarchical regression analyses would have been preferable to account for the multilevel structure of the student data, yet they would also be unstable due to the small subsample of teachers that participated in the additional student evaluation. Thus, we performed regression analyses with robust standard errors to account at least for the heteroscedasticity of the data (Huber, 1967; White, 1980).

Results

Research question 1: Is the training effective for developing teachers' competence to promote SRL, their SRL practice, and their students' SRL?

We tested four hypotheses to evaluate the effectiveness of the teacher training.

Hypothesis 1.1 We expected teachers in the training group to exhibit more growth in knowledge, beliefs, and self-efficacy than those in the control group. Contrary to our assumption, we found only minor changes in teachers' knowledge, beliefs, or self-efficacy in both groups. As Table 1 shows, slight slopes were observable for the intervention group. No significant training effect was found for teachers' beliefs about situative, $b=0.04$, $T(45)=0.31$, $p=0.76$, or cognitive approaches, $b=0.03$, $T(45)=0.22$, $p=0.83$. A similar result was found for developing teachers' knowledge of SRL promotion, $b=0.13$, $T(45)=0.96$, $p=0.34$. Ceiling effects were already present in the pre-test (see Table 5), especially for teachers' knowledge, whereas teachers reported holding rather low self-efficacy beliefs. A marginally significant training effect was found for teachers' self-efficacy beliefs, indicating a tendency that teachers developed more positive self-efficacy beliefs after attending the training, $b=0.16$, $T(45)=1.82$, $p=0.08$.

Hypothesis 1.2 Consistent with our assumption, the results yielded a significant training effect for teachers' cognitive approaches to promoting SRL, $b=0.29$, $T(45)=2.08$, $p=0.04$. However, we did not find a significant training effect for teachers' situative approaches for promoting SRL, $b=0.23$, $T(45)=1.14$, $p=0.26$.

Hypothesis 1.3 In order to test the effectiveness of the training on the student level, the data of 543 students from 38 teachers was considered. Contrary to our assumption, students with teachers in the training groups did not report that their teachers promoted more SRL with regard to cognitive approaches, $b=0.001$, $T(542)=0.01$, $p=0.99$ or situative approaches, $b=-0.03$, $T(542)=-0.26$, $p=0.80$, than the students of the control group. Table 6 provides means and standard deviations for all student data.

Hypothesis 1.4 As the goal of this training was to improve teachers' SRL practice, which should result in an improvement in students' self-regulation of their learning, we expected to find training effects in students' self-reported use of SRL strategies as well. However, as the descriptive statistics in Table 5 show, the students from each group did not differ in their reported use of SRL strategies, $b=0.04$, $T(543)=0.48$, $p=0.63$.

Table 6 Means and standard deviations for student data

Variable	Intervention group					
	Training			Control		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Self-Regulation of Learning	137	2.74	.50	73	2.78	.52
Situated Approaches for SRL	138	3.03	.47	72	2.73	.62
Cognitive Approaches for SRL	143	3.20	.55	73	2.87	.64

All measures were self-report by students

Research question 2: Is the effectiveness of the teacher training moderated by teachers' competence profiles?

In the next step, we investigated whether there are sub-groups for which the training is more effective. Although the teacher profiles were relatively balanced between the training conditions for the entire teacher sample ($N=45$) (see Table 7), of the 16 teachers in the subsample, for whom we could align student and teacher data (which was necessary to identify the teachers' competence), the profiles were imbalanced. All but one teacher in the training condition were in the low-competence profile, while almost half of the control teachers were assigned to the high-competence profile. Thus, there was enough variance in the training condition to perform moderator analyses on the teacher level, but not on the student level.

Hypotheses 2.1 To investigate whether the training effects on the four aspects of SRL competence differed between the two profiles, regression analyses were conducted with four predictors [pre-test score each competence aspect, group assignment (training vs. control group), competence profile (high vs. low), interaction term (group $\times$ profile)]. Contrary to our assumption, the training effect on teachers' post-test knowledge or beliefs did not vary as a function of teachers' SRL competence profile prior to training. Yet, we did find a significant moderating effect of the prior competence profile for training effects on teachers' self-efficacy beliefs in the post-test, which was in line with our hypothesis. The separate regressions for the two profile subgroups revealed that teachers in the training group, who had a high competence profile prior to the training, showed a significantly higher growth in self-efficacy beliefs about promoting SRL compared to the control teachers, $b=0.24$, $T(26)=4.33$, $p=0.02$. No such effect was found for the low-SRL competence profile, $b=0.04$, $T(19)=0.32$, $p=0.75$. Thus, the results partly support our hypothesis and indicate that prior competence profile moderates the training effect on teachers' self-efficacy beliefs: only teachers who had already a high SRL competence profile prior to the training strengthened their self-efficacy beliefs about promoting SRL significantly.

Hypotheses 2.2 To test the moderating effect of the teachers' profile prior to training on students' SRL development, we added the interaction term (profile $\times$ condition) to the regression. Contrary to our assumption, this did not change the results for teachers' self-reported cognitive approaches to promoting SRL. However, in terms of teachers' self-reported situated approaches, separate regression analyses by teacher profile revealed that although there was no significant training effect in the subgroup of teachers with low SRL competence, $b=-0.12$, $T(19)=-0.46$, $p=0.66$, there was a marginally significant training effect for the subgroup of high-competent teachers, $b=0.53$, $T(26)=1.80$, $p=0.08$.

Table 7 Distribution of competence profiles per training group

Group	SRL Competence Profile		Total
	Low	High	
Control	6	6	12
Training	13	20	33
Total	19	26	

Conclusion

In summary, training effects were found on the teacher level, but not on the student level. Congruent with our assumptions, teachers' SRL competence profile moderated the training effect. First, although the results yielded a significant training effect on teachers' self-reported cognitive approaches to promoting SRL in the overall teacher sample, a marginally significant training effect on teachers' self-reported situated approaches to promoting SRL was only evident for the high-competent subgroup of teachers. Second, a marginally significant training effect on self-efficacy was identified for the whole teacher sample; this effect was highly significant for the subgroup of high-competent teachers. This suggests that the teachers who were already highly competent in promoting SRL prior to training benefitted more extensively from the short-term training.

General discussion

This research identifies profiles of teachers' competence in promoting SRL. It investigates how these profiles are related to teachers' and their students' views of teachers' SRL practices in the classroom, to students' perceived self-regulation of learning, and to change in teachers' competence after participating in an SRL training. The results indicate that teachers' competence profiles differ quantitatively rather than qualitatively and that they explain both teacher and student outcomes. Moreover, the teachers' competence profiles moderate their benefit from a short-term PD training about promoting SRL (see Fig. 2 for an overview of results according to each hypothesis). We identified seven milestone conclusions from our findings, focusing on (a) the patterns of teachers SRL competence profiles found in this study, (b) the importance of student ratings and classroom observations to complement teacher ratings, and (c) the effectiveness of the teacher training for teachers' growth in SRL competence. These conclusions can serve to advance research on teachers' learning about the promotion of SRL.

Seven milestone conclusions

Teacher profiles quantitatively differ in competence levels, but do not differ qualitatively

Although some evidence shows that teachers hold more positive beliefs about situative approaches to SRL (e.g., Dignath & Van der Werf, 2012; Lawson et al., 2019), and classroom observation research indicates that teachers' SRL practice is mainly based on situative approaches (e.g., Bolhuis & Voeten, 2001; Dignath & Büttner, 2018; Vandeveldel et al., 2016), we find quantitatively distinct levels of teacher competence in promoting SRL rather than qualitatively distinct patterns of preference for one approach or the other. This has implications for future intervention research with teachers as it suggests that PD training must be adaptive and accommodate diverse competence levels. Thus, PD training should accommodate the needs of teachers at different competence levels, not teach the diverse group different content.

Part 1: Latent Profile Analyses:

Full Teacher Sample (N=191): Pretest Teacher Level: Beliefs, Knowledge, Self-Efficacy

H 1.1 Teachers did not differ in patterns representing preferences for situative or cognitive approaches to foster SRL, but in competence levels (low vs. high).

H 1.2 The profiles did not differ for teachers' gender, age, or teaching experience.

H 1.3 Teachers' competence profile predicted their self-reported SRL practice regarding situative and cognitive approaches for SRL.

H 1.4 Teachers' competence profile did neither predict teachers' situative nor their cognitive approaches for SRL as reported by the students.

H 1.5 Teachers' profile were only marginally associated with students' SRL.

Profile "High-SRL Competence" vs. Profile "Low-SRL Competence"

Part 2: Subsample for PD Training:

Training Group: PD Training (N = 33)

Control Group: no training (N = 12)

1 week

T2: Posttest Teacher Level: Beliefs, Knowledge, Self-Efficacy, Self-Reported SRL Practice

H 2.1 No significant training effect was found for teachers' beliefs about situative or cognitive approaches for SRL or for their knowledge. For teachers' self-efficacy beliefs, a marginally significant training effect was found.

4 weeks

T3: Subsample: Posttest Student Level: Self-Reported SRL, Student-reported SRL Practice

H 2.2 A significant training effect for teachers' cognitive approaches to SRL was found.

H 2.3 Students in the training groups did not report more situative approaches or cognitive approaches for SRL of their teachers than students in the control group.

H 2.4 The students from both groups did not differ in their use of self-regulation strategies.

H 2.5.1 Only teachers' with a high SRL competence profile gained significantly in terms of self-efficacy about promoting SRL

H 2.5.2 In the subgroup of high-competent teachers, there was a marginally significant training effect on teachers' self-reported situative approaches for SRL.

Fig. 2 Summary of results

Competence profiles do not differ as a function of teachers' background characteristics

In line with other research that finds no associations between teachers' background and their beliefs about promoting SRL (e.g., Dignath & Van der Werf, 2012; Lombaerts et al., 2009a, 2009b; Vandeveldel et al., 2012), teachers' competence profiles in this study did not differ according to gender, age or teaching experience. This result indicates that competence in promoting SRL does not naturally grow during a teacher's career—from initial training or teaching experience, for example—but that teachers need PD support in order to develop professional competences for activating SRL among their students.

To assess SRL practice, teachers' own ratings should be complemented by student ratings and classroom observations

One of our main findings shows teacher profiles predict SRL practice as reported by the teachers, but not as reported by students. In line with research on general teacher competence (e.g., Kunter et al., 2013b), teachers with greater knowledge of promoting SRL, favorable beliefs about SRL, and a high self-efficacy report promoting SRL more. Thus, as for general teaching quality and classroom practice, the different aspects of teacher competence should be taken into account when researching teachers' support of SRL in the classroom. Why do students' ratings of teachers' SRL practice not confirm this association?

First, research indicates that ratings of teachers' SRL practice by students, teachers and observers are not highly associated, and that students' ratings and classroom observations of teacher SRL practices explain a higher share of students' SRL than teachers' own ratings of their SRL practice (Dignath et al., 2013). Second, teachers' beliefs and teachers' SRL practice were found to correlate strongly in teacher self-reports, (e.g., Dignath, 2017; Lombaerts et al., 2009a, 2009b; Peeters et al., 2016; Thomas et al., 2020; Vandeveldel et al., 2012), but not when teachers' SRL practice was assessed by means of classroom observations (e.g., Dignath & Büttner, 2018; Spruce & Bol, 2015). Likewise, former research about generic teacher competence indicates that teachers' self-report about aspects of their professional competence, such as self-efficacy, predict teacher ratings of classroom practice, but not student ratings of their teachers' instructional quality (e.g., Holzberger et al., 2013; Kunter et al., 2008; Praetorius et al., 2017). This could partly be explained by the fact that two teacher ratings about their beliefs and about their classroom practice are necessarily more associated than one teacher rating is with a more distant measure, such as student rating or classroom observation. Students' perceptions of their learning conditions have been found to mediate the relationship between instructional quality and students' use of learning opportunities (Seidel & Prenzel, 2006).

Some researchers even assume that the actual teaching methods matter less than the quality of students' educational experiences (Newmann et al., 1996). Hence, the students' perception should be taken into account when investigating teachers' SRL practice. Nevertheless, although teachers' ratings might lack validity, students' ratings do not necessarily reflect the "real" classroom environment, either: students' subjective perspective on the learning environment has been found to differ from objective classroom observations (Kunter et al., 2007), also with regard to promoting SRL (Dignath et al., 2013). Thus, SRL research that evaluates teachers' SRL practice should not rely on one measure alone, as the

different perspectives of the agents in the classroom will represent different perceptions and aspects and can complement each other.

To explain students' SRL, the students' perceptions of their teachers' SRL practice should be taken into account

We find only a marginally significant positive association between teachers' SRL competence profiles and perceived self-regulation of their students. This could partly be due to low explanatory power as this result was based on a small teacher sample. Whereas the teachers' ratings of their SRL practice do not predict students' perceived self-regulation, students' ratings of teachers' SRL practice are a significant predictor for students' perceived self-regulation. While students perception of situated approaches for SRL associate negatively with their perceived SRL, their view on cognitive approaches for SRL was positively associated with their perceived SRL. This is in line with earlier research indicating that students benefit from the direct instruction of SRL strategies to develop their SRL (e.g., Dignath et al., 2013; Kistner et al., 2010; Veenman, 2017).

In terms of teacher competence, the pd training only affected teachers' self-efficacy about implementing SRL

With regard to the aspects of teacher competence, attending the PD training only affected teachers' sense of self-efficacy in implementing SRL in their classrooms, not their beliefs or knowledge. As previous research shows that many teachers lack a strong sense of self-efficacy (De Smul et al., 2018), but that self-efficacy is a powerful predictor of their self-reported SRL practice (Dignath, 2017), the positive effects of the PD training on teachers' self-efficacy development is promising. Yet, more research is needed to clarify which types of PD training can serve to also develop teachers' knowledge and help them reflect on their beliefs about SRL.

Regarding teachers' SRL practice, the PD training affected only teachers' self-reported cognitive approaches for SRL

After the training, we find significant effects on teachers' self-reported cognitive approaches for promoting SRL, but only marginally significant effects for teacher-reported situative approaches. The intervention may have been too short to effectively implement situative approaches to teacher learning. More time in the scope of this workshop may be necessary to help teachers translate the methods used in the PD training to their own classroom. Aside from the amount of time within the PD workshop, teachers and students may also need more time to introduce a situative SRL practice as well as to implement the change in their learning environment and develop self-regulation strategies and experience in applying them, respectively. Another explanation could be that teachers decided that they would have to teach their students how to self-regulate their learning (i.e., cognitive approach to promoting SRL) before they would provide them with open learning environments that require them to self-regulate effectively (i.e., situative approach to promoting SRL). In both situations, a follow-up test would have to be presented with sufficient delay after the end of the PD training.

Finally, it may also be difficult to find large effects of PD training on the student level in general: In a review about the effectiveness of PD training, Kennedy (2016) only finds small effects up to $d=0.20$ on the student level. She argues that the three-step process of the effectiveness of PD training—PD alters teacher competence, which in turn alters their teaching practice, which in turn alters student learning—increases the risk that effects on the student level diminish (Kennedy, 2016).

Teachers with initially high competence levels benefitted more from the short-term PD training

Whereas the training benefitted teachers with low competence only in terms of their self-reported cognitive approaches to promoting SRL, teachers with high competence increased their self-efficacy to promote SRL and reported improving their SRL practice with regard to situative and cognitive approaches to fostering SRL. Earlier research in the field of SRL training also displays this Matthew effect, which entails that learners with high proficiency levels benefit more from training than learners with low proficiency: for example, low achieving students (Otto & Kistner, 2017) and students with a low SRL profile (Dörrenbacher & Perels, 2016) benefitted demonstrably less from SRL training, and teachers with dysfunctional prior beliefs about SRL profited less from training that promote it (Steinbach & Stoeger, 2016). Against this background, our results suggest that training should be adapted and personalized to the individual teachers' initial competencies. We conclude that short-term training on promoting SRL can be highly productive and economic for teachers who already dispose of a certain level of knowledge about promoting SRL, and who have affirmative beliefs about SRL.

Limitations and implications for future research

The outcomes of this study make an important contribution to the literature by bridging SRL research with research on teacher competence by identifying profiles of teachers' competence to promote SRL, by investigating how these profiles are associated with teachers' and students' views of SRL practice and whether they moderate the effectiveness of PD training. Although this study cannot provide data about associations between teachers' competence and their actual classroom behavior, our results unveil teachers' views on SRL and can inform future research about SRL in educational practice. Nevertheless, this study has several limitations; based on its findings and its limitations, we derive ten cornerstones to inspire future research on teachers' SRL competence and intervention research to support teachers' PD about SRL.

First, the external validity of our findings is restricted to primary school teachers and students, who are under the age of ten in Germany. Thus, it is unclear whether the results can be generalized to secondary school teachers and students. As previous research indicates that primary and secondary school teachers promote SRL differently (e.g., Dignath & Büttner, 2018; Spruce & Bol, 2015), future research should ask how teachers' competence on promoting SRL differs across educational levels, and whether primary and secondary school teachers benefit differently from PD training on SRL.

Second, although our quasi-experimental training study allows us to draw causal conclusions on the teacher level, for organizational reasons we could only collect student data in the post-test, so we cannot rule out that differences between students' ratings may have existed a priori. Including student data in the pre-test would account for initial differences in student SRL. Moreover, follow-up tests would help to examine long-term effects on changes in teachers' SRL practice and, eventually, on students' perceptions of their learning environment. Because teachers need time to implement new theories into their practice (Kennedy, 2016), effectiveness measures may have to be repeated after several months in order to truly capture training effects.

Third, our study is limited by the method that is used to assess students' SRL—only by means of self-report. The validity of self-report measures for SRL must be questioned (e.g., Veenman et al., 2006), and other measures are needed that investigate SRL in more valid ways, for example, through observation (Whitebread et al., 2009) or thinking aloud (Heirweg et al., 2019). Moreover, in our study, teachers administered the questionnaires to their students. On the one hand, this has the advantage that students activate their teachers' SRL practice more easily; on the other hand, we cannot exclude that students feel evaluated by their teachers and answer in a socially-desired way. Thus, future research should take both sides of the data collection into account.

Fourth, we only assess students' perceived SRL as an outcome variable on the student level. However, the long-term goal of teacher PD is to alter teachers' classroom practice and, ultimately, to alter students' learning, which should result in better learning outcomes (see Kennedy, 2016). As SRL is beneficial to students' academic achievement, future research should also assess achievement data as a "hard" measure for the effectiveness of teachers' SRL practice (Schunk, 2008).

Fifth, the small teacher sample is another limitation of our study. Due to the sample size, we could not link data of individual teachers to individual students. Some analyses reveal marginally significant effects, and we cannot rule out whether we could not find a statistically significant effect due to a lack of explanatory power. Research based on a larger sample of teachers and their students could deliver more stable results. Incentives may be necessary to convince teachers to participate in the research. Teachers should also be approached as experts within a teacher-researcher community in order to build strong collaborative ties between research and practice and to motivate teachers to participate in intervention research (e.g., Barr & Askell-Williams, 2020).

Sixth, our study was limited to two measurement points, which prevents us from making conclusions about the long-term development of teachers' knowledge and skills and students' SRL. Recent research underlines the power of longitudinal studies in order to broaden our understanding of teachers' and students' learning processes with SRL (e.g., Panadero et al., 2016). Longitudinal studies that assess students' and teachers' SRL and SRL practice over the scope of a whole school year could provide deeper insights into the development of teachers' competence on promoting SRL and into long-term effects on students' learning.

Seventh, despite our efforts to combine different perspectives of teachers and students, an objective observer perspective about teachers' SRL practice could advance our understanding of the association between teacher profiles and teachers' perceived SRL practice as reported by the teachers themselves, but not with teachers' SRL practice as reported by their students (Perry et al., 2002). It would be informative to investigate the degree to

which the students' perception of their teachers' SRL practice mediates the effect of the teacher ratings on students' SRL.

Eighth, another limitation is that our study provides teachers with a short PD training, so we cannot generalize our results to other types of PD. Although a short PD training is time-efficient, it would be notable to compare its effectiveness with that of a long-term PD training on SRL (Garrett et al., 2019) to investigate how teachers can be supported best in developing an effective SRL practice.

Ninth, our findings are limited to teachers' knowledge of, belief in and sense of self-efficacy toward promoting SRL as aspects of teachers' competence in promoting SRL. However, a fourth important aspect of teacher competence in the COACTIV model (Baumert & Kunter, 2013) that underlies our study is teachers' own self-regulation. Whereas Baumert and Kunter (2013) refer to teachers' self-regulation of their own emotional states (i.e., resilience), this aspect could also be applied to teachers' self-regulation of their learning and their teaching (see Kramarski & Michalsky, 2009) and investigate the interplay between these four aspects of teacher competence in the context of SRL. Past research suggests that teachers first need to become proficient at SRL themselves before they can learn how to teach it effectively (Kramarski & Kohen, 2017; Peeters et al., 2014). Adding teachers' self-regulation would complete teachers' profiles of competence on promoting SRL.

Tenth, this study is limited to the assessment of teacher characteristics, such as their background and their professional competence in promoting SRL. However, research indicates that both student characteristics, such as their academic level (Peeters et al., 2016), as well as school characteristics, such as school policy regarding SRL (Thomas et al., 2020) or a shared SRL vision (De Smul et al., 2019), can also affect teachers' SRL practice. Even though most evidence suggests that teachers' beliefs systems about SRL explain more variation in their SRL practice than characteristics on the school level (Lombaerts et al., 2009a, 2009b; Thomas et al., 2020), context characteristics can deliver valuable information about how to support teachers' PD effectively.

Practical implications

Next to advancing the theory about teacher competence in promoting SRL, our findings provide ideas about PD training in the field of SRL. First, teacher education and PD should consider teachers' prior competence when addressing SRL promotion. While highly competent teachers may benefit from short-term training as provided in daily PD by mobilizing their already existing ideas about SRL, teachers who still dispose of little competence may not profit from a short PD training on a new topic, but instead need longer PD courses or follow-up refresher courses in order to develop the competence necessary for an effective SRL practice (Butler et al., 2004). Taking teachers' heterogeneous competencies on promoting SRL into account requires teaching methods in the PD training that adapt to differences in prior knowledge, beliefs and self-efficacy. Such methods include, for example, cooperative learning or individualized learning, and using these methods can serve as a model for teachers to apply them in their own classroom to account for heterogeneity with regard to SRL (Corno, 2008). For example, research shows project-based learning is a promising method to help teachers transfer theory and evidence about SRL into their teaching (Butler et al., 2013). Knowledge about the teachers' competence profiles helps to provide teachers with adaptive training that suits their needs and matches their prerequisites in order to fully profit from the training (see Dörrenbächer & Perels, 2016 for adaptive SRL training for students).

Whereas the idea of direct strategy instruction may be easier to transport within a short PD training, embedding teaching practices that support rich learning in students may require more time. Using pedagogical methods for the PD that engage teachers in the kind of learning activities that reflect the training content (Darling-Hammond et al., 2005), and that they are supposed to design for their students, seems to be a promising method for PD training about SRL (Perry & VandeKamp, 2000), but requires a certain amount of time for the PD. Moreover, there is evidence supporting the effectiveness of communities of teachers for teachers' PD (Palincsar et al., 1998). Most of the PD training described above that focuses on situative approaches for SRL practice has implemented such communities in order to provide teachers with opportunities of exchange, discussion and feedback, and to support co-construction of knowledge (e.g., Butler et al., 2004).

Finally, helping teachers develop their professional competence to promote SRL should start early in teacher education (Bembenutty et al., 2015) to facilitate their professional knowledge development and beliefs about the promotion of SRL, and to develop sustainable self-efficacy for activating SRL in their future classrooms. If future teachers begin learning about SRL promotion during their teacher education, later on they will dispose of the competencies required for benefitting from a short-term PD training.

Appendix

Factor analysis for teachers' self-reported SRL practice

The twenty-one questions of the SRLIT were submitted to a factor analysis using principal component analysis with Varimax (orthogonal) rotation. The two yielded factors explained a total of 48.21% of the variance. Factor 1 was labeled *cognitive approaches for SRL*, due to the high loadings by items such as: to teach students how to provide and how to receive feedback; to reflect the learning behavior with the students; to teach how to plan one's learning; to evaluate each other's results; to instruct learning strategies directly. This first factor explained 35.19% of the variance. The second factor was labeled *situative approaches for SRL*, due to the high loadings by item such as: to let students decide in which order they work on assignments; to have students work on assignments independently; to let students monitor their learning time themselves; to have students work autonomously with week plans (see Table 8). The variance explained by this factor was 13.01%. The communalities of the variables were rather low overall, with one variable (item "Each pupil draws up a week plan for the tasks that he or she should carry out independently.") having a small amount of variance (18%) in common with the other variables in the analysis. However, the Kaiser–Meyer–Olkin Measure of Sampling Adequacy, $KMO=0.89$, and Bartlett's Test of Sphericity both indicate that the set of variables are at least adequately related for factor analysis, $X^2(190)=1836.44$, $p<0.001$. Noticeably, this means that we have identified two patterns of teacher response—one pattern of cognitive approaches for SRL, and one pattern of situative approaches for SRL, which are independent of one another.

Table 8 Factor analysis table for teachers' self-reported SRL practice

	Loadings		
	Factor 1: cognitive approaches	Factor 2: situative approaches	Communality
I teach my pupils how to provide feedback to classmates	.805		.620
I teach my pupils how to deal with feedback	.779		.669
Pupils provide mutual feedback about their approached to the learning task	.764		.591
When working in groups, we discuss the individual contribution of everyone	.698		.488
My pupils evaluate their own learning performances	.686		.521
My pupils evaluate each other's learning results	.663		.475
Group assignments are evaluated by mutual agreement between teacher and pupils	.621		.413
When we review tasks in class, pupils have to say how they tackled a learning problem	.603		.407
I discuss with my pupils their learning behavior	.597		.457
I teach my pupils how to plan their learning activities	.540		.391
In my classroom I teach about learning strategies	.529		.305
Pupils determine the order in which they complete their tasks		.796	.649
Pupils decide themselves how long they work on an assignment		.770	.596
Pupils receive tasks they can work on for several lesson periods		.767	.602
My pupils work on tasks that require them to plan their work themselves towards a deadline		.745	.583
Some tasks have to be carried out independently by a fixed deadline		.726	.492
Pupils can consult a solution overview to evaluate their own work		.557	.207
Each pupil draws up a week plan for the tasks that he or she should carry out independently		.391	.179
Pupils receive tasks they can work on for several lesson periods		.385	.558
Eigenvalue		7.04	2.61
% of Total Variance		35.19	13.03
Total Variance			48.21

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Declarations

Conflict of interest There are no potential conflict of interest.

Informed consent Informed consent was obtained from all participants in the studies.

Research involving human participants Research involving human participants was limited to anonymous survey studies.

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References

- Anderson, J. R. (1996). ACT: A simple theory of complex cognition. *American Psychologist*, 51, 355–365.
- Askill-Williams, H., Lawson, M. J., & Skrzypiec, G. (2012). Scaffolding cognitive and metacognitive strategy instruction in regular class lessons. *Instructional Science*, 40(2), 413–443.
- Bandura, A. (1997). *Self-efficacy. The exercise of control*. WH Freeman.
- Barr, S., & Askill-Williams, H. (2020). Changes in teachers' epistemic cognition about self-regulated learning as they engaged in a researcher-facilitated professional learning community. *Asia-Pacific Journal of Teacher Education*, 48(2), 187–212.
- Basma, B., & Savage, R. (2018). Teacher professional development and student literacy growth: A systematic review and meta-analysis. *Educational Psychology Review*, 30(2), 457–481.
- Baumert, J., & Kunter, M. (2013). The COACTIV model of teachers' professional competence. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), *Cognitive activation in the mathematics classroom and professional competence of teachers* (pp. 25–48). Springer.
- Bembenutty, H., White, M. C., & Vélez, M. R. (2015). Self-regulated learning and development in teacher preparation training. In H. Bembenutty, M. C. White, & M. R. Velez (Eds.), *Developing self-regulation of learning and teaching skills among teacher candidates* (pp. 9–28). Springer.
- Bernacki, M. L., Vosicka, L., & Utz, J. C. (2020). Can a brief, digital skill training intervention help undergraduates "learn to learn" and improve their STEM achievement? *Journal of Educational Psychology*, 112(4), 765.
- Boekaerts, M. (1999). Self-regulated learning: Where we are today. *International Journal of Educational Research*, 31(6), 445–457.
- Bolhuis, S., & Voeten, M. J. M. (2001). Toward self-directed learning in secondary schools: What do teachers do? *Teaching and Teacher Education*, 17, 837–855.
- Bouwmeester, S., Sijtsma, K., & Vermunt, J. K. (2004). Latent class regression analysis for describing cognitive developmental phenomena: An application to transitive reasoning. *European Journal of Developmental Psychology*, 1(1), 67–86.
- Butler, D. L., Lauscher, H. N., Jarvis-Selinger, S., & Beckingham, B. (2004). Collaboration and self-regulation in teachers' professional development. *Teaching and Teacher Education*, 20(5), 435–455.
- Butler, D. L., Perry, N. E., & Schnellert, L. (2017). *Developing self-regulating learners*. New Jersey: Pearson.
- Butler, D. L., Schnellert, L., & Cartier, S. C. (2013). Layers of self-and co-regulation: Teachers working collaboratively to support adolescents' self-regulated learning through reading. *Education Research International*, 2013, 1–19.

- Cartier, S. C., Butler, D. L., & Bouchard, N. (2010). Teachers working together to foster self-regulated learning through reading by students in an elementary school located in a disadvantaged area. *Psychological Test and Assessment Modeling*, 52(4), 382.
- Cochran-Smith, M. (2005). Studying teacher education: What we know and need to know. *Journal of Teacher Education*, 56(4), 301–306.
- Collins, L. M., & Lanza, S. T. (2010). *Latent class and latent transition analysis: With applications in the social, behavioral, and health sciences* (Vol. 718). Wiley.
- Corno, L. Y. N. (2008). On teaching adaptively. *Educational Psychologist*, 43(3), 161–173.
- Darling-Hammond, L., Hammerness, K., Grossman, P., Rust, F., & Shulman, L. (2005). The design of teacher education programs. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do* (pp. 390–441). Wiley.
- De Corte, E. (1990). Towards powerful learning environments for the acquisition of problem-solving skills. *European Journal of Psychology of Education*, 5(1), 5–19.
- De Corte, E., Verschaffel, L., & Masui, C. (2004). The CLIA-model: A framework for designing powerful learning environments for thinking and problem solving. *European Journal of Psychology of Education*, 19(4), 365–384.
- De Smul, M., Heirweg, S., Devos, G., & Van Keer, H. (2019). It's not only about the teacher! A qualitative study into the role of school climate in primary schools' implementation of self-regulated learning. *School Effectiveness and School Improvement*. <https://doi.org/10.1080/09243453.2019.1672758>
- De Smul, M., Heirweg, S., Van Keer, H., Devos, G., & Vandeveldel, S. (2018). How competent do teachers feel instructing self-regulated learning strategies? *Teaching and Teacher Education*, 71, 214–225.
- Depaepe, F., De Corte, E., & Verschaffel, L. (2010). Teachers' approaches towards word problem solving: Elaborating or restricting the problem context. *Teaching and Teacher Education*, 26(2), 152–160.
- Depaepe, F., & König, J. (2018). General pedagogical knowledge, self-efficacy and instructional practice: Disentangling their relationship in pre-service teacher education. *Teaching and Teacher Education*, 69, 177–190.
- Dignath, C. (2017). What determines whether teachers enhance self-regulated learning? Predicting teachers' reported promotion of self-regulated learning by teacher beliefs, knowledge, and self-efficacy. *Front-line Learning Research*, 4, 83–105.
- Dignath, C., & Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition and Learning*, 3, 231–264.
- Dignath, C., & Büttner, G. (2018). Investigating teachers' direct and indirect promotion of self-regulated learning in primary and secondary mathematics classrooms—insights from video-based classroom observations and teacher interviews. *Metacognition and Learning*, 13, 127–157.
- Dignath, C., Dickhäuser, O., & Büttner, G. (2013). Assessing how teachers enhance self-regulated learning - a multi-perspective approach. *Journal of Cognitive Education and Psychology, Special Issue on Self-Regulated Learning*, 21, 338–358.
- Dignath, C., & Van der Werf, G. (2012). What teachers think about self-regulated learning: An investigation of teacher beliefs about enhancing students' self-regulation and how they predict teacher behavior. *Education Research International*, 2012, 1–10.
- Dignath, C., & Veenman, M. V. (2021). The role of direct strategy instruction and indirect activation of self-regulated learning—evidence from classroom observation studies. *Educational Psychology Review*, 33, 489–533.
- Dörrenbächer, L., & Perels, F. (2016). Self-regulated learning profiles in college students: Their relationship to achievement, personality, and the effectiveness of an intervention to foster self-regulated learning. *Learning and Individual Differences*, 51, 229–241.
- Efklides, A. (2011). Interactions of metacognition with motivation and affect in self-regulated learning: The MASRL model. *Educational Psychologist*, 46, 6–25.
- Fauth, B., Decristan, J., Decker, A. T., Buettner, G., Hardy, I., Klieme, E., & Kunter, M. (2019). The effects of teacher competence on student outcomes in elementary science education: The mediating role of teaching quality. *Teaching and Teacher Education*, 86, 102882.
- Finstervald, M., Wagner, P., Schober, B., Lüftenegger, M., & Spiel, C. (2013). Fostering lifelong learning—Evaluation of a teacher education program for professional teachers. *Teaching and Teacher Education*, 29, 144–155.
- Fives, H., & Buehl, M. M. (2012). Spring cleaning for the “messy” construct of teachers' beliefs: What are they? Which have been examined? What can they tell us? In K. R. Harris, S. Graham, T. Urdan, S. Graham, J. M. Royer, & M. Zeidner (Eds.), *APA Educational psychology handbook: Individual differences and cultural and contextual factors* (Vol. 2, pp. 471–499). Washington: APA.

- Fives, H., & Buehl, M. M. (2016). Teachers' beliefs, in the context of policy reform. *Policy Insights from the Behavioral and Brain Sciences*, 3(1), 114–121.
- Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist*, 34, 906–911.
- Garrett, R., Citkowitz, M., & Williams, R. (2019). How responsive is a teacher's classroom practice to intervention? A meta-analysis of randomized field studies. *Review of Research in Education*, 43(1), 106–137.
- Geduld, B. (2019). A snapshot of teachers' knowledge and teaching behaviour to develop self-regulated learning. *Journal of Education*, 77, 60–78.
- Glogger-Frey, I., Ampatzidis, Y., Ohst, A., & Renkl, A. (2018). Future teachers' knowledge about learning strategies: Misconceptions and knowledge-in-pieces. *Thinking Skills and Creativity*, 28, 41–55.
- Greeno, J. G., Collins, A. M., & Resnick, L. B. (1996). Cognition and learning. In D. Berliner & R. Calfee (Eds.), *Handbook of educational psychology* (pp. 15–46). Macmillan.
- Gregoire, M. (2003). Is it a challenge or a threat? A dual-process model of teachers' cognition and appraisal processes during conceptual change. *Educational Psychology Review*, 15(2), 147–179.
- Hattie, J. (2013). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge.
- Heirweg, S., De Smul, M., Devos, G., & Van Keer, H. (2019). Profiling upper primary school students' self-regulated learning through self-report questionnaires and think-aloud protocol analysis. *Learning and Individual Differences*, 70, 155–168.
- Hermans, R., van Braak, J., & Van Keer, H. (2008). Development of the beliefs about primary education scale: Distinguishing a developmental and transmissive dimension. *Teaching and Teacher Education*, 24(1), 127–139.
- Hickendorff, M., Edelsbrunner, P. A., McMullen, J., Schneider, M., & Trezise, K. (2018). Informative tools for characterizing individual differences in learning: Latent class, latent profile, and latent transition analysis. *Learning and Individual Differences*, 66, 4–15.
- Holzberger, D., Maurer, C., Kunina-Habenicht, O., & Kunter, M. (2021). Ready to teach? A profile analysis of cognitive and motivational-affective teacher characteristics at the end of preservice teacher education and the long-term effects on occupational well-being. *Teaching and Teacher Education*, 100, 103285.
- Holzberger, D., Philipp, A., & Kunter, M. (2013). How teachers' self-efficacy is related to instructional quality: A longitudinal analysis. *Journal of Educational Psychology*, 105(3), 774.
- Huber, P. J. (1967). The behavior of maximum likelihood estimates under nonstandard conditions. In *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability* (Vol. 1, pp. 221–233). Berkeley: University of California Press.
- Karlen, Y., Hertel, S., & Hirt, C. (2020). Teachers' professional competences in self-regulated learning: An approach to integrate teachers' competences as self-regulated learners and as agents of self-regulated learning in a holistic manner. *Frontiers in Education*, 5, 159. <https://doi.org/10.3389/educ.2020.00159>
- Kennedy, M. M. (2016). How does professional development improve teaching? *Review of Educational Research*, 86(4), 945–980.
- Kiewra, K. A. (2002). How classroom teachers can help students learn and teach them how to learn. *Theory into Practice*, 41(2), 71–80.
- Kistner, S., Rakoczy, K., Otto, B., Dignath-van Ewijk, C., Büttner, G., & Klieme, E. (2010). Promotion of self-regulated learning in classrooms: Investigating frequency, quality, and consequences for student performance. *Metacognition and Learning*, 5(2), 157–171.
- Kistner, S., Rakoczy, K., Otto, B., Klieme, E., & Büttner, G. (2015). Teaching learning strategies. The role of instructional context and teacher beliefs. *Journal for Educational Research Online*, 7(1), 176–197.
- Kollmayer, M., Pfaffel, A., Schultes, M. T., Lüftenegger, M., Finsterwald, M., Popper, V., Jöstl, G., Spiel, C., & Schober, B. (2020). REFLECT–ein Interventionsprogramm zum Aufbau von Lehrkräftekompetenzen für Reflexive Koedukation. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie*, 51, 110–122.
- Kramarski, B., & Kohen, Z. (2017). Promoting preservice teachers' dual self-regulation roles as learners and as teachers: Effects of generic vs. specific prompts. *Metacognition and Learning*, 12(2), 157–191.
- Kramarski, B., & Michalsky, T. (2009). Investigating preservice teachers' professional growth in self-regulated learning environments. *Journal of Educational Psychology*, 101, 161–175.
- Kramarski, B., & Revach, T. (2009). The challenge of self-regulated learning in mathematics teachers' professional training. *Educational Studies in Mathematics*, 72(3), 379–399.

- Kunter, M., Baumert, J., Blum, W., Klusmann, U., Krauss, S., & Neubrand, M. (Eds.). (2013). *Cognitive activation in the mathematics classroom and professional competence of teachers: Results from the COACTIV project*. Springer.
- Kunter, M., Baumert, J., & Köller, O. (2007). Effective classroom management and the development of subject-related interest. *Learning and Instruction*, 17(5), 494–509.
- Kunter, M., Klusmann, U., Baumert, J., Richter, D., Voss, T., & Hachfeld, A. (2013). Professional competence of teachers: Effects on instructional quality and student development. *Journal of Educational Psychology*, 105(3), 805–820.
- Kunter, M., Tsai, Y. M., Klusmann, U., Brunner, M., Krauss, S., & Baumert, J. (2008). Students' and mathematics teachers' perceptions of teacher enthusiasm and instruction. *Learning and Instruction*, 18(5), 468–482.
- Lanza, S. T., & Cooper, B. R. (2016). Latent class analysis for developmental research. *Child Development Perspectives*, 10(1), 59–64.
- Lau, K. L. (2013). Chinese language teachers' perception and implementation of self-regulated learning-based instruction. *Teaching and Teacher Education*, 31, 56–66.
- Lawson, M. J., Vosniadou, S., Van Deur, P., Wyr, M., & Jeffries, D. (2019). Teachers' and students' belief systems about the self-regulation of learning. *Educational Psychology Review*. <https://doi.org/10.1007/s10648-018-9453-7>
- Lipowsky, F., & Rzejak, D. (2015). Key features of effective professional development programmes for teachers. *Ricercazione*, 7(2), 27–51.
- Lombaerts, K., De Backer, F., Engels, N., Van Braak, J., & Athanasou, J. (2009). Development of the self-regulated learning teacher belief scale. *European Journal of Psychology of Education*, 24(1), 79–96.
- Lombaerts, K., Engels, N., & Athanasou, J. A. (2007). Development and validation of the self-regulated learning inventory for teachers. *Perspectives in Education*, 25, 29–47.
- Lombaerts, K., Engels, N., & Van Braak, J. (2009). Determinants of teachers' recognitions of self-regulated learning practices in elementary education. *The Journal of Educational Research*, 102(3), 163–174.
- Lubke, G. H., & Muthén, B. (2005). Investigating population heterogeneity with factor mixture models. *Psychological Methods*, 10(1), 21.
- Marks, H. M., Doane, K. B., & Secada, W. (1996). Support for student achievement. In F. M. Newman (Ed.), *Authentic achievement: Restructuring schools for intellectual quality* (pp. 209–227). Jossey-Bass.
- Marsh, H. W., Lüdtke, O., Trautwein, U., & Morin, A. J. (2009). Classical latent profile analysis of academic self-concept dimensions: Synergy of person-and variable-centered approaches to theoretical models of self-concept. *Structural Equation Modeling: A Multidisciplinary Journal*, 16(2), 191–225.
- Morris, D. B., Usher, E. L., & Chen, J. A. (2017). Reconceptualizing the sources of teaching self-efficacy: A critical review of emerging literature. *Educational Psychology Review*, 29(4), 795–833.
- Newmann, F. M., Marks, H. M., & Gamoran, A. (1996). Authentic pedagogy and student performance. *American Journal of Education*, 104(4), 280–312.
- Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling: A Multidisciplinary Journal*, 14(4), 535–569.
- Otto, B. (2007). *SELVES. Schüler-, Eltern- und Lehrertrainings zur Vermittlung effektiver Selbstregulation*. Dissertation. Darmstadt: Technische Universität, Fachbereich Humanwissenschaften.
- Otto, B., & Kistner, S. (2017). Is there a Matthew effect in self-regulated learning and mathematical strategy application?—Assessing the effects of a training program with standardized learning diaries. *Learning and Individual Differences*, 55, 75–86.
- Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62(3), 307–332.
- Palincsar, A. S., Magnusson, S. J., Morano, N., Ford, D., & Brown, N. (1998). Designing a community of practice: Principles and practices of the GIsML community. *Teaching and Teacher Education*, 14, 5–19.
- Panadero, E., Klug, J., & Järvelä, S. (2016). Third wave of measurement in the self-regulated learning field: When measurement and intervention come hand in hand. *Scandinavian Journal of Educational Research*, 60(6), 723–735.
- Paris, S. G., & Paris, A. H. (2001). Classroom applications of research on self-regulated learning. *Educational Psychologist*, 36, 89–101.
- Pauli, C., Reusser, K., Waldis, M., & Grob, U. (2003). Erweiterte Lehr- und Lernformen" im Mathematikunterricht der Deutschschweiz ["Extended forms of learning and teaching" in Swiss mathematics instruction. *Unterrichtswissenschaft*, 31, 291–320.

- Peeters, J., De Backer, F., Kindekens, A., Triquet, K., & Lombaerts, K. (2016). Teacher differences in promoting students' self-regulated learning: Exploring the role of student characteristics. *Learning and Individual Differences*, 52, 88–96.
- Peeters, J., De Backer, F., Reina, V. R., Kindekens, A., Buffel, T., & Lombaerts, K. (2014). The role of teachers' self-regulatory capacities in the implementation of self-regulated learning practices. *Procedia-Social and Behavioral Sciences*, 116, 1963–1970.
- Perels, F., Merget-Kullmann, M., Wende, M., Schmitz, B., & Buchbinder, C. (2009). Improving self-regulated learning of preschool children: Evaluation of training for kindergarten teachers. *British Journal of Educational Psychology*, 79(2), 311–327.
- Perels, F., & Otto, B. (2009). Förderung selbstregulierten Lernens im Vor-und Grundschulalter. In F. Hellmich & S. Wernke (Eds.), *Lernstrategien in der Grundschule* (pp. 174–193). Kohlhammer.
- Perry, N. E. (1998). Young children's self-regulated learning and contexts that support it. *Journal of Educational Psychology*, 90(4), 715.
- Perry, N. E., Hutchinson, L., & Thauberger, C. (2008). Talking about teaching self-regulated learning: Scaffolding student teachers' development and use of practices that promote self-regulated learning. *International Journal of Educational Research*, 47, 97–108.
- Perry, N. E., & VandeKamp, K. J. (2000). Creating classroom contexts that support young children's development of self-regulated learning. *International Journal of Educational Research*, 33, 821–843.
- Perry, N. E., VandeKamp, K. O., Mercer, L. K., & Nordby, C. J. (2002). Investigating teacher-student interactions that foster self-regulated learning. *Educational Psychologist*, 37(1), 5–15.
- Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, M. Zeidner, & P. R. Pintrich (Eds.), *Handbook of self-regulation* (pp. 451–502). Elsevier.
- Praetorius, A. K., Lauermaun, F., Klassen, R. M., Dickhäuser, O., Janke, S., & Dresel, M. (2017). Longitudinal relations between teaching-related motivations and student-reported teaching quality. *Teaching and Teacher Education*, 65, 241–254.
- Pressley, M., Harris, K. R., & Marks, M. B. (1992). But good strategy instructors are constructivists! *Educational Psychology Review*, 4, 3–31.
- Resnick, L. B., Levine, J. M., & Teasley, S. D. (1991). *Perspectives on socially shared cognition*. American Psychological Association.
- Schmitz, G. S., & Schwarzer, R. (2000). Selbstwirksamkeitserwartung von Lehrern: Längsschnittbefunde mit einem neuen Instrument. *Zeitschrift Für Pädagogische Psychologie/german Journal of Educational Psychology*, 14(1), 12–25.
- Schunk, D. H. (2008). Metacognition, self-regulation, and self-regulated learning: Research recommendations. *Educational Psychology Review*, 20(4), 463–467.
- Seidel, T., & Prenzel, M. (2006). Stability of teaching patterns in physics instruction: Findings from a video study. *Learning and Instruction*, 16(3), 228–240.
- Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1–23.
- Skott, J. (2015). The promises, problems, and prospects of research on teachers' beliefs. In H. Fives & M. Gregoire Gill (Eds.), *International handbook of research on teachers' beliefs* (pp. 37–54). New York: Routledge.
- Spruce, R., & Bol, L. (2015). Teacher beliefs, knowledge, and practice of self-regulated learning. *Metacognition and Learning*, 10(2), 245–277.
- StataCorp. (2017). *Stata statistical software: Release 15*. StataCorp LLC.
- Steinbach, J., & Stoeger, H. (2016). How primary school teachers' attitudes towards self-regulated learning (SRL) influence instructional behavior and training implementation in classrooms. *Teaching and Teacher Education*, 60, 256–269.
- Tekle, F. B., Gudicha, D. W., & Vermunt, J. K. (2016). Power analysis for the bootstrap likelihood ratio test for the number of classes in latent class models. *Advances in Data Analysis and Classification*, 10(2), 209–224.
- Thomas, V., Peeters, J., De Backer, F., & Lombaerts, K. (2020). Determinants of self-regulated learning practices in elementary education: A multilevel approach. *Educational Studies*. <https://doi.org/10.1080/03055698.2020.1745624>
- Timperley, H., Wilson, A., Barrar, H., & Fung, I. (2007). *Teacher professional learning and development: Best evidence synthesis iteration*. Wellington: Ministry of Education.
- Tschannen-Moran, M., Woolfok Hoy, A. W., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research*, 68(2), 202–248.
- Vandeveld, S., Van Keer, H., & De Smul, M. (2016). Do regular and special education teachers differ in the way they promote self-regulated learning?. Presentation at the 7th biennial meeting of the Special

- Interest Group (SIG) 16 Metacognition of the European Association for Research on Learning and Instruction (EARLI). August, Nijmegen.
- Vandevelde, S., Vandenbussche, L., & Van Keer, H. (2012). Stimulating self-regulated learning in primary education: Encouraging versus hampering factors for teachers. *Procedia-Social and Behavioral Sciences*, 69, 1562–1571.
- Veenman, M. V. (2017). Assessing metacognitive deficiencies and effectively instructing metacognitive skills. *Teachers College Record*, 119(13), n13.
- Veenman, M. V. J., Van Hout-Wolters, B. H. A. M., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and methodological considerations. *Metacognition and Learning*, 1, 3–14.
- Venitz, L., & Perels, F. (2019). Promoting self-regulated learning of preschoolers through indirect intervention: A two-level approach. *Early Child Development and Care*, 189(13), 2057–2070.
- Vosniadou, S. (2001). What can persuasion research tell us about conceptual change that we did not already know? *International Journal of Educational Research*, 35(7–8), 731–737.
- Vosniadou, S. (2007). The cognitive-situative divide and conceptual change. *Educational Psychologist*, 42(1), 55–66.
- Wagner, D., Dörrenbächer, S., & Perels, F. (2014). A framework for designing training programs to foster self-regulated learning and text analysis skills. *Education Research International*, 2014, 1–15. <https://doi.org/10.1155/2014/510342>
- Werth, S., Wagner, W., Ogrin, S., Trautwein, U., Friedrich, A., Keller, S., Ihringer, A., & Schmitz, B. (2012). Förderung des selbstregulierten Lernens durch die Lehrkräftefortbildung «Lernen mit Plan. *Zeitschrift für Pädagogische Psychologie*, 4, 291–305.
- White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*, 48, 817–830.
- Whitebread, D., Coltman, P., Pasternak, D. P., Sangster, C., Grau, V., Bingham, S., Almqeqdad, Q., & Demetriou, D. (2009). The development of two observational tools for assessing metacognition and self-regulated learning in young children. *Metacognition and Learning*, 4, 63–85.
- Zepeda, C. D., Hlutkowsky, C. O., Partika, A. C., & Nokes-Malach, T. J. (2019). Identifying teachers' supports of metacognition through classroom talk and its relation to growth in conceptual learning. *Journal of Educational Psychology*, 111(3), 522.
- Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts & P. R. Pintrich (Eds.), *Handbook of self-regulation* (pp. 13–39). Academic Press.
- Zimmerman, B. J., & Bandura, A. (1994). Impact of self-regulatory influences on writing course attainment. *American Educational Research Journal*, 31(4), 845–862.
- Zohar, A., & Barzilai, S. (2015). Metacognition and teaching higher order thinking (HOT) in science education: Students' thinking, teachers' knowledge, and instructional practices. In R. Wegerif, L. Li, & J. Kaufman (Eds.), *Routledge international handbook of research on teaching thinking* (pp. 229–242). Routledge.
- Zohar, A., & Ben David, A. (2008). Explicit teaching of meta-strategic knowledge in authentic classroom situations. *Metacognition and Learning*, 3(1), 59–82.
- Zohar, A., Degani, A., & Vaaknin, E. (2001). Teachers' beliefs about low-achieving students and higher order thinking. *Teaching and Teacher Education*, 17(4), 469–485.
- Zohar, A., & Lustov, E. (2018). Challenges in addressing metacognition in professional development programs in the context of instruction of higher-order thinking. In Y. Weinberger & Z. Libman (Eds.), *Contemporary pedagogies in teacher education and development* (pp. 87–100). IntechOpen.
- Zohar, A., & Peled, B. (2008). The effects of explicit teaching of metastrategic knowledge on low-and high-achieving students. *Learning and Instruction*, 18(4), 337–353.
- Zohar, A., & Schwartz, N. (2005). Assessing teachers' pedagogical knowledge in the context of teaching higher-order thinking. *International Journal of Science Education*, 27(13), 1595–1620.