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Teachers' direct and indirect promotion of self-regulated learning in primary and secondary school mathematics classes – insights from video-based classroom observations and teacher interviews

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Abstract Self-regulated learning has a positive effect on academic outcomes; however, little is known about whether and how teachers at various education levels promote it in their classes. Video-based classroom observations were conducted to assess primary and secondary school mathematics teachers' direct and indirect promotion of self-regulated learning (SRL). Teachers' implicit and explicit instruction of SRL strategies (direct promotion of SRL) and the learning environment they created (indirect promotion of SRL) were rated according to how conducive they were to self-regulation. In addition, semi-structured interviews were conducted with the secondary school teachers to gain insight into their subjective views on SRL. Although the teachers' instructional practices could foster SRL, teachers spent little time explicitly teaching SRL strategies. Moreover, they taught mainly cognitive strategies and very few metacognitive strategies. These results were more pronounced at the primary level than at the secondary level. Primary school teachers provided learning environments conducive to self-regulation more often than secondary school teachers did. The interviews revealed that the teachers lacked knowledge about metacognition as an important component of SRL and were rather reluctant to promote it; however, most of them valued cognitive and motivational components of SRL. Primary and secondary school teachers need training to enhance their direct and indirect instruction of SRL. They could benefit in particular from learning about explicit instruction of SRL strategies and metacognition.

Keywords Self-regulated learning · Metacognition · Teacher · Observation · Interview · Strategy instruction · Learning environment

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Theoretical background

Self-regulated learning (SRL) refers to self-generated thoughts, feelings, and actions that help students reach their goals (Schunk and Zimmerman 1998). Researchers in the field of educational psychology have found SRL to be essential to success in and beyond school and from early childhood on (EU Council 2002). Results of international comparative studies conducted over the past few decades of students' academic performance indicate that students in most countries in most age groups lack competence in self-regulation (Artelt et al. 2003). In response, researchers have focused increasingly on how SRL can be enhanced at school. Despite the large amount of research on SRL, many questions concerning SRL and school practices remain unanswered, for example, do teachers currently promote SRL in their classrooms, if so, how, and do teachers promote SRL at different levels of schooling. Ostensibly, little investigation has been made into teachers' SRL practices and no comparison has been made of teachers' SRL practices in various settings. In this paper investigation is made into primary and secondary school mathematics teachers' knowledge and beliefs about SRL and the extent to which they promote SRL in their classrooms. First, two well-known models of SRL are presented. Second, an overview is given of research conducted on the teacher's role in supporting SRL at primary school and secondary school.

Models of SRL

Two well-respected models of SRL that have been used extensively as a basis for research on SRL (Panadero 2017) are those by Zimmerman (2000) and Boekaerts (1999). While Zimmerman's (2000) cyclical model describes the processes of SRL, Boekaerts (1999) three-layer model depicts the interaction among components of SRL.

Zimmerman's cyclical model of self-regulation Zimmerman (2000) describes self-regulation as being cyclical by nature, since "self-generated thoughts, feelings, and actions […] are planned and cyclically adapted to the attainment of personal goals" (p.14). This cyclical process is adapted to the characteristics of the immediate environment and the person her- or himself. Regulation processes are initiated whenever comparison of the current state and anticipated state leads to unsatisfying results, meaning that attainment of the goal is at risk. According to Zimmermann (1998), the process of SRL has three stages: a forethought phase that involves goal-setting and planning, a performance phase that involves performing a task and self-monitoring, and a reflection phase that involves evaluation of the result and learning process. The conclusions drawn from self-reflection have an impact on the learner's self-concept. The outcome of this self-evaluation influences the subsequent forethought phase, leading to the cyclical character of the model. Zimmerman (2000) illustrates this as a feedback loop process.

Boekaerts' three-layer model Boekaerts (1999) depicts SRL as having various components that interact. In Boekaerts (1999) model SRL has three layers: The inner layer represents cognitive strategies, the middle layer represents the way students direct their learning process, and the outer layer represents the self-system comprising students' goals, motivation, and emotions. During the process of learning, cognitive, metacognitive, and motivational strategies interact (Boekaerts 1999). Metacognition, however, has a special

status in SRL theory, as it maintains the system's efficiency by monitoring and controlling concentration, affect, and use of cognitive strategies (Corno 1986).

In the present study we refer to the social-cognitive models of SRL developed by Zimmerman (2000) and Boekaerts (1999), which take into account various features of the learning process and the learning environment. The two models come together in Boekaerts' (2002) adapted version of Schunk and Zimmerman's (1994) well-known definition of self-regulation in which self-regulation is described as "students' attempts to attain personal goals by systematically generating thoughts, actions, and feelings at the point of use, taking account of the local conditions" (Boekaerts 2002, p. 595).

The Teacher's role as strategy instructor

There is an abundance of empirical evidence that SRL has a positive effect on academic achievement and learning efficiency (e.g., Zimmerman and Bandura 1994). Although results of numerous intervention studies indicate that students can learn strategies to regulate their own learning (see e.g., Dignath and Büttner 2008; Hattie et al. 1996), many questions remain unanswered (Winne 2005) about the instruction of SRL strategies in real classrooms. In a meta-analysis of the effectiveness of training programs to foster SRL, Dignath and Büttner (2008) found that self-regulation training was most successful when led not by students' regular teachers but rather by researchers, a finding which is alarming because teachers play a crucial role as multipliers in supporting their students' self-regulation of learning. According to the conclusions drawn from the findings of that meta-analysis, teachers might not be receiving enough training on how to teach self-regulation strategies or might not be able to see the benefits of teaching SRL or the need to support it. Little investigation has been made into regular classroom teachers' instruction of SRL strategies. In the few studies of this topic teachers spent little time teaching SRL strategies in class (see e.g., Bolhuis and Voeten 2001; Hamman et al. 2000; Moely et al. 1992; Spruce and Bol 2014), and if teachers addressed aspects of SRL in class, they focused on the instruction of cognitive strategies but did not draw students' attention explicitly to the self-regulatory processes they were using (Cartier et al. 2010; Dignath- van Ewijk et al. 2013). Correspondingly, Cartier et al. (2010) found that students reported gains in using cognitive strategies but not self-regulatory strategies. Moreover, they found students' increase in cognitive strategy use to decline after a while, indicating that teachers' practices to support cognitive strategy use had only a short-term effect. However, research on SRL has revealed new implications for schools and teachers. One suggestion is to embed the teaching of SRL strategies in the curriculum in order to lay the foundation for strategic learning as early as possible (e.g., Randi and Corno 2000). Many national and international institutions have incorporated the instruction of SRL strategies in their educational programs as part of a lifelong learning initiative (e.g., the European Framework of Lifelong Learning (EU Council 2002)). Thus, one component of teacher education should be methods to help students learn how to learn. There is evidence that teachers can be supported in developing their SRL practices. Butler et al. (2013) examined in-service teachers' SRL practices in the scope of a professional development project based on inquiry. The teachers in their sample modified their instructional practices by employing strategies to draw students' attention to learning processes with more content-focused instruction. Such SRL practices were strongly associated with an increase in the students' self-reported use of SRL strategies. Perry et al. (2008) investigated how mentors of preservice teachers supported their student

teachers in SRL instructional practices during post-observation discussions. Their results indicate that the mentors scaffolded student teachers' learning of SRL instructional practices, and they differed in terms of explicitness in their discourse about SRL. These studies offer promising examples of how (beginning) teachers can be supported in developing SRL instructional practices.

Ways to promote SRL

The aforementioned concepts of SRL integrate various elements such as the instruction of strategies and the construction of the learning environment into one model of how to promote SRL (e.g., Boekaerts and Cascallar 2006; Pintrich 2000). Zimmerman and Bandura (1994), for example, underlines the impact of the classroom context on students' self-regulation. A classroom context that indirectly encourages students to self-regulate is one based on constructivist views on learning, which involves active and collaborative, and authentic learning and acquisition of knowledge and skills (De Corte et al. 2004). Constructivist learning theory postulates that learners actively construct their knowledge (Harris & Alexander 1998). Although definitions of constructivism may emphasize different aspects of learning, and their theoretical perspectives on constructivist learning environments are not always the same (Gijbels et al. 2006), they are based on similar assumptions about learning (see Loyens et al. 2007): First, knowledge acquisition is defined as a process of knowledge construction, with learners building their knowledge by relating new input to previously gained knowledge. Second, constructivist views on learning share the idea that social interaction impacts knowledge construction (e.g., Greeno et al. 1996). Because the level of communication among students is similar but differs from the level of communication of the teacher, social interaction among the students should foster discussion on the subject matter, which often leads to deeper understanding (Slavin 1996). Third, constructivist learning as learning in context should occur during activities that resemble real-life situations, as they challenge students with authentic and meaningful problem structures which are complex in that they have interacting elements and multiple solutions and thereby encourage the transfer of knowledge (e.g., Mayer & Wittrock 1996). Fourth, constructivist learning takes place in contexts resembling real-life situations by challenging students with authentic and meaningful problems. Research has shown that students can benefit from learning environments that allow them to take responsibility for their learning (e.g., Tenenbaum et al. (2001)). Cartier et al. (2010) investigated teachers' SRL practices during reading lessons and found that teachers used many of the above-mentioned characteristics of learning environments to create opportunities for students to engage in self-regulation. However, they observed that teachers did not explicitly discuss with their students what SRL was or when or how they could employ SRL strategies.

In addition to fostering SRL indirectly by creating opportunities for students to engage in SRL, teachers can promote SRL directly by teaching strategies implicitly or explicitly (see Dignath- van Ewijk et al. 2013). If teachers give students a task that requires applying a certain strategy without providing the students with any information about this strategy in order to foster understanding about the significance of this activity, no explicit instruction of SRL strategies takes place; rather, teachers implicitly initiate strategic activity. Further, students learn about a strategy in an implicit way if the teacher models the strategic activity without explicitly informing the students that the activity is helping them develop a learning strategy.

Although this can enhance students' use of the strategy, it often fails to maintain its generalization (Veenman 2011). If students are both induced to employ a certain strategy and provided with explicit information about the significance of that strategy, the result should be an improvement in performance and the development of the ability to employ the strategy again when faced with a similar problem (Veenman 2013).

Most researchers of SRL agree that direct and indirect promotion of SRL have to be combined in order to develop self-regulated learners (e.g., Paris and Paris 2001). They argue that direct training of SRL strategies alone would be too abstract for students to understand what they were to do; however, indirect training of SRL strategies alone would overstrain students, as they would be unable to cope with the autonomy without knowing strategies to act effectively (Pressley et al. 1992). They suggest teachers scaffold strategy use until students are able to self-regulate their learning. With this scaffolding method, students learn to self-regulate first by being regulated by their teacher; next, by modeling and receiving guidance; then, by reflecting on feedback (Perry et al. 2008). According to the concept of scaffolding, young students, who still are unexperienced learners, first might need more direct instruction of SRL strategies than older, more experienced learners, who already have acquired some self-regulation skills; however, both younger and older students need learning opportunities that allow them to engage in self-regulation at the same time SRL strategies are being taught and scaffolding is taking place.

Teaching SRL strategies at the primary and secondary school levels

Research on self-regulated learning has revealed that SRL and metacognitive strategies develop with age (Pressley et al. 1992), and that although progression and regression occur, this development takes place continuously, and the components of metacognitive skills can develop at various speeds and different moments (Van der Stel & Veenman 2014). Although for decades experts have agreed that metacognition and SRL develop after the age of eight (Veenman et al. 2006), research conducted over the last two decades has revealed that metacognitive ability and SRL can be detected in younger children (e.g., Perry 2002; Whitebread and Coltman 2010; Whitebread et al. 2009). There is evidence that executive functions, a precursor of self-regulation, rapidly develop between the ages of two and seven due to an increase in neural pathways in the prefrontal cortex that relate to executive functions (McKenna et al. 2017). After this period the prefrontal cortex, executive functions, and self-regulation progress more gradually until young adulthood (Zelazo & Carlson 2012). These findings indicate that there are differences in how students self-regulate at different ages. Moreover, there is evidence that self-regulation plays an important role in young children's classroom behavior and achievement (e.g., Ponitz et al. 2008). Unlike prior research on teaching SRL strategies, which was conducted mostly with students older than elementary school age, recent studies have reported the use of self-regulation strategies by younger children (e.g., Biemiller et al. 1998; Bronson 2000; Perry et al. 2002, 2004; Whitebread 1999). Results of a meta-analysis conducted by Hattie et al. (1996) of SRL strategy interventions revealed that the youngest children in primary school benefitted the most from strategy training. Dignath et al. (2008) also found in a meta-analysis that interventions to promote the SRL of primary school students proved to be effective at a young age (a mean effect of $d = .69$). According to the findings of this meta-analysis, training students' self-regulation skills is more effective for younger primary school students than for older primary school students. Fostering SRL at the beginning of schooling is especially

important because during these first few years students develop attitudes toward learning and self-efficacy (Whitebread 2000), which are difficult to change once established. Therefore, De Corte et al. (2000) argue that SRL should be induced from early schooling on as it is one of the main goals of learning processes.

The question as to how students can be supported most effectively with their learning to self-regulate at various developmental stages remains unanswered. In another meta-analysis, Dignath and Büttner (2008) compared the effectiveness of self-regulation training at primary and secondary school levels. They found that at primary school, basing a SRL training program on motivational learning theories (e.g., Schober & Ziegler 2001) led to greater effects than interventions based on metacognitive learning theories (e.g., Desoete et al. 2003). At secondary school, the opposite was the case. Furthermore, metacognitive reflection only at secondary school had positive effects. This could indicate that younger students, who have less stable self-regulation capacity, still need more support to increase their motivation in order to develop SRL, whereas older students, who have more advanced self-regulation capacity, can integrate new self-regulation strategies into their learning more easily. Therefore, metacognitive strategies might be more easily taught directly to older children than to younger children. These findings suggest that teaching younger children a combination of metacognitive and motivational strategies might be more suitable.

With regard to the indirect promotion of SRL, Dignath and Büttner (2008) found a positive impact of group work at secondary school but a negative effect at primary school (Dignath and Büttner 2008). Older students, who already employ the strategies needed to self-regulate their learning, probably benefit more from a self-directed learning environment where they have the opportunity to engage in SRL effectively. Younger children may need to learn the strategies needed for self-regulation before they can benefit from an open learning environment. However, little is known about age differences in students' self-regulation of learning and how different age groups can be supported best.

Investigating the promotion of SRL in context

Investigation into how teachers support SRL in their classroom has been made predominantly by means of self-report questionnaires (see e.g., Lombaerts et al. 2009). Most questionnaires developed to assess teachers have focused on general teaching quality, which often includes some aspects that can serve to assess teachers' promotion of SRL. In self-report questionnaires investigation is made into teachers' perceptions of their teaching, which might not be the same as students' or observers' perceptions of their teaching (see Den Brok et al. 2006; Seidel 2006). Fraser (1998), for example, found that teachers tended to perceive their classroom management more positively than their students did. Dignath- van Ewijk et al. (2013) replicated this result for teachers' support of SRL. They showed that teachers' self-ratings of their promotion of SRL did not correlate with direct classroom observation. Compared to survey research portraying the beliefs of the person under investigation, observational research has the advantage of directly portraying the actions of the investigated behavior (Patrick and Middleton 2002).

In very few studies have direct measures been used to assess teachers' promotion of SRL (e.g., Perry et al. 2002). Data gathered by observing teachers during class can add to teachers' self-reported data by providing new perspectives on their promotion of SRL. Most observation instruments designed for investigating teachers' SRL instructional practices assess teachers' direct promotion of SRL through explicit instruction of SRL strategies. Moely et al. (1992)

observed 69 primary school teachers and found that instruction of SRL strategies was relatively infrequent. Teachers of older primary school students provided a rationale for teaching cognitive strategies more often than teachers of younger children did. Hamman et al. (2000) observed 11 secondary school teachers during daily instruction on three separate occasions. They found that the teachers rarely supported learning strategy use. In their observation-based study of 68 secondary school teachers Bolhuis and Voeten (2001) found that little time was spent on teaching students how to learn. Dignath- van Ewijk et al. (2013) observed 34 lessons of secondary school teachers. They found evidence that the instruction of self-regulation strategies took place rather infrequently and mainly cognitive learning strategies were taught. Also Spruce and Bol (2014) conducted classroom observations of 10 primary and secondary school teachers and found teachers supported SRL in a limited way only. The findings of observation-based research on teachers' direct promotion of SRL are consistent in that instruction of SRL strategies is infrequent in primary and secondary school classrooms. Since research has shown the importance of direct strategy instruction (see e.g., Pressley et al. 1992; Veenman 2011), the question arises as to why teachers do not address SRL more explicitly during their teaching. Gathering data through observation allows direct scrutiny and immediate assessment of behavior, which is less subjective than assessment of behavior based on self-report; however, it provides only limited insight into teachers' beliefs. Observation and self-report measures should be combined to investigate the relationship between both, as they do not necessarily measure the same thing (Patrick and Middleton 2002). Also, different methods should be employed and different perspectives should be taken when investigating classroom instruction in order to conduct a thorough analysis (Clausen et al. 2003).

Research questions

The aims of this study were (1) to investigate similarities and differences in teachers' promotion of SRL in primary and secondary mathematics classrooms, and (2) to combine information on the promotion of SRL from classroom observations with information on teachers' self-reported beliefs and knowledge about promoting SRL. To reach the first aim, we video recorded primary and secondary school mathematics classes to assess teachers' promotion of SRL. To reach the second aim, we conducted semi-structured interviews with the video-recorded teachers in order to investigate their self-perceptions, beliefs, and knowledge about supporting SRL. For organizational reasons, the interviews could be realized with a sub-sample of the secondary school teachers only. The following research questions were addressed:

RQ 1: Do the primary and secondary school teachers differ in how they promote SRL directly (instruction of strategies) and indirectly (learning environment)?
RQ 2: What do the secondary school teachers know and believe about the promotion of SRL?
RQ 3: How are the secondary school teachers' knowledge and beliefs about promoting SRL and their perception of their promotion of SRL in the classroom related to their observed promotion of SRL in the classroom?

This research is innovative since in most previous studies of teachers' promotion of SRL focus has been on the direct promotion of SRL, that is, teachers' instruction of SRL strategies (Hamman et al. 2000; Moely et al. 1992; Spruce and Bol 2014). Only in the studies by Butler et al. (2013), Dignath- van Ewijk et al. (2013), and Kistner et al. (2010) were teachers' indirect

promotion of SRL additionally assessed. These three studies were conducted in secondary school classrooms. Ostensibly, no comparison has been made of the SRL instructional practices between primary school teachers and secondary school teachers.

Methods

Participants

Participation of schools and teachers was voluntary. Pupils and their parents were asked for their consent to participate in the study. Participating teachers were informed that the researchers were testing a newly developed instrument for observing teachers' classroom design. Twenty-eight teachers took part in the video study. Since participation was voluntary, the participating teachers were assumed to be fairly motivated and interested in the topic. The schools were located in the outskirts (up to 50 km from the city center) of a mid-sized city in southwest Germany. All the teachers had a master of education degree. None of the teachers had a migration background. Teachers claimed to have had little experience with SRL; none of them had ever attended specific training on SRL. Teachers were asked to teach in a natural way so that the recorded lesson would be representative of each teacher's teaching style.

Primary school sample Only schools that represented the average primary school in this area were contacted about participating in the study. The participating primary schools did not differ much in size ($M = 292.83$ students; $Min = 200$; $Max = 362$). They all were situated in socially mixed neighborhoods and had heterogeneous student populations in terms of SES and cultural background. Twelve primary school teachers (mean age: 39 years ($SD = 10.53$); average number of teaching years = 14 ($SD = 12.53$); 1 male) were video recorded during mathematics and science lessons. Two lessons of each teacher were recorded (one in mathematics and one in science), with each lesson lasting 45 min. For comparability reasons with the secondary school sample, only the mathematics lessons were analyzed. The 12 teachers worked in nine different primary schools. Each teacher was teaching third grade while being video recorded. Classes on average consisted of 20 students aged 8 and 9.

Secondary school sample With regard to the secondary school sample, we also contacted schools that were representative for the area. Most of the participating schools were located in a mid-sized city in southwest Germany; some were in the surrounding area. The schools were rather large schools ($M = 1107.29$ students; $Min = 780$; $Max = 1350$), which was representative of schools in the city. Sixteen secondary school teachers[1] (mean age: 46 years ($SD = 11.02$); mean number of years of teaching experience: 17 years ($SD = 12.92$); 11 male) were video recorded while teaching grade 7 mathematics at a "Gesamtschule" or "Gymnasium". These are secondary schools in the Germany[2] that students attend after primary school at the age of 10,

[1] This was a subsample of teachers who had participated in another study in which we compared the observation data of these lessons to questionnaire data from teachers' own ratings of their promotion of SRL as well as with students' ratings of their teachers' promotion of SRL (see Author et al., 2013).

[2] Germany has a tripartite school system. After finishing primary school at around the age of 10, students are assigned to one of four types of secondary school, which end either at the age of 15 ("Hauptschule") or at the age of 16 ("Realschule") with a qualification for vocational training, or at the age of 18/19 with a general qualification for higher education studies ("Gymnasium" and "Gesamtschule").

and upon successful completion they obtain general qualification for higher education studies. The students were $M = 12.4$ years on average ($SD = .57$), and the gender of the students was almost equally distributed (female: 48.5%). The average number of students per class was 21.19. In addition to the video recordings, interviews were conducted with a subsample of nine teachers who volunteered to participate in an additional interview. This subsample of teachers did not differ from the rest of the sample with regard to their experience or interest, but according to the teachers the choice not to participate in an interview was related to the additional workload. Teachers who volunteered to participate in the interview were assumed to be particularly interested in the study or the topic of SRL. To determine the comparability of teachers who participated in the interview and those who did not, we conducted Mann-Whitney U-tests of both groups. Moreover, to test the reliability of our findings we compared the primary school teachers and the secondary school teachers by conducting the same analyses with those who were interviewed and with those who were not. With this procedure we excluded differences in direct and indirect promotion of SRL between secondary school teachers who participated in the interview and those who did not. The results of the comparison of the primary school teachers to both subsamples of secondary teachers indicated comparability among the groups.

Design

This study followed a mixed-method design in which qualitative and quantitative measures were combined to assess teachers' promotion of SRL and their knowledge and beliefs about the promotion of SRL. The design also was quasi-experimental in that primary and secondary school teachers' promotion of SRL in mathematics classes were compared. All teachers were first video recorded while teaching and secondary school teachers then participated in interviews.

Data analysis

The classroom videos were coded systematically by two coders with *ATES* (*Assessing How Teachers Enhance Self-regulated Learning*) observation instrument developed by Dignath et al. (2008). The *ATES* instrument had been developed in several steps (a description can be found in Dignath- van Ewijk et al. 2013) and tested for reliability and validity. The coders in this study were students in a master of psychology study program. They had participated in extensive coder training and had been working on the project on SRL for quite some time. To help the coders become familiar with the coding system, the first author conducted training in coding with the two coders prior to data collection. This training involved coding 22 video recorded lessons of five primary school teachers which were not included in the final data collection. These video recorded lessons served for training and for interrater reliability checks. The 30 h of training in coding involved differentiating among the categories of the observation instrument. Once coders were familiar with the theoretical background of the instrument and the coding procedures, they started collaborative coding of the video recorded classroom lessons, which were not included in the analyses of this study. After successfully coding five videos collaboratively, coders started coding the videos separately, and results were discussed together afterwards. The training in coding took place until intercoder agreement reached

80%. Each of the coders coded half of the videos. During the coding process, regular comparison took place in order to ensure intercoder agreement.

The interviews were coded by two trained coders who were not the coders of the classroom videos. The interviews were highly structured and could be coded by means of a systematic coding scheme. Coding teachers' definitions of strategies (direct promotion of SRL) and their descriptions of the learning environment (indirect promotion of SRL) was in line with the model of the observation instrument (see Instruments section below). All interviews were coded twice by both coders. Thanks to the systematic coding scheme, intercoder agreement reached 94%, and disagreement was resolved through discussion.

From the observation data we identified the teacher who had the highest scores with regard to direct and indirect promotion of SRL. Regarding the direct promotion of SRL, we considered mainly the instruction of metacognitive strategies, which are central to self-regulation. We provide an in-depth description of the interview data gathered on this particular teacher in order to provide an example of how SRL could be promoted effectively in a real classroom setting.

Instruments

Observation instrument

Analyses of classroom videos were conducted with the highly structured *ATES* observation instrument (Dignath et al. 2008; Dignath- van Ewijk et al. 2013), which had been developed to assess teachers' promotion of SRL and employed in several studies (see e.g., De Smul et al. 2017; Dignath- van Ewijk et al. 2013). The part of the *ATES* that can be used to rate the indirect promotion of SRL (*characteristics of the learning environment*) requires high-inferent coding; the part that can be used to rate the direct promotion of SRL (the *type of strategy* addressed, and whether a teacher teaches a strategy in an *explicit or implicit way*) requires low-inferent coding. While direct instruction of strategies provides students with a repertoire of strategies to self-regulate their learning, the learning environment can support the automation of self-regulatory processes by creating opportunities to practice the application of strategies and to experience conditions of its application (Paris and Paris 2001).

For coding purposes, each time-sampling observation took 1 minute, producing approximately 45 segments for a representative lesson. Videotaping began as soon as a lesson began and continued until the lesson ended. As recordings could differ in length, a standardized average frequency related to the total length of each lesson was computed. Teachers' behavior during each time-sampling was scored as an occurrence of one of the three strategies (cognitive, metacognitive, or motivational) being taught, or as no strategy being taught. As the length of the lessons varied between 29 and 60 min (M = 42.17 min; SD = 5.88), total frequencies per lesson were standardized to an interval of 45 min (variable/min × 45), which is the standard length of a lesson at primary and secondary schools in Germany. The videos were coded according to time-sampling with 1 minute being the unit of analysis because shorter units proved to be impractical during the testing phase of the instrument (mainly because the interval had to be long enough to capture at least parts of teachers' utterances), and longer units would increase the risk of information loss. During the pilot testing of the instrument, the coding procedure was varied with the aim of coding as much detailed information as possible, but at the same time, regular checks were performed to assure that satisfactory intercoder agreement was attainable. Consequently, the time-sampling was varied in order to find the shortest unit that is possible to code precisely. This procedure created between 60 and 135

segments that could be scored for each teacher (two to three observations × 30–45 min x one segment per minute).

To determine the reliability of coding of the low-inferent coding Cohen's (1960) Kappa coefficient was computed. This measurement, for the agreement of nominal data, is corrected for chance and most frequently is used to assess the reliability of data of observation systems (Simon 2006). Teachers' instructions (during each one-minute segment) were categorized as instances of the four main categories. Inter-observer reliability checks based on the coding of 22 video recorded lessons ranged from .65 to .90 (Cohen's Kappa).

Direct promotion of SRL

The coding system of the *ATES* is based on the models of SRL by Zimmerman (2000) and Boekaerts (1999). Accordingly, strategies are classified within the three areas of cognitive, metacognitive, and motivation strategies. Instruction of strategies was coded as *implicit* each time a teacher activated the students' strategic behavior without addressing the strategic aspects of that behavior, for example, when asking a question that encourages the students to elaborate on their learning. Moreover, instruction of strategies was coded as implicit if the teacher acted as a role model without addressing the strategic aspect in her or his behavior; e.g., by thinking aloud when solving a mathematics problem. Finally, any utterance made by a teacher which could be assumed to trigger strategic behavior in students through observing the teacher's behavior was coded as implicit instruction of strategies even if it was unclear whether the teacher had intended to enhance students' strategic behavior or not. Instruction of strategies was coded as *explicit* when the students were induced to perform a certain activity and were explicitly informed that the activity involved using a SRL strategy. "Explicit" meant that the teacher uses the word "strategy" or the name or description of the strategy. The teacher's intention to instruct a strategy at this point was made clear. The teacher provided students with information about the application or the benefit of a certain strategy or engaged in and/or encouraged students to engage in metacognitive reflection on this strategy.

Indirect promotion of SRL

1. Constructivist characteristics of the learning environment were coded according to the learning opportunities they provided for indirectly fostering SRL. Unlike the direct instruction of SRL strategies, which was coded in one-minute intervals of teachers' utterances, the characteristics of the learning environment were coded at the end of the lesson by means of a rating scale. This rating scale contained nine items, each of which were rated on a four-point Likert scale with the options *never*, *rarely*, *often*, or *mainly observable* (see Dignath et al. 2008; Dignath- van Ewijk et al. 2013). Quantity and Quality of Cooperative Learning

    - The teacher encourages various forms of cooperative learning during class.
    - The teacher ensures that the students work together cooperatively and intervenes if necessary.

2. Activation of Prior Knowledge

    - The teacher prompts the students to activate prior knowledge and to integrate new input.

- The teacher presents new information in a meaningful context and/or introduces information by creating a cognitive conflict.
- The teacher presents complex and/or open and/or marginally structured problems which can be handled in different ways and/or allow several solutions.

3. Fostering Transfer Through Situated Learning and Problem-Based Learning

- The teacher allows the students to take responsibility for structuring their learning by giving them some freedom to make decisions.
- There is a balance between self-directed learning and teacher-directed learning.

4. Self-Determination of Students

- Learning takes place in a real-life context.
- The teacher presents the learning content in diverse contexts and/or presents diverse ways of looking at a problem.

The internal consistency of the overall rating scale was satisfactory (Cronbach's $\alpha = .69$). For the high-inferent part of the instrument, intra-class correlations were analyzed (ICC; Shrout and Fleiss 1979), that revealed acceptable reliability for all of the scales (ICC = .78 to 1.00).

Teacher interview

The interview addressed teachers' knowledge of self-regulation strategies, their beliefs on the importance of teaching these strategies, as well as the frequency of teaching these strategies in their classes and the questions asked were constructed according to the models of SRL upon which the *ATES* was based. Questions were posed about teachers' knowledge, beliefs, and frequency of instruction of cognitive, metacognitive, and motivational strategies. Moreover, the questions addressed teachers' knowledge and beliefs about designing a learning environment conducive to SRL, which promotes cooperative learning, activation of prior knowledge, transfer between learning content and students' experiences and their everyday life, analysis of problems that can be solved in different ways, students taking responsibility for their learning, balance between teacher-directed and student-directed learning, and situated learning. Teacher interviews were semi-structured with 10 questions about their beliefs (e.g., "How important is it to integrate cognitive strategies into your teaching?") and frequency of teaching SRL strategies (e.g., "How often do you teach cognitive strategies?"), which were to be answered on scales (e.g., "Please indicate on a scale from 1 to 6, with "1" indicating "never" and "6″ indicating "very often".), and 10 questions about their knowledge (e.g., "What do you understand by the term cognitive strategy?") and behavior (e.g., "How do you embed learning in naturalistic problems or authentic situations?"), which had an open-ended answering format. The answering scale for teachers' self-reported frequency of application ranged from 1 ("I never do that") to 6 ("I always do that"), and for teachers' beliefs from 1 ("I do not find this important at all") to 6 ("very important"). Open-ended answers were transcribed from the audio recorded interviews and coded according to a coding scheme by two coders. Teachers' answers were coded according to the definition of the three types of strategies mentioned in the manual of the *ATES* (see Dignath et al. 2008). The answers were coded as 0 (no answer), 1

(correct description or correct example), or 2 (correct description and correct example). Intercoder reliability reached 94% and differences in coding were resolved through discussion.

Results

RQ 1: Do the primary school teachers and secondary school teachers differ in how they promote SRL directly (instruction of strategies) and indirectly (learning environment)?

To answer the first research question, means and standard deviations were computed for teachers' instruction of cognitive, metacognitive, and motivation strategies (direct promotion of SRL), as well as for the aspects of the design of the learning environment that are expected to foster SRL (indirect promotion of SRL).

Direct promotion of SRL

Explicit vs. implicit instruction of strategies In terms of direct promotion of SRL, hardly any explicit instruction of strategies was observed. Due to the lack of variation in the observed teacher behavior, intercoder reliability with regard to the distinction between *implicit* and *explicit* instruction of strategies was low and therefore results have to be interpreted with caution. No explicit instruction of strategies was observed in the videos of primary school-teachers. In the videos of secondary school teachers, Michael was the only teacher who spent 2.43 min of his lesson on metacognitive reflection of strategy use. Moreover, six secondary school teachers discussed with their classes the benefit of using a particular strategy. They spent $M = 1.14$ min ($SD = 6.92$) on average on this explicit instruction of strategy ($Min = 0$; $Max = 6.92$).

The following results concern the implicit modelling of strategies. The cognitive strategies were the most frequently taught by primary and secondary school teachers, whereas motivation strategies and metacognitive strategies were less often taught. Table 1 represents means of the respective strategy taught per standardized 45-min segment.

Primary school At primary school, no direct instruction of any type of learning strategies took place. If teachers spent time promoting students' self-regulation, they emphasized the use of cognitive strategies and very seldom the use of metacognitive or motivation strategies. The instruction of cognitive strategies varied substantially with some primary school teachers not spending any time at all on cognitive strategies and others spending up to 18 min on promoting cognitive strategies. On average, primary school teachers devoted almost 7 minutes of their 45-min lesson to the implicit instruction of cognitive strategies. On average, teachers spent 2 minutes per lesson on the promotion of metacognitive strategies and 2 minutes on the promotion of motivation strategies. Here, primary school teachers also varied: some spent hardly any time teaching metacognitive strategies or motivation strategies while others spent more than 5 minutes on each of these. Tom, the teacher who spent the most time teaching metacognitive strategies, also encouraged cooperative learning during his lesson and maintained a good balance between teacher-directed and student-directed learning. He did not teach any cognitive strategies and spent only 1 minute on

Table 1 M and SD at primary and secondary school levels

Categories	*M* (*SD*) for Primary School (*N* = 12)	*Min* for Primary School (N = 12)	*Max* for Primary School (N = 12)	*M* (*SD*) for Secondary School (*N* = 16)	*Min* for Secondary School (N = 16)	*Max* for Secondary School (N = 16)
Cognitive strategy instruction	6.59 (5.51)	0	18	25.38 (8.67)	13.3	39.16
Metacognitive strategy instruction	2.59 (1.64)	.33	5.33	3.64 (3.93)	0	11.25
Motivation strategy instruction	2.03 (1.61)	.33	5.67	6.69 (5.10)	0	16.36
Overall sum score rating scale learning environment	19.53 (1.33)	18	21	15.44 (3.27)	12	23
Overall mean score rating scale learning environment	2.17 (.15)	1.96	2.37	1.72 (.36)	1.33	2.56

motivation strategies. Hilde, the teacher who spent the second most amount of time teaching metacognitive strategies, spent almost equally as much time on cognitive and motivation strategies, encouraged cooperative learning, and created constructivist learning opportunities for her students. Frieda also instructed metacognitive strategies and spent one third of her lesson on cognitive strategies. She used rather teacher-centered methods, but nevertheless created a highly constructivist learning environment and initiated authentic learning activities. Similarly, Anna and Quintin's lessons were teacher-directed and involved complex and authentic learning tasks. They spent more than 10 min teaching cognitive strategies but no time on metacognitive or motivation strategies.

Secondary school Four secondary school teachers spent more than 5 minutes teaching metacognitive strategies. Walter spent the most time teaching metacognitive strategies (11.25) and motivation strategies (16.36). He also spent a considerable amount of time on cognitive strategies (13.30). His instruction was very much teacher-directed and did not offer students many opportunities to engage in SRL. Michael invested a comparable amount of time on the instruction of cognitive strategies (15.81) and metacognitive strategies (10.95) but less time on motivation strategies (4.87). Meanwhile, he constructed a very student-centered learning environment that offered complex and authentic learning tasks and required students to work cooperatively. While Karl spent most of the time on cognitive strategies (35.58), he neglected the other strategies and employed a highly teacher-centered style of instruction. In contrast, Hans spent an equal amount of time teaching cognitive strategies (31.71) but also taught metacognitive strategies (9.21) and motivation strategies (6.14) and offered student-centered learning opportunities that promoted SRL.

These findings indicate that the teachers differed substantially in how they promoted SRL directly and indirectly. While some teachers supported SRL directly and at the same time

indirectly by offering opportunities to participate in SRL, others concentrated either on teaching some SRL strategies (mainly secondary school teachers) or on creating a learning environment conducive to SRL (mainly primary school teachers).

Indirect promotion of SRL

Primary school teachers were homogeneous with regard to their indirect promotion of SRL. On a scale from 1 to 4, they scored 2.17 on average with the lowest mean score of 1.96 and the highest mean score of 2.37 per teacher. The primary school teachers with high scores for the indirect promotion of SRL gave students complex learning tasks that encouraged them to search for their own solution. They embedded the tasks into real-life contexts that encouraged transfer of knowledge to a context outside of school. Students were gaining knowledge through instructional methods that offered open learning opportunities. In many cases, the teachers used cooperative learning methods to elicit discussion among the students. Nancy, Kim, Elly, and Sandra, the four teachers with highest scores for the indirect promotion of SRL, created many opportunities for students to self-regulate, but they spent hardly any time teaching strategies. In contrast, Hilde, who received the lowest score on the rating scale, taught students cognitive, metacognitive, and motivation strategies.

Unlike the primary school teachers, the secondary school teachers obtained lower mean scores on the rating scale. Many of them exhibited a highly teacher-directed style of teaching that did not allow the students to have an active role in, or to take responsibility for, their learning. Moreover, teachers with low scores on the rating scale did not create learning opportunities that encouraged transfer of the learning content to real-life situations; rather, they kept the learning content at an abstract level. They did not initiate tasks that activated the students' prior knowledge and did not make any attempt to create cognitive conflict. Only three secondary school teachers obtained high scores with regard to their indirect promotion of SRL. These three teachers had students work in groups on open and complex problems that were presented in everyday contexts. One of these teachers, Hans, spent more than half of his teaching time modelling cognitive strategies (31.71), and he received the highest scores on modelling metacognitive strategies (9.21) and motivation strategies (6.14). Michael also was one of the teachers who spent the most time on implicit instruction of metacognitive strategies (10.95), and quite some time on cognitive strategies (15.81) and motivation strategies (4.87). Benjamin scored rather high on all aspects of the learning environment, but he instructed only few metacognitive strategies (2.09) and motivation strategies (4.18) and focused more on cognitive strategies (15.70).

Difference between primary and secondary school

For variables that were normally distributed according to the Kolmogorov-Smirnov test, analyses of variance were run to compare primary and secondary school lessons. For variables that were not normally distributed, Mann-Whitney U tests were computed to investigate differences in the central tendency of two independent samples. Additionally, Cohen's *d*, corrected for different sample sizes by including the pooled standard deviation, was computed from mean values and standard deviations, and served as effect size in order to facilitate the interpretation of the practical significance of possible differences (Hedges and Olkin 1985).

Direct promotion of SRL With regard to the direct promotion of SRL strategies, results of analyses of variance indicated significant differences in the amount time spent teaching cognitive strategies ($F = 43.00$; $df = 1/26$; $p < .01$; Cohen's $d = 2.51$) and motivation strategies ($F = 9.24$; $df = 1/26$; $p < .01$; Cohen's $d = 1.16$). On average, secondary school teachers spent more time on modelling strategic thinking than primary school teachers did. However, when taking a closer look at the types of strategy taught, it becomes clear that instruction differed between primary school teachers and secondary school teachers with regard to cognitive and motivation strategies only. Very little time was spent teaching metacognitive strategies at either school level. Results of U-tests revealed no significant difference in the instruction of metacognitive strategies between primary school and secondary school ($U = 92$, $p = .85$; Cohen's $d = .33$) (Fig. 1).

Indirect promotion of SRL With regard to the learning environment, results of an analysis of variance indicate that primary school teachers significantly exceeded secondary school teachers with an average rating of 19.53 versus 15.44 on the rating scale ($F = 16.63$; $df = 1/26$; $p < .01$; Cohen's $d = 1.56$). Results of U-tests revealed that primary school teachers had significantly higher scores on the *cooperative learning* ($U = 50.5$, $p = .02$), *constructivist learning* ($U = 23$, $p = .001$), and *creating environments conducive to SRL* ($U = 42.5$, $p = .01$) subscales. No significant difference was found for the *student-directed learning and teacher-directed learning* ($U = 62$, $p = .11$) subscale although the descriptives point in the same direction and Cohen's d indicates a medium-sized effect (see Table 2).

RQ 2: What do the secondary school teachers know and believe about promoting SRL?

The interview questions were constructed according to the models of SRL upon which the ATES is based in order to allow comparison of the outcomes assessed with both parts of the instruments. Answers to the open questions were coded using the *ATES* scheme. Some items on the questionnaire involved rating on a scale similar to the rating scale of the *ATES*. In

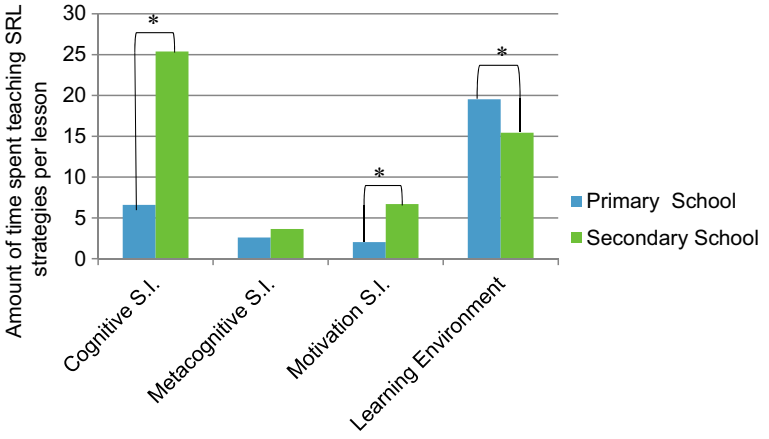

Fig. 1 Amount of time spent teaching SRL strategies per lesson (S.I. = strategy instruction) at primary school and secondary school

Table 2 Significantly different rating scores between primary school and secondary school

Subscale	Item	*M* (*SD*) primary school	*M* (*SD*) secondary school	*U*	*p*	Cohen's *d*
Cooperative learning	The teacher promotes cooperative learning during class.	1.85 (.78)	1.38 (.89)	49.5	.03	.56
	The teacher ensures that the students work together cooperatively and intervenes if necessary.	1.14 (.30)	1.06 (.25)	79	.19	.29
Constructivist learning	The teacher prompts the students to activate prior knowledge and to integrate new input.	2.74 (.82)	2.13 (.50)	51.5	.03	.93
	The teacher integrates new input in a meaningful context and/or introduces new information by creating a cognitive conflict.	2.58 (.35)	2.06 (.44)	34	.002	1.29
	The teacher presents complex, open, and/or marginally structured problems which can be solved in different ways and/or allow several solutions.	1.92 (.49)	1.44 (.73)	47.5	.002	.75
Student-directed and teacher-directed learning	The teacher allows the students to take responsibility for structuring their learning by giving them some freedom to make decisions.	2.28 (.87)	1.81 (.83)	70	.22	.56
	There is a balance between self-directed learning and teacher-directed learning.	2.28 (.87)	1.69 (.87)	58	.07	.68
Creating authentic learning environments	Learning is integrated in a real-life context.	2.46 (.64)	2.25 (.58)	70.5	.22	.35
	The teacher presents the content to be learned in diverse contexts and/or from various perspectives.	2.29 (.88)	1.63 (.50)	44	.01	.96

addition to summarizing the answers of all the teachers, we present the data on one teacher (Michael[3]) in order to give a more in-depth overview of one exemplary case. We chose the teacher with the best performance with regard to the observed teaching of metacognitive strategies as a central point of fostering SRL.

Case description

With 30 years of teaching experience, Michael was one of the older teachers of the sample (55 years old). He was chosen for in-depth case description as he was the teacher with the highest scores in classroom observations with regard to the instruction of metacognitive strategies, a key component of SRL. He was one of the few teachers who explicitly explained to students the benefits of using SRL strategies, and he was the only one to foster students' metacognitive reflection on strategy use explicitly. When analyzing in more detail the metacognitive sub-strategies that he taught, it became clear that he focused mainly on planning strategies. Unlike the rest of the group, he did not address many mathematical cognitive strategies; rather, he addressed mainly organization strategies. With regard to the learning environment, Michael received middle to high scores in all domains. He scored well on promoting constructivist learning, fostering transfer, and keeping a balance between teacher-directed learning and student-directed learning. For most areas, he estimated his promotion of SRL comparably with the observer ratings.

Knowledge, beliefs, and self-reported instruction of self-regulation strategies (direct promotion of SRL)

Knowledge about SRL strategies Knowledge about SRL strategies was assessed by asking the teachers to define cognitive, metacognitive, and motivation strategies. Similar to the findings regarding classroom observations, teachers demonstrated the least amount of knowledge about metacognitive strategies. Some teachers were able to describe SRL strategies, but in general, teachers found it difficult to describe the three types of strategies. When asked to describe what a *cognitive learning strategy* was, only four out of the nine teachers interviewed gave an answer (M = .75, SD = .89). They mentioned "different options regarding how to solve a problem," "procedures that help to solve unknown problems," and "strategies developed while reasoning in order to find solutions." Michael brings it to the point: "Learning strategies about how to proceed to learn effectively." For *metacognitive strategies*, only two teachers gave a description (M = .38, SD = .74): "to reason about strategies," "strategies concerning an approach to learning." Five teachers provided definitions of *motivation strategies* (M = .50, SD = .53). While one definition was rather vague ("design of the learning environment"), another which was mentioned by two teachers was "to motivate yourself, for example, by promising yourself a reward." Another teacher said it meant "to find your own impulse to start working on things." One teacher misunderstood that the definition was supposed to be of a self-regulation strategy and instead described a teaching strategy to foster student motivation: "making a certain topic interesting."

Beliefs about the instruction of SRL strategies After being given a definition of *cognitive strategies*, almost all of the teachers considered cognitive strategies to be highly important and

[3] Names of teachers were changed.

felt they should be included in their teaching (M = 5.1), their ratings ranging from 3 to 6. Michael rated it as being very important (6). Teachers' ratings of the importance of teaching *metacognitive strategies* in the classroom ranged from 2 to 6 (M = 4.1), with Michael giving the highest rating (6) of the whole group. Teachers generally found the instruction of motivation strategies important (M = 4.8; ratings ranging from 2 to 6). Also, Michael rated the instruction of motivation strategies relatively high (5). These findings indicate that the teachers have positive beliefs about the instruction of SRL strategies, but they considered cognitive and motivation strategies more important than metacognitive strategies.

Self-reported instruction of SRL strategies Teachers' self-reported instruction of SRL strategies reflected the observations made that the teachers addressed mainly cognitive strategies and least often metacognitive strategies. When asked how often they taught *cognitive strategies*, the teachers' answers ranged from 3/4 to 6 (M = 4.5). Michael rated the frequency of his instruction of cognitive strategies with a 5. Teachers were rather reluctant about teaching *metacognitive* strategies (M = 2.9, ratings ranging from 2 to 5), with Michael being the most positive about this (5) of all the teachers. Although the teachers found instruction of *motivation strategies* important, most of them rated their instruction of motivation strategies rather low (M = 3.3, ratings ranging from 2 to 5). Michael rated the importance of teaching motivation strategies one point higher than his estimation about his instruction of them in his teaching. Teachers' self-reported instruction of SRL strategies reflected their knowledge and beliefs about SRL. The teachers claimed they instructed mainly cognitive strategies, and considerably less often motivation strategies. Little instruction of metacognitive strategies was reported.

Beliefs about and self-reported design of the learning environment (indirect promotion of SRL)

Cooperative learning When asked how they promoted cooperative learning, most of the teachers claimed they promoted it "if it fits into the content of the lesson," "sometimes letting students working in pairs, but rather seldom in groups," "only if the students ask for it" or they said it "happens by itself." One teacher was still considering promoting cooperative learning, which was a rather new method for him: "Ehm, I already decided to use cooperative learning methods, like more playful elements, and I have already done this now successfully, in particular when the students are a bit turbulent and eh, that works fine. Ehm, I had a game with me today in which one had to stick to the rules and in groups of three or four students had to be considerate of the others, and that works really well now with these students." It becomes clear that he perceives cooperative learning as a game ("playful") rather than as an effective instructional strategy. Michael gives a more differentiated answer in which he explains the reasons for choosing to employ cooperative learning: "The children learn together and work together, and in the end present their solution together[…] I use it as far as it fits with the learning content. That depends on the time, eh, and what you have to practice at this moment of the lesson, you can say that, for example, students practice the use of different media, eh, in terms of presentations. That is best to practice with a concrete example. And that does not only concern mathematics, but all subjects. But also in mathematics, you can find topics that are suitable for a presentation." In general teachers claimed to be rather reluctant to promote cooperative learning. On a scale from 1 to 6, teachers' answers to how frequently they promoted cooperative learning ranged from 2 to 5 (M = 3.1). As some of the teachers' answers

indicated, teachers' reluctance might be due to misconceptions about cooperative learning as being a playful method rather than an effective teaching method.

Constructivist learning When asked how they activated students' prior knowledge, teachers responded differently. One teacher claimed to activate prior knowledge during teacher-directed phases of the lesson: "Not so much during group work, but during phases of direct instruction, it happens often that I do that; that I tell them 'we have already worked on that once,' and then I remind them of what they already know." Michael also claimed he drew his students' attention to the fact that they already had learned something about the topic being discussed in class and that they could apply their knowledge during the current lesson, and he mentioned activating students' prior knowledge through the instruction of assignments: "Ehm, yes, I think so. Mmhm, and I think that it always works best when an assignment presents a problem that has to be solved. And then you discuss with them [the students] where they might have already dealt with similar problems in the past, so that they can fall back on what they had learned before." Three teachers claimed they directly asked students about their prior knowledge. When asked about the activation of students' prior knowledge two teachers explained that they regularly repeated mental arithmetic with lower numbers (as in former grades). When asked how they would link the current learning content to students' experiences with everyday life, four teachers answered "wherever possible," and one teacher answered "only if the textbook gives me ideas," while another teacher criticized that "good examples are difficult to find and the examples presented in the textbooks often are obscure." Michael claimed he presented examples especially when introducing new topics and "after having been teaching some basics, in order to show in which situations the [more abstract] learning content is relevant to solve everyday problems. […] Yes, actually, students' experiences and everyday life examples are always, let's say, the starting point when introducing a new topic, so one tries to start with the everyday experiences of the children, but also later, after having worked on the basics, you try as often as possible to show situations in which the learned content is relevant in order to solve everyday situations and to understand problems right." In general, all the teachers found this type of task very important ($M = 5.2$, ratings ranging from 4 to 6). Most of the teachers claimed they tried to create a learning environment that connected the learning content to students' prior knowledge and prior experience, although teachers did this in a rather teacher-centered way.

Using authentic learning environments With regard to situated learning, teachers' responses diverse. One teacher admitted that lessons in which he manages to embed learning in naturalistic and authentic settings are rather "highlights. That doesn't happen so often. There are topics for which this is suitable and where you can do this, but that happens maybe twice in an academic year. That involves quite some time and effort to prepare, as you cannot find it ready-made in a textbook." One teacher was in favor of the method but concerned with the realization: "That means for example, … we have learned how to estimate the width of a river with geometrical methods, so without throwing a measuring tape to the other side of the river, that means that we could go to the river in our city and try it. […] That is a problem, if I see how many learning materials I have to cover… a lot of things could be done if the basic conditions were different, then yes, gladly, I do see opportunities, but the basic conditions do not allow us to do a lot. […] and then the 45-minute duration of a lesson and other things that you can't change." Michael was more positive but at

the same time unclear about how he should realize situated learning in the classroom: "It is always good if there are connecting factors that come from everyday life and can be picked up in the lesson, in order to understand the problem." The teachers differed in their understanding of genuineness of the learning situation: some teachers understood a situation to be authentic and naturalistic if they brought students into the real-life situation (or brought the real-life problem to the classroom). As Michael described it, the other half of the teachers understood situatedness in a less literal way. One teacher, for example, claimed he used newspaper reports in his mathematics class to relate to real-life problems without having to leave the classroom. Teachers' responses to the frequency of creating learning situations that are similar to an everyday situation ranged from 2 to 5 ($M = 3.4$), with Michael being rather positive (4). These results indicate that the teachers' understanding of situated learning and methods for realizing it in the classroom were inconsistent. Half of the teachers were very positive about situated learning but did not have clear ideas about how to promote it in their teaching.

Student-directed learning and teacher-directed learning The last interview question concerning the learning environment referred to the balance between teacher direction and student direction. First, teachers described the extent to which they allow their students to take responsibility for their learning; then, they indicated the relationship between teacher-directed learning and student-directed learning during the average lesson. One teacher admitted to being rather unexperienced with student-directed learning but wanted to try it: "Mmh…the students can choose their homework or can sometimes also choose an assignment from the textbook… like: what do I find most interesting…and I have started to implement a homework protocol, which means that the students should record what they did as homework assignments and how much time they spent on them. Some students thought that would be a new way to control them, but I told them that I wouldn't check them if there were no problems, only if students wanted to hand it in voluntarily. And I have the impression that the students do take more responsibility for their learning like that. But the lessons go up and down and sometimes the teaching is so dependent on the mood." Another teacher claimed to have gained experience in letting the students self-regulate: "I try to give the students a lot of responsibility; however, I have the problem that the students don't want to take it. Like… they don't want to take responsibility for their own learning in the way that I want them to. In that way it is like a fight about how much responsibility I can transfer to them. Mmh, like preparations for an assignment, or in general we try to make requirements as transparent as possible for the students about what they should know at the end of a learning unit; in our whole school we do it like that. Like what should be learned, and then there are opportunities to test yourself; so, I ask the students to check: what do I know, what do I not know yet? And then to train what is still lacking. And then they have the option to do training assignments and they also get the solutions then to check themselves. Ehm, the question is: To what extent do they really do that? And that is hard to control." The teachers' answers suggest that the teachers and students in this sample were rather unexperienced with student-directed learning environments. Even if the teacher was motivated to promote more student-directed learning, the students did not know how to handle the new responsibility. This could indicate that the teacher would first

or simultaneously have to instruct self-regulation strategies to provide students with the tools that they need to engage in SRL.

RQ 3: How are the secondary school teachers' knowledge and beliefs about promoting SRL as well as their perception of their promotion of SRL in the classroom related to their observed promotion of SRL in the classroom?

Connection between observation and teacher's perspective To investigate the correspondence between the teachers' perception and the observer's perception of teachers' promotion of SRL, correlations were computed between the teachers' rating and the observers' rating regarding the instruction of strategies and the design of the learning environment. Since results of Kolmogorov-Smirnov tests had revealed that some of the data were not distributed normally, probably due to the small sample size, Spearman correlations were computed to investigate the relationship between teacher ratings and observer ratings. For the sub-scales assessing the learning environment, teachers' ratings were obtained for cooperative learning, student vs. teacher direction, and presentation of real-life problems only. Regarding the instruction of strategies, correlations could be computed for the frequencies of teaching cognitive, metacognitive, and motivation strategies.

Similar to the results of the classroom observations of teaching SRL strategies, teachers claimed to teach cognitive strategies the most and metacognitive strategies the least. Observations of the lessons did not correlate with teachers' perceptions of the frequency of their teaching cognitive strategies ($r = -.40$, $p = .27$), metacognitive strategies ($r = .41$, $p = .31$), or motivation strategies ($r = .02$, $p = .97$).

With regard to the learning environment, no significant correlation was found between the teachers' observed and their self-reported promotion of cooperative learning ($r = .34$, $p = .29$), balance between teacher-directed learning and student-directed learning ($r = -.28$, $p = .50$), or their presentation of real-life problems and fostering transfer ($r = .24$, $p = .57$).

Michael's perception about his instructional strategies in general was in line with the results of his observed lesson. He claimed to spend a lot of time teaching cognitive strategies and metacognitive strategies (score 5 on the rating scale) and slightly less time on motivation strategies (score 4 on the rating scale). In the observed lesson, he spent a lot of time on implicitly modeling cognitive strategies (12 min) and metacognitive strategies (17 min), but even more on implicitly activating motivation strategies (22 min).[4] With regard to the learning environment, Michael claimed he promoted more cooperative learning (4) and activated more transfer (4) than could be observed in his lesson (2). Although he indicated only a limited balance between student-directed learning and teacher-directed learning (3), the balance in his observed lesson was rated very high (6). Carl's perception of his indirect promotion of SRL corresponded more closely with the classroom observations. He claimed he promoted cooperative learning slightly more frequently (3) than could be observed in his lesson (2), and he was more positive about keeping a balance between student-directedness and teacher-directedness (3.5) than could be observed (2); however, his perception about activating transfer and what was observed during his lesson corresponded (both 4). With regard to strategy instruction, his perception about teaching cognitive (4), metacognitive (2), and motivation strategies (3) was in line with the classroom observations (cognitive strategies: 36.17;

[4] Note that several strategies could be coded within each one-minute segment.

metacognitive strategies: .80; motivation strategies: 5.62) despite the fact that hardly any instruction of metacognitive strategies could be observed.

Connection between observation and teachers' beliefs and knowledge To examine how teachers' beliefs corresponded with their promotion of SRL, correlations were computed between teachers' beliefs and observation data, as well as between teachers' beliefs and teachers' self-reports about the promotion of SRL. Due to the small sample of interviewed teachers, Spearman correlations had to be computed.

Teacher knowledge regarding cognitive, metacognitive, and motivation strategies did not correlate with teachers' observed or self-reported promotion of SRL. However, teachers' knowledge about cognitive strategies correlated positively with teachers' beliefs about the importance of teaching cognitive strategies ($r = .85$, $p = .007$), with teachers who were able to define cognitive strategies caring more about the instruction of cognitive strategies. No such relationship was found for teachers' knowledge and beliefs regarding metacognitive strategies or motivation strategies (see Table 3). For the interpretation of these results, it should be kept in mind that, due to the small sample size of the interviewed teachers, hardly any variation could be found in teachers' answers concerning metacognitive strategies and motivation strategies.

No significant correlation could be found between teachers' beliefs about cognitive, metacognitive or motivation strategies (i.e., teachers' ratings of the importance of teaching such strategies) and teachers' self-reported or observed instruction of these two types of strategy. Teachers' beliefs about the importance of teaching motivation strategies correlated marginally with teachers' observed instruction of motivation strategies (see Table 4). In general, teachers' beliefs about teaching SRL strategies were more positive than the actual frequency of instruction they reported or that was observed (see Table 4). This result is largely reflected in the interview and observation data of the two cases: both Michael and Carl rated the importance of teaching strategies one point higher than their actual frequency of teaching strategies in the classroom. Only for metacognitive strategies did Carl have equally low values for both ratings (2). When comparing the observation data on instruction of strategies to teachers' beliefs, it becomes clear that Michael's very positive beliefs (6) corresponded with the large amount of instruction of metacognitive strategies in the observed lesson. He indicated slightly more positive beliefs about the instruction of cognitive strategies (6) than about the instruction of motivation strategies (5) although he taught more motivation strategies than cognitive strategies during the lesson. However, these differences were marginal and his overall high ratings concerning beliefs corresponded with his overall high scores on the observation of teaching SRL strategies. A similar pattern was found for Carl, who was the most positive about teaching cognitive strategies (5) and very positive about teaching motivation strategies (4), which also was reflected in his teaching behavior during the observed lesson. In the opposite direction, this is comparable for the instruction of metacognitive

Table 3 Spearman correlations between teachers' knowledge and teachers' promotion of SRL and teachers' beliefs

Teachers' knowledge about…	Self-reported...	Observed...	Teachers' beliefs about…
Cognitive strategy instruction	.37	−.18	.85**
Metacognitive strategy instruction	.17	.02	−.13
Motivation strategy instruction	−.44	.44	−.23

* $p < .05$; ** $p < .01$

Table 4 Spearman correlations between teachers' beliefs and teachers' self-reported and observed promotion of SRL

Teachers' beliefs about…	Self-reported...	Observed...
Cognitive strategy instruction	.60	−.51
Metacognitive strategy instruction	.51	.30
Motivation strategy instruction	.28	.63[t]

[t] $p < .10$

strategies, which Carl hardly addressed during his lesson, and toward which he also was not very positive (2).

Discussion

Summary of the results

In this study, the teachers' direct and indirect promotion of SRL was assessed by means of classroom observations. Differences between the primary and secondary school teachers' SRL practices were investigated, and the relationship between the teachers' promotion of SRL and their beliefs and knowledge about promoting SRL were assessed by means of teacher interviews. With regard to the direct instruction of SRL strategies, the results of the classroom observations indicate that the instruction of metacognitive and motivation strategies is seldom. Both the primary school teachers and the secondary school teachers focused mainly on cognitive strategies. Moreover, mostly implicit instruction of SRL strategies could be observed. The observed secondary school teachers hardly taught or explained strategies explicitly to their students, and among the primary school teachers no explicit instruction of SRL strategies or reflection on such strategies was observed at all. Regarding the indirect promotion of SRL, the results indicate that although some of the teachers were rather reluctant about promoting cooperative learning, many of them created opportunities for students to engage in SRL by applying constructivist learning principles in their teaching, promoting situated learning, and fostering student-directed learning. This is in line with Cartier et al. (2010) and Perry et al. (2008), who also observed positive attempts by teachers to provide learning environments conducive to SRL even though teachers were not very explicit about SRL. The low frequency of explicit instruction of SRL strategies found in our sample, especially regarding metacognitive strategies, is consistent with results reported in other observation studies of the instruction of SRL strategies (see Hamman et al. 2000; Moely et al. 1992; Spruce and Bol 2014). Kline et al. (1992) pointed out the difficulties of teaching SRL strategies for teachers who had participated in an intervention about promoting strategy use in the classroom. Teaching SRL strategies seems to be an intensive and long-term challenge faced not at one particular moment during teaching but rather over an extended period of time (Kline et al. 1992).

The results of the investigation into RQ 1 indicate that primary and secondary school teachers differed in the way they promoted SRL. Secondary school teachers spent more time teaching cognitive strategies and motivation strategies than primary school teachers did, but they worked in more teacher-centered learning environments allowing for less self-regulation

than primary school teachers did. Primary school teachers engaged more in creating a learning environment that provides students with autonomy, but they spent less time teaching cognitive strategies than the secondary school teachers did. Primary and secondary school teachers did not differ in their low frequency of addressing metacognitive strategies. It seems intuitive that teachers deal differently with students at different developmental stages and challenge older students more with cognitive and metacognitive strategies than younger students. In our sample we found secondary school teachers spent significantly more time teaching cognitive strategies than primary school teachers did. This might be due to the fact that secondary school mathematics is more complex and requires the use of cognitive strategies more than primary school mathematics. The secondary school teachers also outperformed the primary school teachers in terms of instruction of motivation strategies. Following the findings of the meta-analysis conducted by Dignath and Büttner (2008) in which primary school students in particular benefitted from SRL strategy training embedded in motivation theories, one could assume that they also would benefit from the instruction of motivation control strategies. Regarding the indirect promotion of SRL, our findings indicate that the primary teachers offered more student-centered and constructivist learning environments than the secondary teachers did. This finding is in line with results of the secondary school classroom observations by Kistner et al. (2010), who found hardly any teachers were aware of the characteristics of a learning environment conducive to SRL. This could be related to the fact that in Germany like in many other countries primary school teachers receive training that is oriented more toward pedagogical strategies and child development than secondary school teachers, who receive training that is more focused on the subject matter (Boe et al. 2007). Therefore, primary school teachers may be more familiar with learning methods that support SRL than secondary school teachers. Yet, secondary school students may benefit equally from learning opportunities that allow them to engage in SRL. As Kistner et al. (2010) demonstrated, teachers' indirect promotion of SRL correlated significantly with performance gain after the observed teaching unit.

Our classroom observations reveal that both primary and secondary school teachers do not spend a lot of time teaching metacognitive strategies. This confirms previous research on teachers' instruction of strategies (Hamman et al. 2000; Kistner et al. 2010; Spruce and Bol 2014). Nonetheless, there is evidence that both primary school students and secondary school students benefit substantially from applying metacognitive strategies (see e.g., Dignath and Büttner 2008; Hattie 2013; Veenman 2011; Whitebread 2000). Evidence of the metacognitive development of children has shown that students use more complex metacognitive strategies only at secondary school age (see e.g., Paris and Newman 1990). Nevertheless, research has shown that students can learn metacognitive strategies at primary school age and younger (Biemiller et al. 1998; Perry et al. 2002, 2004; Whitebread 1999) and that they can benefit from SRL training (Dignath et al. 2008; Hattie et al. 1996).

Regarding RQ 2, which was assessed by means of semi-structured teacher interviews, the results indicated that the secondary school teachers found the instruction of cognitive strategies important, but were rather unaware of the importance of teaching motivation strategies and particularly metacognitive strategies. Concerning their knowledge, the teachers had difficulties defining metacognitive strategies. Teachers' limited knowledge of SRL strategies has been reported elsewhere. Waeytens et al. (2002) found that SRL was a rather fuzzy concept for teachers. Spruce and Bol (2014) and Dignath-van Ewijk and Van der Werf (2012) found teachers to have only limited knowledge of how to support SRL. According to Kline et al. (1992), teachers lack an overall instructional plan, preparation time needed for effective

instruction of strategies, support needed to teach strategies, as well as the skills as teachers and managers to promote metacognitive strategies.

With respect to RQ 3, the correlations between teacher-reported and observed promotion of SRL indicate that there is limited correspondence between how teachers describe their promotion of SRL and how they actually promote it during their lessons. Several explanations for the missing link between what the teachers did versus what the teachers said they did are possible. First, the observations of the teachers' classroom behavior were of just one single lesson, while the teachers' perception of their behavior will be an average rating of several weeks, months, or years. Thus, in the observed lessons, teachers might not have taught metacognitive strategies because they might have just done so in the preceding weeks. Second, teachers may have answered the interview questions more positively in order to present themselves in a better light. Because assessment through interviews is not as anonymous as completing a questionnaire, teachers might have tried to answer in a socially desirable way. However, previous research yielded similar results: in a case study, Alvi and Gillies (2015) found that teachers' beliefs about their promotion of SRL and classroom observations did not correspond, but rather supplemented each other. Teachers' self-report and classroom observations seem to assess constructs that are overlapping, but still, both seem to explain their own share in the variation in the teachers' promotion of SRL. However, the correlation results in our study have to be interpreted with caution because only eight teachers were interviewed. The correlation coefficients for the Spearman correlations of teachers' perception with observation ratings regarding the instruction of metacognitive strategies indicate a moderate association between both ratings. Further research on a larger sample should clarify this question, which cannot be answered conclusively with our current data.

Concerning the relationship between the teachers' promotion of SRL and teachers' knowledge and beliefs, the results of RQ 4 indicate that there was a connection between teachers' beliefs and their knowledge, at least with regard to the instruction of cognitive strategies. However, teachers' beliefs about the direct promotion of SRL were more positive than their self-reported and observed behavior. However, congruence between beliefs and practice has been found elsewhere: Vandenvelde, Vandenbussche, and Van Keer (2012) and Steinbach and Stöger (2016) found that teachers' beliefs corresponded with their SRL practices. Likewise, Dignath-van Ewijk (2016) found teachers' beliefs and knowledge predicted their promotion of SRL, although teachers' self-efficacy regarding the promotion of SRL was found to be the most substantial predictor.

Limitations

In this study, teachers' behavior was observed to obtain a direct view on teachers' promotion of SRL. As pointed out, this observation was complimented by teachers' subjective views obtained by means of self-report in order to gain insight into teachers' thoughts and attitudes (Patrick and Middleton 2002). In our sample, it was possible to conduct interviews with the secondary school teachers only. In future studies, it would be interesting to obtain self-reported data from the primary school teachers in order to broaden the view. Due to the small sample size, only little variation was found, particularly concerning the instruction of metacognitive strategies. Replications with a larger sample might reveal relationships between the teachers' promotion of SRL in the classroom and their beliefs or knowledge that were not reflected in our data. Moreover, in this study, we tried to assess the way teachers promote SRL by examining *explicit* instruction and *implicit* instruction of SRL strategies. Yet, due to the little

variation in teachers' instruction of strategies, which was mainly implicit, intercoder reliability for this distinction was too low to be included in the analyses. In future studies, data collection should take place in more diverse contexts, possibly with teachers who are more experienced with SRL, in order to increase variation and obtain more details about instruction of SRL strategies (see Brown et al. 1981). Finally, the sample of teachers in this study might not have been representative, as only a limited number of teachers were observed and participation in the study was voluntarily. For these reasons, generalization of our results is not possible; however, our findings indicate that teachers are able to promote SRL in a variety of ways, and this could differ as a function of the context.

Substantial effort was made to diminish the effects of such limitations. For example, instruments that had been tested before in several settings were used. Triangulation took place across data sources, instruments, perspectives, and coders in order to obtain a more valid and reliable picture of teachers' promotion of SRL in real classroom settings and their knowledge and beliefs.

Implications and future directions

What can be learned from this study? Regarding RQ 1, our findings confirm those of previous observation research and indicate that teachers acknowledge SRL in their regular teaching, but there still is opportunity to improve the explicitness of how teachers address SRL in their classrooms. It is not yet clear why many teachers do not teach SRL strategies explicitly and, in particular, metacognitive and motivation strategies. Are they not *aware* of the importance of explicit instruction of strategies and the design of the learning environment (see Hamman et al. 2000), or do they *want* to promote SRL but *do not know* how because they do not know enough about the concept of SRL (see Waeytens et al. 2002)? We were able to show with our sample that both primary and secondary school teachers could enhance their SRL practices by being more explicit in their teaching of the metacognitive strategies students need to engage effectively in SRL. These teachers could benefit from training in order to learn more about metacognitive strategy use and how students benefit from this. The results of this study suggest that the problem is not teachers' negative beliefs about the promotion of SRL; rather, teachers lack knowledge about how metacognitive strategies can enhance their students' SRL. Zohar and Barzilai (2013) conclude from a literature review of research on metacognition in science education that there still is a gap in the research on teachers' knowledge about metacognition and the relevant pedagogical knowledge pertaining to teaching metacognitive strategies. Future research should build on the current evidence regarding teachers' promotion of SRL by conducting intervention studies to foster metacognitive knowledge and pedagogical knowledge on how to address SRL explicitly in pre-service and in-service teacher training.

Our results also suggest that teachers foster SRL among primary school students differently from how they foster SRL with secondary school students. Findings of research on the effectiveness of teaching SRL strategies to these age groups indicates that primary school students benefit more from particular training characteristics than secondary school students do (Dignath and Büttner 2008; Hattie et al. 1996). The question arises as to whether certain pedagogical strategies would be more effective with younger students or older students. Investigation should be made into students' SRL competences and what teachers can build

on at various developmental stages. At the same time, teacher training is needed to raise awareness among primary school teachers that the instruction of SRL strategies should start at an early age when children have not yet developed their own repertoire of strategies and still are flexible in adapting effective learning strategies (Whitebread 2000). Providing students with learning opportunities that permit self-regulation is important, but combining these opportunities with explicit instruction of SRL strategies may even improve the students' self-regulation of learning. At the same time, secondary school teachers need ongoing support to be able to teach SRL strategies explicitly and create student-centered learning environments that promote self-regulation.

The findings from RQ 3 indicate that teachers' perception of their attempts to foster SRL is no less important than observations of their instructional practices when researching SRL. Both measures seem to assess their own share, and have their own advantages and disadvantages. In future studies of teachers' promotion of SRL, the relationship between the two measures should be explored by asking teachers before and/or after the observed lesson about their intentions and their efforts to foster SRL. Moreover, the advantages of classroom observations could be increased if more than one lesson per teacher were video recorded in order to broaden the picture of teachers' promotion of SRL.

With regard to RQ 3, what can be learned from our findings of incongruence among teachers' beliefs, knowledge, and promotion of SRL? Empirical evidence regarding this question has turned out to be inconsistent. If teachers' beliefs and knowledge are not directly linked to teachers' promotion of SRL, the connection might be mediated by some other variable. Zohar and colleagues found, for example, that teachers' beliefs about teaching higher-order thinking to low-achieving students often was related to the lack of knowledge or instructional means for this purpose (Zohar et al. 2001). The research of Vandevelde et al. (2012) pointed in a similar direction, showing that teachers who do not promote SRL reported feelings of incompetence in stimulating SRL. Likewise, Dignath-van Ewijk (2016) found teachers' self-efficacy regarding the promotion of SRL to have a higher predictive value for teachers' SRL instructional practices than their knowledge or beliefs. Empirical evidence indicates that teachers need metacognitive knowledge as well as the right skills in order to feel able to teach metacognition (Veenman et al. 2006) and SRL to their students. Therefore, in future research assessment should be made of teachers' self-efficacy in order to enlarge the picture of variation in teachers' competence in fostering SRL. In this study we found primary school teachers used strategies to promote SRL that were different from those used by secondary school teachers, and we observed many examples of learning opportunities that could enhance students' SRL. In future studies, teachers' SRL instructional practices need to be aligned with students' gains in self-regulation and performance in order to learn about the adaptiveness and the effectiveness of the diverse approaches to promoting SRL in the classroom. In future research exploration should be made of students' perceptions and how they take opportunities to develop and to engage in SRL. Obtaining data from multiple sources is important for future research on SRL in the classroom.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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