REVIEW ARTICLE

Stimulating Elementary School Students' Self-Regulated Learning Through High-Quality Interactions and Relationships: A Narrative Review

Niels J. de Ruig[1] · **Peter F. de Jong**[1] · **Marjolein Zee**[1,2]

Abstract

One of the most important competencies to become a life-long learner is considered to be self-regulated learning (SRL). In this narrative review study, we describe research on the relationships between classroom- and dyad-level student-teacher interactions and the components of elementary students' SRL. These components include metacognition and the regulation of cognition, motivation, behavior, and emotions. Three electronic databases were examined, which resulted in 30 studies that met our eligibility criteria. The results suggest that both well-organized and emotionally supportive classroom climates, in addition to high-quality instructional support, are associated with students' metacognition. Results also show that associations between classroom-level interactions and the components of SRL that tap students' behaviors and motivation are mixed. In contrast, at the dyad-level, higher quality teacher-student interactions were consistently found to be related to the motivational component of SRL. We also found a positive relationship with metacognition, but at the dyad level studies on the other components of SRL were hardly available. The review revealed a number of gaps in research on SRL, such as the paucity of studies on the regulation of cognitions and emotions, the overreliance on self-reports in the measurement of SRL, and the absence of cross-cultural research.

✉ Niels J. de Ruig
N.J.deRuig@uva.nl

[1] Research Institute of Child Development and Education, University of Amsterdam, P.O. Box 15776, Amsterdam NL-1001 NG, The Netherlands

[2] Department of Psychology, Education and Child Studies, Erasmus University Rotterdam, Rotterdam, The Netherlands

Due to technological developments and changes in the availability of information, competencies that enable elementary school students to become life-long learners have become more important (Dignath et al., 2008). One of the most important competencies in this respect is self-regulated learning (SRL). SRL is the process in which students systematically attempt to monitor, regulate, and control multiple components of learning, including cognition (e.g., the use of different learning strategies), metacognition (e.g., skills and strategies that regulate and control learning behaviors), motivation (e.g., students' motivational beliefs, self-efficacy, and interests), emotions (e.g., students' ability to understand, temper or modify emotions), and behaviors (e.g., time management, effort control, and help-seeking) for the attainment of their learning goals (Boekaerts, 2011; Schunk & Greene, 2018). When students go through this process effectively, they are believed to achieve at higher levels and more motivated for learning than peers who are less capable of regulating their own learning (e.g., Chung, 2000).

The majority of research on SRL has been conducted in secondary or higher education, based on the assumption that elementary school students are unable to regulate their learning (e.g., Veenman et al., 2006; VandeVelde et al., 2013). A growing body of studies, however, has demonstrated that elementary school students are able to regulate their learning effectively on a basic level (e.g., Diamond, 2016; Hughes, 2011; Vernon-Feagans et al., 2016). For example, a recent overview study shows that working memory tends to improve during the elementary school years, resulting in an increased capacity to monitor and control (meta)cognitive strategies (Hoyle & Dent, 2018). These findings suggest that students' SRL becomes more complex and academically focused throughout elementary school, demonstrating the importance of this period for students' SRL-development (Perry et al., 2018). This study therefore focuses specifically on elementary school students' SRL.

Several studies have shown that the degree to which students can effectively regulate their own learning may vary within and across classrooms (e.g., Dignath & Veenman, 2021; Vandevelde et al., 2013). These findings suggest that the quality of teacher–student interactions are relevant to the development of SRL, just as they are considered to be the driving force behind other aspects of learning, such as executive functioning and motivation (Cumming et al., 2020; Hamre et al., 2013; Perry et al., 2018). The quality of these interactions concern both the classroom and the dyadic level (Verschueren & Koomen, 2012). Notably, no recent review has been conducted that provides an overview in which associations between the quality of teacher–student interactions and various components of SRL have been investigated, especially during the elementary school years. Therefore, the aim of the current study is provide an up-to-date narrative review of existing literature on the quality of teacher–student interactions and components of SRL, both at the classroom and dyadic-level. Furthermore, we aimed to review these associations within elementary schools. Before examining relationships between teacher–student interactions and students' SRL, we provide an introduction to theoretical and conceptual perspectives on SRL.

Theoretical Perspectives and Conceptual Framework

Self-regulated learning has been defined and conceptualized in numerous ways, resulting in many theoretical models (e.g., Panadero, 2017; Schunk and Greene, 2018). These models are predominantly grounded in information processing- and social-cognitive theory (Hadwin et al., 2018; Schunk & Greene, 2018). Information processing theory describes that SRL is metacognitively driven and develops in interaction with materials through practice (Winne, 2011). According to social-cognitive theory, students improve their self-regulation through interactions with the environment (Hoyle & Dent, 2018). As such, SRL is characterized as a goal-oriented process that enables students to monitor, regulate, and control aspects of learning.

Irrespective of whether SRL develops through practice or interactions with the environment, most researchers agree that SRL consists of several broad components, including motivation, cognition, and metacognition (Schunk & Greene, 2018). The regulation of motivation entails motivational beliefs that students have with respect to a task, including self-efficacy beliefs, interests, and goal orientations (Pintrich, 2004). Regulation of cognition refers to the use of different learning strategies to understand information better, including comprehending, predicting, and summarizing (Winne, 2018). Metacognition is considered to be the core component of SRL and refers to the skills and strategies that actually regulate and control learning behaviors, such as task-orientation, goal-setting, planning, self-evaluating, monitoring, and organizing (Usher & Schunk, 2018; Veenman, 2017).

Less commonly recognized are the emotional and behavioral components of SRL, which have been introduced by socio-cognitive theorists (Boekaerts, 2011; Pintrich, 2004; Zimmerman & Moylan, 2009). Regulation of emotions entails students' capacity to understand, temper, or modify their emotions, such as anxiety or shame, in order to prevent their negative influence on learning goals (Boekaerts, 2011). Regulation of behavior during tasks consists of the regulation of effort, persistence, time management, and help-seeking (Usher & Schunk, 2018). The regulation of both components are considered particularly important for young students' academic performance within elementary school (Dignath et al., 2008). Therefore, we refer to SRL as a process in which students systematically attempt to monitor, regulate, and control not only their cognition, metacognition, motivation, but also their emotions, and behaviors. In doing so, we rely primarily on models from the social-cognitive tradition (Panadero, 2017).

Models based on social-cognitive theory and information processing theory both assume that the components of SRL are embedded within a cyclic process, comprising a preparatory, performance, and appraisal phase (Puustinen & Pulkkinen, 2001). The preparatory phase reflects students' planning, goal-setting, and self-efficacy beliefs, and activation of knowledge *prior* to tasks (Pintrich, 2004). In the next phase, the performance phase, self-regulated learners actually *perform* and *finish* tasks, while monitoring and controlling their progress (Panadero, 2017). In the final phase, the appraisal phase, learners *reflect* on their performance and *adjust* their strategies to future tasks (Puustinen & Pulkkinen, 2001).

There is theoretical debate about whether there are clear distinctions between the different phases (Panadero, 2017). For example, some researchers suggest that self-

regulated learners follow the preparatory, performance, and appraisal phases sequentially when going through a task (Pintrich, 2004; Zimmerman, 2002). Yet, others assume that the phases may occur more dynamically (Boekaerts, 2011; Winne, 2011). This implies that there is not always a clear distinction between the phases and that students may go back-and-forth between them while working on a task. For this reason, our review is structured according to the five different components of SRL, rather than the phases of SRL.

Classroom-Level Interactions and Self-regulation

Elementary classrooms are considered to be crucial in the development of students' SRL (Dignath et al., 2008; Vandevelde et al., 2013). Within these classrooms, the quality of teacher–student interactions have been suggested to be the driving forces behind students' academic adjustment and learning (Bronfenbrenner & Morris, 1998; Hamre et al., 2013), including their executive functioning (Cumming et al., 2020; Vandenbroucke et al., 2018), engagement (Hamre et al., 2013), and school success (Hamre & Pianta, 2010). Social-cognitive theory and recent empirical research suggests that the quality of teacher–student interactions might also be relevant for the development of SRL (Dignath & Veenman, 2021; Perry et al., 2018).

The Teaching Through Interactions Framework (TTI-framework) is a commonly used framework for conceptualizing high-quality teacher–student interactions (Hamre et al., 2013). This TTI-framework may be particularly relevant in the context of the current review, as it provides a comprehensive framework that integrates multiple theories, such as attachment theory and self-determination theory. The TTI-framework includes three broad domains; instructional support, classroom organization, and emotional support (Hamre et al., 2013). Instructional support consists of the degree to which teachers are able to promote inquiry skills, use a variety of learning formats, provide high-quality feedback, involve students in instructional dialogue, and help them understand content at a deeper level (Pianta et al., 2012). The domain of classroom organization represents the organization of and managerial tasks within the classroom, such as behavioral management, daily routines and maximization of learning time (Pianta et al., 2012). Last, teachers provide emotional support through creating an affective classroom climate, high levels of sensitivity, and regard for students' perspectives by being flexible and providing autonomy (Pianta et al., 2012).

Based on the TTI-framework, there are several mechanisms that explain why interaction quality may lead to higher SRL across different components (Hamre et al., 2013). Starting off with instruction quality, it has previously been suggested that teachers who provide high-quality instruction may facilitate the development of students' self regulation (Hamre et al., 2013). This type of high-quality instruction is usually tailored to students' prior knowledge and includes real-life examples to offer them opportunities to demonstrate current skills, expand their knowledge and develop new cognitive and metacognitive skills (Veenman, 2017).

Of all domains of the TTI-framework, instructional support is probably the most widely studied (e.g., Dignath et al., 2008; Dignath & Veenman, 2021). Aspects of high-quality instructional support, and explicit strategy instruction in particular, were found to be positively related to various components of SRL (Dignath et al.,

2008). For instance, a recent review has found a positive association between explicit instructional time and students' use of metacognitive strategies (Dignath & Veenman, 2021). Moreover, a meta-analysis showed that students benefit the most from explicit strategy instruction interventions, when instruction is aimed at a combination of cognitive, metacognitive and motivational self-regulation strategies (Dignath et al., 2008). Students who obtained knowledge about strategy application and its benefits were also more likely to be more effective in applying self-regulation strategies compared to students without this knowledge. These effects of explicit strategy instruction seem particularly strong in the early years of elementary school, when students may be more receptive to instruction and have not yet developed their own, potentially less effective, strategies (Dignath et al., 2008).

The effects of teachers' classroom organization and emotional support on SRL have received far less attention than instructional support (Cumming et al., 2020; Vandenbroucke et al., 2018). In the TTI-framework, the order and structure that teachers bring to their classroom is expected to help their students focus on their tasks, which in turn enables them to work towards and achieve their learning goals (Hamre et al., 2013). Some researchers suggest that teachers who effectively organize their classrooms are also likely to express higher levels of SRL themselves (Blair & Diamond, 2008). This behavior may function as an example for the effective use of SRL (Vandenbroucke et al., 2018). In addition, in well-organized classrooms, students may optimally profit from instructional time, which may result in higher exposure to challenging learning activities and strategy instruction (Choi et al., 2016; Pianta et al., 2012). Based on these suppositions, we hypothesized that well-organized classrooms promote students' metacognition and their regulation of cognition and behavior.

The TTI-framework posits that emotionally supportive teachers provide a sense of safety and security, which can lead to increased self-reliance, feelings of competence, and willingness of students to take risks to explore the world (Hamre et al., 2013). Such feelings, in turn, may support the development of self-regulated learning. Indeed, empirical studies suggest that emotionally supportive teachers may create safe and secure learning environments that help students to feel competent and autonomous, which enables students to choose more difficult tasks, strive for greater understanding, and persist through challenges (e.g., Hadwin and Oshige, 2011; Perry et al., 2018). Given that the domain of emotional support is partly based on the self-determination theory, it is likely that emotionally supportive teachers may promote the regulation of motivation, behavior, and emotions (e.g., Ryan and Deci, 2002). Additionally, a meta-analysis by Cumming et al. (2020) showed that emotionally supportive classroom environments can also enhance students' executive functioning (EF), which is closely related to students' regulation of cognition (e.g., the use of effective learning strategies, Nigg, 2017). We therefore hypothesize that high levels of emotional support may also be positively related to the regulation of cognition.

Dyadic Interactions and Self-regulation

Next to high-quality classroom interactions, it is argued that the affective quality of dyadic teacher–student interactions may have a positive effect on student outcomes, including self-regulation (Perry et al., 2018). Consistent with attachment theory,

these dyadic interactions are examined in terms of three dimensions: Closeness, conflict, and dependency (Verschueren & Koomen, 2012). High levels of closeness refer to warm and supportive relationships between teachers and students, whereas conflict is marked by discordance and negativity in relationships (Pianta, 2004). Moreover, teacher–student dependency reflects students' overreliance on teachers, and also their possessiveness and clingy behaviors in relation to teachers (Pianta et al., 2003). High levels of dependency indicate that students fail to use their teachers as a secure base from which they can explore (Verschueren & Koomen, 2012).

When students feel close to their teachers, they are more likely to feel emotionally secure, which can help them develop positive beliefs about themselves as learners (Pianta, 2004). In addition, these students have more self-confidence and persistence, and are therefore more likely to explore within classrooms and engage themselves in more challenging tasks than students who do not experience close relationships with their teachers (Cadima, Enrico et al., 2016; Cadima et al., 2016). Together, researchers suggest that these supportive learning opportunities are likely to promote motivational, behavioral, and emotional components of SRL throughout elementary school (Perry et al., 2018).

High levels of teacher–student conflict and dependency, on the other hand, may hamper students' SRL development (Perry et al., 2018). Recent meta-analyses, for instance, showed that conflictual relationships negatively affected the way in which students from lower grades used their working memory and inhibitory control (Cumming et al., 2020; Vandenbroucke et al., 2018). It has also been suggested that relationships that consist of conflict and dependency may increase students' stress, externalizing and internalizing behavior, and will reduce engagement (e.g., Roorda et al., 2020; Verschueren and Koomen, 2012). The negative outcomes resulting relationships that are marked by low levels of closeness and high levels of conflict and/or dependency, are believed to prevent students from exploring the school environment and persisting with school work becomes difficult, which might hinder their ability to self-regulate (Cadima, Enrico et al., 2016).

Present Study

In this study we examined the literature on associations between the quality of teacher–student interactions and elementary school students' SRL. Results of this review may contribute to a fairly recent and increasingly evolving area of research, and may provide a narrative overview of the current state of research that can future research. Our review builds on and extends current reviews (e.g., Cumming et al., 2020; Dignath et al., 2008; Dignath & Veenman, 2021; Vandenbroucke et al., 2018) in several ways: (1) we included classroom- and dyad-level teacher–student interactions as predictors in this review; (2) we included different components of SRL as outcome variables; and (3) we focused on elementary school students rather than high-schoolers. Our main question is: What is the extent to which the quality of teacher–student interactions, both at the classroom (i.e. teachers' instructional support, classroom organization, and emotional support) and dyadic level (i.e. teacher–student closeness, conflict, and dependency) are associated with components of SRL,

including metacognition and the regulation of cognition, motivation, emotion, and behavior?

Based on the TTI-framework and prior research, it is likely that there are positive relationships between the three domains of classroom interactions and the five components of SRL. However, we expect the strongest positive relationships between: (1) instructional support and metacognition and the regulation of cognition; (2) classroom organization and metacognition, and the regulation of cognition and behavior; (3) and emotional support and the regulation of motivation, behavior and emotions. Furthermore, we hypothesized that teacher–student closeness is positively associated with motivational, behavioral, and emotional components of students' SRL and conflict and dependency are negatively related to all five components of self-regulation.

Method

Literature Search

We developed a search syntax for our literature search and applied it to the following databases: Educational Resources Information Center (ERIC), PsycInfo, and Web of Science (WoS). Search queries included synonyms and/or components of: (1) 'students' SRL', primarily based on models from the social-cognitive tradition, including Pintrich's SRL model and the five components; metacognition and the regulation of cognition, motivation, emotions, and behavior (Pintrich, 2004; Zimmerman & Moylan, 2009); (2) 'teacher–student interactions' at the classroom and dyad level based on the TTI-framework and research on the quality of teacher–student relationships (e.g., classroom organization, instructional support, closeness, conflict); (3) 'elementary school', including 1st to 6th grade in the elementary school and an age range from 4 to 13 years old. We also included search queries for 7th, 8th, and 9th grade, middle school, and secondary school, because some studies compared elementary school students to other age-levels. The full search syntax can be found in Online Resource 2. Search parameters were set from 1970 until October 2020. This time span was set as social-cognitive research on students' self-regulated learning started in the 1970s (Schunk & Greene, 2018). Our search resulted in 1438 studies retrieved from ERIC, 1492 records from PsycInfo, and 1624 records from WoS (see Fig. 1). The records were imported into reference software Zotero 5.0 (Roy Rosenzweig Center for History and New Media, 2020), through which we identified and deleted duplicates. Screening was done in Rayyan (Ouzzani et al., 2016).

Inclusion and Exclusion Criteria

There were five criteria for inclusion of records into our narrative review. First, studies were required to measure at least one (sub)component of students' SRL. We used Pintrich's model of SRL (2004) to distinguish the major components of self-regulation. This model consists of four components, including cognition, metacognition, motivation, and behavior. Pintrich (2004) also specified subcomponents for each component, such as students' target goal setting and prior content knowledge. In

addition, we added an emotional regulation component based on Boekaerts' (2011) dual processing self-regulation model and included multiple subcomponents from Vandevelde and colleagues (2013) that are specifically tailored to the elementary school. An overview of the components and subcomponents of SRL are given in Table 1.

Second, records were considered eligible if they described at least one of the domains of teachers-student interaction at the classroom and dyadic level. The classroom-level domains were specified based on the Teaching Through Interaction Framework. This framework consists of the broad domains of instructional support, classroom organization, and emotional support (Pianta et al., 2012). Each of these broader domains involves a number of specific domains described in the observer manual of the Classroom Assessment Scoring System (CLASS; Pianta et al., 2012). The three broad domains and their specific dimensions are presented in Table 2. At the dyadic level, studies were selected if they described the quality of relationships in terms of closeness, conflict, or dependency (Pianta et al., 2003).

Third, records had to address at least one direct relationship between a domain or dimension of the quality of teacher–student interactions at the classroom or dyadic level and SRL, as shown by correlations, or unstandardized and standardized regression coefficients. Fourth, English peer-reviewed articles were considered for inclusion, including empirical quantitative, observational, and mixed-method studies. Moreover, to avoid publication bias, (unpublished) book sections, conference papers and dissertations were also included (Polanin et al., 2016). Fifth and last, to be included, studies had to be conducted in regular classroom settings. Interventions or publications that focused specifically on ICT or student tutors, mentors, school counselors, preservice teachers or teaching assistants were excluded.

Phases in Selection of the Studies

The literature search gave 3612 studies. Using the five criteria, these studies were labeled for in- or exclusion based on title and abstract. In case of doubt, the full text was consulted. To check for the reliability of the labeling process, the final author labeled 160 of the studies, resulting in good inter-reliability (ICC=0.83, with 95% confidence interval=0.78-0.88, Koo and Li, 2016). Studies that were labeled differently (5.6%) were discussed and used as examples to improve the labeling process. This resulted in the selection of 192 articles. Subsequently, these articles were assessed for eligibility by the first author. Double coding was not deemed necessary, because in the previous phase of the selection process we had good inter-reliability with respect to the codes from Tables 1 and 2. The other codes, such as students' age and effect sizes, could be applied without doubt. Following Cummings et al. (2020), we kept the possibility open that studies might mention components of SRL that were not in our coding scheme, but did not happen to be the case. In total, 30 articles were found eligible and included in the final narrative analysis. A flow diagram of the selection process is given in Fig. 1.

Studies were excluded for various reasons. First, the studies often did not meet the age criteria, which required that the research was conducted in elementary schools. Furthermore, a large number of studies had experimental designs, and did not reflect

Table 1 Overview of the Components and Subcomponents of Students' SRL

Components of SRL (codes)

Phases	Cognition (Cog)	Metacognition (Meta)	Motivation (Moti)	Behavior (Behav)	Emotions (Emo)
Preparatory phase[a]	- Target goal setting[b] - Prior content knowledge activation[b] - Meta-cognitive knowledge activation[b]	- Task-orientation[C] - Planning[C]	- Goal orientation approach[b] - Efficacy judgements[b] - Ease of learning judgements; perceptions of task difficulty[b] - Task value activation[b] - Interest activation[b] - External-, introjected-, identified- regulation, and intrinsic motivation[C]	- Time and effort planning[b] - Planning for self-observation of behavior[b]	- Expressing (venting) emotions[d] - Suppressing emotions[d] - Denial and distraction[d] - Re-appraising the situation[d] - Acquiring and providing social support[d]
Performance phase[a]	- Meta-cognitive awareness and monitoring of cognition[b] - Selection and adaption of cognitive strategies for learning and thinking[b] - Learning strategies (surface- and deep-level learning strategies)[b]	- Monitoring[C]	- Awareness and monitoring of motivation and affect[b] - Selection and adaptation for managing motivation and affect[b] - Motivational strategies[C]	- Awareness and monitoring of effort, time use, need for help[b] - Self-observation of behavior[b] - Increase/ decrease effort[b] - Persist, give up[b] - Help-seeking behavior[b]	
Appraisal phase[a]	- Cognitive judgements[b]	- Self-evaluation (product and process evaluation)[C]	- Affective reactions[b]	- Choice behavior[b]	

Note. Codes are based on: [a] Puustinen and Pulkkinen, 2001. [b] Pintrich, 2004. [c] Vandevelde et al., 2013. [d] Boekaerts, 2011. Emotions are regulated throughout the three phases of SRL.

day-to-day classroom practice. Other reasons for exclusions were that the studies did not provide a direct relationship between support and SRL, or that they did not measure SRL but a similar concept, such as executive functioning.

Of the 162 excluded studies, 80 (49.3%) were conducted in the United States and seven (4.3%) in Canada. Other studies (46,4%) were conducted in (mostly Western) Europe (37,1%), and non-Western countries (9.3%). In total, 13 studies (8%) did not report where they were conducted. In comparison, about half of the reviewed studies were conducted in the United States (43.3%) and another 3.3% in Canada. Other included studies (40%) were conducted in Western-European countries or in non-Western countries (13.3%). There is large similarity between the countries from which included and excluded studies originated, which strengthening the validity of our search process and representative nature of the research.

literature on SRL. It also shows that our search criteria were applied irrespective of the country from which a study originated.

Analysis

The features of teacher-student interaction and SRL of the 30 studies were already coded following Tables 1 and 2 (see above). In addition, the first author coded for each study the author(s), country, number of participants, their age and grade, design (cross-sectional or longitudinal), type of statistical analysis, and the strength of the relationships between the quality of teacher-student interactions and components of SRL (Snilstveit et al., 2012). The type of instrument used in the study, was also coded. Both for teacher support and the components of SRL, we distinguished between observations, teacher reports and student reports. Next, the findings of each study were summarized in an overview table (see Online Resource 1). Then, we examined which types of teacher-student interaction were related to each of the components of SRL. We also considered for each component whether these relations vary according to effect size, type of measure, sample size, age and grades, design, and the countries from which studies originated. Subsequently, we examined differences and similarities in studies across the components of SRL.

Results

### Overall Study Characteristics

An overview of the study and sample characteristics of the 30 reviewed studies can be found in the Online Resource 1. The majority of studies (70%) included multiple dimensions for measuring the quality of teacher–student interactions, whereas the other 30% only included a single dimension. Regarding the outcome variables, 30% of the studies included a combination of multiple components of SRL, compared to 70% that only included a single component. Most studies ($n=19$, 63.3%) included regulation of motivation as outcome variable, compared to 12 studies that included regulation of behavior (40%), seven that included metacognition (11.7%), and two that included the regulation of cognition (6.7%). None of the studies included the

Table 2 Overview of the Domains and Dimensions of Teacher–Student Interactions at the Classroom Level based on the Teaching Through Interactions Framework

Instructional Support (IS)	Classroom Organization (CO)	Emotional Support (ES)
Instructional Learning Formats: - Learning targets/organization - Variety of modalities, strategies, and materials - Active facilitation - Effective engagement	*Behavior Management*: - Clear expectations - Proactive - Effective redirection of misbehavior - Student behavior	*Positive Climate*: - Classroom relationships - Positive affect - Positive communications - Respect
Content Understanding: - Depth of understanding - Communication of concepts and procedures - Background knowledge and misconceptions - Transmission of content knowledge and procedures - Opportunity for practice of procedures and skills	*Productivity*: - Maximizing learning time - Routines - Transitions - Preparation	*Teacher Sensitivity*: - Awareness - Responsiveness to academic and social/emotional needs and cues - Effectiveness in addressing problems - Student comfort
Analysis and Inquiry: - Facilitation of higher-order thinking - Opportunities for novel application - Promoting metacognition	*Negative Climate*: - Negative affect - Punitive control - Disrespect	*Regard for Student Perspectives*: - Flexibility and student focus - Connections to current life - Support for autonomy and leadership - Meaningful peer interactions
Quality of Feedback: - Feedback loops - Scaffolding - Building on student responses - Encouragement and affirmation *Instructional Dialogue*: - Cumulative content-driven exchanges - Distributed talk - Facilitation strategies		

regulation of emotions. Last, 20 studies (66.6%) provided information on associations at the classroom level, whereas eight (26.6%) were focused on relationships at the dyadic-level. Only two articles were found in which associations between teacher–student interactions and SRL were described at both the classroom and dyadic-level (McCombs et al., 2008; Pitzer & Skinner, 2017). Only one study (3.3%) of the included studies was conducted before 2000, compared to eight (4.9%) of the excluded studies.

The total sample size of the 30 studies was 31,628 students (M_{age}: 9.06 years, M_{range}: 4.53–11.8 years; 49.9% boys). The studies involved 2620 teachers (M_{age}: 43.17 years, M_{range}: 32.91-52 years; 8.3% males) but note that only 50% of the studies provided information about the teacher sample size. The majority of studies was conducted in third to sixth grade ($n=23$; 76.6%), with four studies (13.3%) focusing specifically on first to third grade and the remaining two studies involved a wider
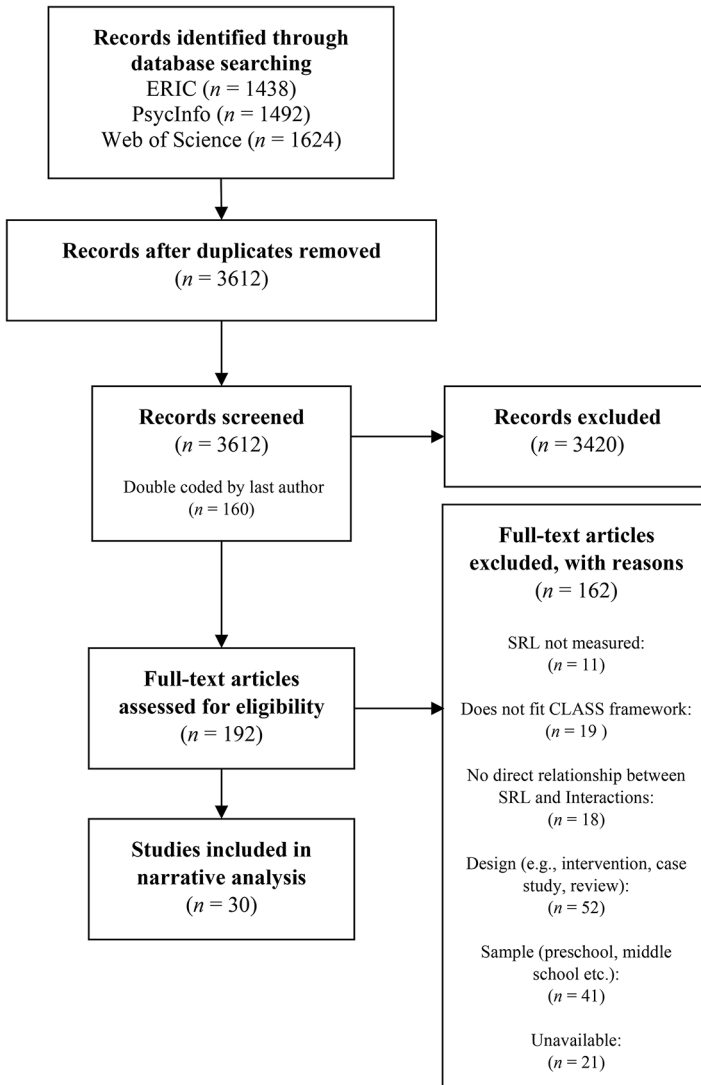
Fig. 1 Flow Diagram of the Selection Process

range of grades (6.7%). Of the 30 studies, 23 (76.6%) had a cross-sectional and seven longitudinal design.

As described, most of the included studies were conducted in the United States and Western-European countries, with a small minority that was conducted in non-Western countries. This distribution is consistent with an overview study, describing that most of the studies on SRL have been conducted in Western-oriented countries, such as the United States and parts of Europe (McInerney & King, 2018). It shows that our sample may be a good representation of the current field, although our ability to gain insights into cross-cultural similarities and differences in SRL is limited by

the predominantly Western studies. Despite differences in national school policies, self-regulation appeared to be a consistent predictor of both school engagement and achievement across cultures (Cumming et al., 2020; McInerney & King, 2018). We therefore decided not to limit the results to a particular country.

An overview of the instruments used in the studies can be found in Online Resource 1. At the classroom level, either the Classroom Assessment Scoring System (CLASS, Pianta et al., 2012), or an adaption of this instrument (e.g., Havik and Westergård, 2020), was mostly used to measure teachers' instructional support, classroom organization, and emotional support ($n=5$). Overall, these domains were found to have a good reliability (Cronbach's α ranging from $=0.72$ to 0.87). At the dyadic level, teacher–student closeness, conflict and dependency were most frequently measured ($n=6$) with the Student-Teacher Relationship Scale (STRS, Pianta, 2001). The three subscales generally showed good psychometric properties (Cronbach's α ranging from $=0.74$ to 0.93), except for the 'conflict' scale used by Huang (2010) which was only marginally reliable (Cronbach's $α=0.63$).

In total, 21 out of the 30 included studies (70%) relied exclusively on student self-reports measures for SRL. These measures seem suitable for large scale research, since they are relatively easy to collect and score and can often be used across different contexts. Moreover, self-report measures for SRL are also limited as they often focus on a narrow subset of strategies, resulting in that the multiple component structure of SRL is not always captured. For instance, Ryan and Connell's (1989) Academic Self-Regulation Questionnaire was mostly used ($n=4$), containing four subscales on external, introjected, identified, and integrated regulation (Cronbach's α ranging from $=0.72 – 0.91$). These subscales measure only a single component of SRL, which is the regulation of motivation. Only two studies in our sample (Baas et al., 2015; Lee et al., 2019) used multidimensional instruments to provide insight into the component structure of SRL, including Children's Perceived Use of Self-Regulated Learning Inventory (CP-SRLI, Vandevelde et al., 2013) and the Motivated Strategies for Learning Questionnaire (MSLQ, Pintrich and de Groot, 1990). Subscales of both instruments include items on regulation of (meta)cognition and motivation. Overall, the CP-SRLI and MSLQ had sufficient reliability (Cronbach's α ranging from $=0.70$ to 0.89) and construct validity. Internal consistency of the 'planning' subscale of the CP-SRLI, however, was marginal (Cronbach's $α=0.65$).

Tables 3 and 4 present a summary of the results for the associations between teacher–student interactions and the different components of SRL. In the following sections, we examine differences and similarities between the included studies in terms of grade level, instruments, measurement methods, and outcomes, both at the classroom and the dyad level. detailed overview of each study can be found in Online Resource 1.

Regulation of Cognition

We did not find studies that described relationships between the quality of teacher–student relationships at the dyadic level and students' regulation of cognition. Only two cross-sectional studies on teacher–student interactions at the classroom level and the regulation of cognition were found (Baas et al., 2015; Neitzel & Davis, 2014).

Table 3 Overview of Results at the Classroom Level

Components	Instructional support	Classroom organization	Emotional support	N studies	M student sample size (range)	M teacher sample size (range)
Cognition	± (β_{range}: −0.43 − 0.58, M=0.13, $N_{studies}$ = 2)	n/a	+ (β_{range}: 0.21 − 0.36, M=0.29, $N_{studies}$ = 1)	2	310 (93−528)	4*
Metacognition	+ (β_{range}: 0.00 − 0.48, M=0.20, $N_{studies}$ = 4)	+ (β_{range}: 0.09 − 0.20, M=0.15, $N_{studies}$ = 3)	± (β_{range}: 0.00 − 0.32, M=0.18, $N_{studies}$ = 3)	5	581 (106−996)	30* (5−54)
Motivation	± (β_{range}: −0.05 − 0.26, M=0.03, $N_{studies}$ = 4) (B_{range}: −0.06 − 0.38, M=0.17, $N_{studies}$ = 1)	± (β_{range}: 0.00 − 0.38, M=0.08, $N_{studies}$ = 5) (B_{range}: 0.06 − 0.32, M=0.13, $N_{studies}$ = 1) (r_{range}: −0.06 − 0.55, M=0.16, $N_{studies}$ = 3)	± (β_{range}: −0.04 − 0.44, M=0.10, $N_{studies}$ = 7) (B_{range}: −0.28 − 0.26, M=0.00, $N_{studies}$ = 2) (r_{range}: −0.15 − 0.43, M=0.14, $N_{studies}$ = 3)	15	1368 (144−4847)	121* (14−621)
Behavior	± (β_{range}: 0.00 − 0.37, M=0.15, $N_{studies}$ = 4) (B_{range}: 0.02 − 0.29, M=0.13, $N_{studies}$ = 2)	± (β_{range}: 0.00 − 0.65, M=0.21, $N_{studies}$ = 4) (B_{range}: 0.03 − 0.04, M=0.04, $N_{studies}$ = 2) (r=.54, $N_{studies}$ = 1)	± (β_{range}: 0.00 − 0.32, M=0.12, $N_{studies}$ = 4) (B=0.03, $N_{studies}$ = 0.53) (r_{range}: 0.51 − 0.54, M=0.53, $N_{studies}$ = 1)	9	940 (93−3548)	73 (4−322)
Emotions	n/a	n/a	n/a	0	n/a	n/a

Note. Teacher sample size was not always provided, indicated by a *. Mean sample size is based on available teacher sample sizes

+ = positive relationships; ± = mixed findings; n/a = no findings available

Magnitude guidelines to interpret β (Keith, 2006): Small = (-)0.01 to (-)0.09; Moderate = (-)0.10 to (-)0.24; Medium = (-)0.25 to (-)0.39; Large = (-)0.40 to (-)1

Magnitude guidelines to r (Cohen, 1988): Small = (-)0.10 to (-)0.30; Medium = (-)0.30 to (-)0.50; Large = (-)0.50 to (-)1

Table 4 Overview of Results at the Dyad Level

Components	Closeness	Conflict	Dependency	N studies	M student sample size (range)	M teacher sample size (range)
Cognition	n/a	n/a	n/a	0	n/a	n/a
Metacognition	+ (β_{range}: 0.35 – 0.50, M=0.20, $N_{studies}$ = 1) (r_{range}: 0.36 – 0.37, M=0.37, $N_{studies}$ = 1)	± (β_{range}: −0.23 – 0.00, M=−0.12, $N_{studies}$ = 1) (r_{range}: −0.37 – −0.27, M=0.31, $N_{studies}$ = 1)	n/a	2	388 (370–407)	16*
Motivation	+ (β_{range}: 0.06 – 0.38, M=0.14, $N_{studies}$ = 4) (B_{range}: 0.06 – 0.53, M=0.36, $N_{studies}$ = 1) (r_{range}: 0.05 – 0.28, M=0.17, $N_{studies}$ = 1)	- (β_{range}: −0.47 – 0.00, M=−0.16, $N_{studies}$ = 3)	- (β_{range}: −0.07 – 0.00, M=−0.02, $N_{studies}$ = 1)	6	1046 (195–2087)	103* (29–207)
Behavior	± (β_{range}: 0.00 – 0.34, M=0.22, $N_{studies}$ = 2) (r_{range}: 0.11 – 0.14, M=0.13, $N_{studies}$ = 1)	- (β_{range}: −0.26 – −0.09, M=−0.18, $N_{studies}$ = 2) (r_{range}: −0.34 – −0.29, M=−0.32, $N_{studies}$ = 1)	n/a	3	707 (67–1364)	318*
Emotions	n/a	n/a	n/a	0	n/a	n/a

Note. Teacher sample size was not always provided, indicated by a *. Mean sample size is based on available teacher sample sizes.

+ = positive relationships; ± = mixed findings; - = negative relationships; n/a=no findings available

Magnitude guidelines to interpret β (Keith, 2006): Small = (-)0.01 to (-)0.09; Moderate = (-)0.10 to (-)0.24; Medium = (-)0.25 to (-)0.39; Large = (-)0.40 to (-)1

Magnitude guidelines to r (Cohen, 1988): Small = (-)0.10 to (-)0.30; Medium = (-)0.30 to (-)0.50; Large = (-)0.50 to (-)1

These studies were conducted in upper elementary schools in the Netherlands and the United States. One of these two studies is unique in the sample for its use of the Children's Perceived Use of Self-Regulated Learning Inventory, which is the only instrument that distinguishes between different components and phases of SRL (Baas et al., 2015). Results of this large-scale study showed that students who perceived high levels of scaffolding from their teachers used more surface- and deep-level strategies during the performance phase of SRL (Baas et al., 2015). Another small-scale observational study showed that diverse forms of instructional support may have different relationships with cognitive outcomes (Neitzel & Davis, 2014). More specifically, high-quality basic instruction was positively associated to improved recall of information and students were better able to do deep-level processing. However, when provided with performance feedback, students were more likely to have a reduced interest in task-process information and strategy and process instruction had negative effect on students' pursuit of normative information. Emotional support through autonomy supportive questioning was linked to improved use of task-process and procedural information, thereby supporting the hypothesis that emotional support contributes to regulation of cognition (Neitzel & Davis, 2014).

Conclusion About the Regulation of Cognition

It is impossible to draw definitive conclusions based on two studies that differ in method, sample size, and that were solely focused on the classroom level. Moreover, as other studies do not distinguish between the phases of SRL, it is challenging to make generalized claims about the phases based on a single study (Baas et al., 2015). However, the findings provide some insights into relationships between teacher–student interactions and the regulation of cognition in the upper elementary grades. For example, it seems that teachers who provide certain types of instructional support, such as scaffolding, and emotional support are likely to help students develop the regulation of their cognition. It should be noted, however, that some aspects of instructional support seem to be negatively associated with the regulation of cognition, such as performance feedback and instruction targeted at metacognition.

Metacognition

Seven medium- to large-size cross-sectional studies reported about relationships between teacher–student interactions and students' metacognition in grades 3 to 6 (N_{range} = 106–996 students). Two studies found that students with closer relationships with their teachers also demonstrated better metacognitive abilities (Huang, 2010; Zee & de Bree, 2017). Furthermore, both studies reported that students with higher levels of conflict in the relationship with their teachers were more likely to display lower levels of metacognition, such as independent participation (i.e., independent, self-directed behavior in the classroom; Huang, 2010) and task-orientation (Zee & de Bree, 2017). The relationships of teacher- or student-perceived closeness and conflict with independent participation were similar in strength (e.g., student perceived closeness, $r = .37$ versus teacher perceived closeness, $r = .36$; Huang, 2010). Solely based on students' self-reports, students perceptions of conflict in the relation-

ship with teachers was not associated to their overall metacognition (Zee & de Bree, 2017). The latter finding suggests that for specific metacognitive skills students may be negatively affected by conflict with teachers, whereas for overall metacognition other dimensions of dyadic relationships might have played a role. Despite these partly unexpected findings, there is consensus among both studies on the positive associations between high levels of teacher–student closeness and metacognition in upper elementary school.

At the classroom level, five studies examined relationships of instructional support, classroom organization, and emotional support with upper elementary school students' metacognition. Rieser and colleagues (2013) were the only ones to examine direct cross-sectional relationships between all three domains of the TTI-framework and students' metacognitive strategy use ($N_{students}$ = 996 and $N_{teachers}$ = 54). They found that students who reported higher levels of instructional support, classroom organization, or emotional support were also better in using metacognitive strategies than students who reported lower levels of the three domains in their classroom. Furthermore, instructional support had the strongest direct relationship with metacognitive strategy use. These findings align well with the mechanisms from the TTI-framework, which suggest that there are positive relationships between the three domains and the metacognitive component of SRL, with the strongest positive relationships between instructional support and metacognition.

Three small- to large-scale cross-sectional studies focused on relationships between specific aspects of the instructional support domain and metacognition (Baas et al., 2015; Lee et al., 2019; Neitzel & Connor, 2017). These studies generally show that different aspects of instructional support may promote students' metacognitive abilities in SRL. For instance, students who were positive about the level of feedback and scaffolding from their teachers were also better in task-orientation, planning, and evaluating their own learning process in comparison to students who were less positive (Baas et al., 2015). Additionally, students whose teachers reported higher academic emphasis perceived themselves to be better able to regulate their learning strategies (Lee et al., 2019). Multiple moderate- and medium sized direct relationships were also observed between instructional support, including metacognitive strategy and process instruction, heuristic questions for autonomous thinking, formative feedback, and classroom attunement to individual needs, and students' self-regulation strategies (Neitzel & Connor, 2017). Other forms of instructional support, including basic forms of instruction or corrective feedback, were not related to self-regulation strategies (Neitzel & Connor, 2017). In addition, both perceived feedback and scaffolding, did not seem to be related to students' product evaluation (Baas et al., 2015). These findings suggest that these forms of instructional support alone may not always be sufficient for promoting (aspects of) SRL in students.

A small- and large-scale cross-sectional study have also explored the associations between classroom organization and emotional support with metacognition in upper elementary schools (Neitzel & Connor, 2017; Patrick et al., 2007). These studies generally found smaller effect sizes compared to research in the instructional support domain, although the limited amount of studies makes it challenging to generalize these results (Neitzel & Connor, 2017; Patrick et al., 2007). A little more evidence is available for teachers' emotional support, which seems to be positively related to

metacognitive outcomes in the form of self-regulation strategy use during learning tasks (Patrick et al., 2007). However, a specific aspect of observed emotional support, measured as sanctioned talk, does not seem to promote the use of self-regulation strategies by students (Neitzel & Connor, 2017). This raises the empirical question of which specific aspects of emotional support may have a positive or a negative impact on the development of SRL.

Conclusion About Metacognition

Most studies focused on the relationships between (aspects of) instructional support and upper elementary school students' metacognition. Together, the results of these studies generally suggest that teachers who provide high-quality instructional support, including a combination of monitoring, scaffolding, academic emphasis, strategy and process information instruction, heuristic questions, formative feedback, and classroom attunement, seem to promote upper elementary students' metacognition. The mere focus on instructional support makes it difficult, however, to draw definite conclusions about the associations of the other domains of the TTI-framework or relationships at the dyad level with metacognitive skills. We found some initial evidence that classroom organization and emotional support may be positively linked with metacognition, although a single study also found a negative relationship between an aspect of the emotional support domain and metacognition (Neitzel & Connor, 2017). It often appears that the relationship between instructional support and metacognition is stronger than between the other domains of the TTI-framework based on the effect sizes, although more research is needed to further examine these findings. Other studies showed improved metacognition in upper elementary students when the relationship with teachers was reported to be closer, whereas reported conflictual relationships might have hampered students' use of specific metacognitive skills. However, in some cases, it also appears that teacher-student conflict is not related to metacognition. These findings are only based on two studies and need to be repeated to draw more generalized conclusions.

Regulation of Motivation

Nineteen studies described associations with students' motivation, of which 15 medium- to large-sized studies examined relationship between classroom-level interactions and the regulation of students' motivation ($N_{range} = 144$–4847 students). Two studies that included the three domains of the TTI-framework did not find consistent evidence for the relationship in the upper elementary grades (Havik & Westergård, 2020; Rimm-Kaufman et al., 2014). For instance, in a study by Rimm-Kaufman et al. (2014), longitudinal associations of instructional support, classroom organization, and emotional support with aspects of regulation of motivation were either very small and non-significant or no effects were reported. In contrast, a large-scale cross-sectional study found that upper elementary students' perceptions of the quality of interactions within the three domains were positively related to their emotional engagement (Havik & Westergård, 2020).

Other studies that only included parts of the domains of the TTI-framework also found mixed results. Starting with the instructional support domain, three medium- to large-sized cross-sectional studies have focused on different aspects of instructional support and relationships with motivation in upper elementary (Lee et al., 2019; Thoonen et al., 2011) and lower elementary schools (McCombs et al., 2008). Focusing on *teacher-perceived* facilitation of learning and thinking in the lowest grades of elementary school, no associations with students' interest and academic competence were found (McCombs et al., 2008). However, when *students perceived* their teachers as facilitators of learning and thinking, they were likely to feel more interested and academically competent.

Turning to upper elementary students, students' feelings about the quality of instructional support was not associated to their perceived self-efficacy, intrinsic motivation, mastery goals, and performance avoidance goals (Thoonen et al., 2011). Students' school investment even slightly decreased after receiving process-oriented instruction. Another study contradicts these findings by presenting positive associations between teachers reported academic emphasis and students perceived self-efficacy and intrinsic motives (Lee et al., 2019).

Mixed findings were also found in nine studies that examined the relationships between teachers' classroom organization and the regulation of motivation in upper elementary grades. Two large-scale cross-sectional studies showed that classroom management was positively associated with the regulation of academic motivation, consisting of self-efficacy, intrinsic motivation, and perseverance (van Dijk et al., 2019), and students' subject and mastery goal interest (Schiefele, 2017). Other studies have explored the role of structure in students' regulation of motivation, which is considered to be a part of classroom organization (see Table 2). A cross-sectional and longitudinal study showed that upper elementary students are likely to demonstrate higher levels of motivational resilience (i.e., engagement, coping, and re-engagement, Pitzer and Skinner, 2017) and emotional engagement (Skinner & Belmont, 1993) when their teachers provided structured classroom environments, indicating that structure is positively related to the regulation of motivation. Other large-scale cross-sectional studies, however, did not find any association of structure with controlled and autonomous motivation (Domen et al., 2020; Guay et al., 2017), intrinsic, identified, and introjected regulation, and students' amotivation (Hornstra et al., 2020). Notably, students who reported external regulation were also found to experience higher levels of structure (Hornstra et al., 2020).

We expected that the associations between teachers' emotional support and motivation would be positive, based on the TTI-framework. Again, results were found to be mixed. Longitudinal and cross-sectional studies evaluating specific aspects of emotional support in upper elementary grades showed that teachers' involvement, autonomy support, and collaborative rule-setting, were positively associated with aspects of the regulation of motivation, including motivational resilience (Pitzer & Skinner, 2017) and emotional engagement (Skinner & Belmont, 1993; Zhou et al., 2019). Effect sizes, however, varied from small to large across these three studies which where conducted in the United States and China and are solely based on students' self-reports. It could be that the strength of the relationships described here

is dependent on which specific construct from the TTI-framework or SRL is being measured.

Along similar lines, upper elementary school students whose teachers reported high levels of autonomy support also reported less introjected and external regulation and more intrinsic and identified regulation (Hornstra et al., 2020). Other medium- to large-scale cross-sectional studies demonstrated that upper elementary students' mastery goals and academic efficacy (Patrick et al., 2007; Thoonen et al., 2011), intrinsic motivation (Carreira et al., 2013), and self-efficacy (Lee et al., 2019), were more likely to increase with emotionally supportive teachers. However, emotional support did not increase autonomous and controlled motivation (Domen et al., 2020).

On the contrary, other large-scale cross-sectional studies have reported no or negative relationships between emotional support and the regulation of motivation. For instance, students perceived elements of emotional support, including connecting to students' world and stimulating cooperation, were not related to students' academic efficacy, intrinsic motivation, performance avoidance goals, and school investment (Thoonen et al., 2011). In addition, promoting cooperation in the classroom was not found to be associated with higher levels of mastery goal orientation. In another study, lower elementary *students' perceptions* of motivational support resulted in higher levels of interest in school and improved academic competence, whereas *teachers' perceptions* of motivational support were not found to be related to motivational outcomes (McCombs et al., 2008). These studies provide further evidence that the relationship between emotional support and motivation remains inconclusive.

Associations between the quality of dyadic relationships and motivation are generally more consistent than the findings at the classroom level. These associations were assessed in seven studies. Findings from two longitudinal studies that were conducted throughout elementary school in the United States and the Netherlands, revealed that students who experienced close teacher–student relationships in the early grades also had more positive attitudes about school (Heatly & Votruba-Drzal, 2019) and a higher sense of self-efficacy, task motivation, and motivational attitudes in fifth or sixth grade compared to their peers (Zee et al., 2020). Heatly and Votruba-Drzal (2019) also showed that close teacher–student relationships in fifth grade were also associated to better attitudes about school in the same year. Turning to teachers' relationship perceptions, positive longitudinal associations between third grade teachers' perceptions of closeness and higher levels of students' task motivation and motivational attitudes in sixth grade were found (Zee et al., 2020). Teachers' perceptions of closeness, however, were not associated to improved students' academic competence.

For teacher–student conflict, high levels of conflict in first, third, and fifth grade was negatively related to students' attitudes about school in fifth grade (Heatly & Votruba-Drzal, 2019). Along similar lines, teacher-perceived conflict in third grade was associated with less positive students' motivational attitudes and lower task motivation in sixth grade (Zee et al., 2020). Moreover, teacher perceived conflict in grade 3 was not related to students self-efficacy in grade 6. Associations between teacher–student dependency and motivation were also explored, showing that students whose teachers perceived them to be overly reliant in third grade had lower motivational attitudes in sixth grade (Zee et al., 2020). No associations were found

between teacher–student dependency and students self-efficacy and task motivation in sixth grade.

The results of cross-sectional studies that were conducted in grade 1 to 6, are in line with these longitudinal findings. They demonstrate that students who reported higher levels of closeness in first grade tend to feel more engaged in school (Portilla et al., 2014) and students in the higher grades are more likely to exhibit motivational resilience (Pitzer & Skinner, 2017). Negative reciprocal relationships between teachers perceived conflict and school engagement in first grade were also found (Portilla et al., 2014). Moreover, students reported to have higher levels of academic competence and interest in school when they experienced positive relationships with their teachers (McCombs et al., 2008). However, when teachers reported on their relationships with students, the association with academic competence was not significant anymore. Finally, students perceived closeness was positively related to a higher sense of mastery goal orientation and academic efficacy (Wilson et al., 2016). Teacher–student closeness was not related to performance or performance avoidance approaches.

Conclusion About the Regulation Motivation

Overall, the findings with regard to students' regulation of motivation are mixed at the classroom level, but more consistent at the dyad level. These mixed findings at the classroom level do not entirely align with the mechanisms outlined by the TTI-framework, which states that high-quality teacher–student interactions will support students in feeling competent, autonomous, and more motivated to work at a task. We expected that this would especially be the case in emotionally supportive classrooms. However, our review did not find consistent evidence to support this expectation, suggesting that the relationships between emotional support and motivation were not always positive and not stronger than the associations with other domains. It also seems that students' motivational SRL (e.g., engagement, self-efficacy) improved when teachers applied specific aspects of instructional support (e.g., academic emphasis), classroom organization (e.g., classroom management), and emotional support (e.g., autonomy support). Reasons for these inconsistencies may be differences in conceptualizations and measurements of the domains of the TTI-framework and regulation of motivation. The large number of studies within the motivational domain at the classroom level may have brought this to the surface.

At the dyad level, findings are more consistent. Results showed that close relationships between teachers and students may be related to higher levels of the regulation of motivation in class throughout elementary school. Conflictual relationships with teachers, on the other hand, were negatively associated with motivation. These findings are in line with our expectations. In addition, given the limited amount of studies on students' dependency and SRL, definite conclusions cannot be drawn about this domain based on the evidence provided in the present study.

Regulation of Behavior

In total, 12 studies focused on associations between the TTI-framework domains and the regulation of behavior, four large-scale studies of which have included all three domains (N_{range} = 387–3548 students). Findings from these studies, which were all conducted in grade 3 to 6, are inconsistent. Two cross-sectional studies reported that when teachers provided high levels of student perceived instructional support and emotional support, they were also likely to feel behaviorally engaged and had higher levels of volitional control (Havik & Westergård, 2020; Rieser et al., 2013). Moreover, students also reported higher levels of volitional control compared to their peers when they experienced high-quality classroom organization (Rieser et al., 2013). In contrast, findings demonstrated that behavioral management, which is part of high-quality classroom organization, was not related to behavioral engagement (Havik & Westergård, 2020). Moreover, using a combination of measures, other studies reported that associations of teachers' instructional support, classroom organization, and emotional support with the regulation of behavioral engagement and effort were not significant (Rimm-Kaufman et al., 2014; Schenke, 2018). In addition, there was no difference in the relationship with observed or teacher- and student- perceived behavioral engagement. It is possible that these results differentiate from the other studies due to their mixed-methods designs. More evidence based on a variation of designs seems therefore necessary to draw definite conclusions.

Other small- to large-scale studies that included one or two domains of the TTI-framework and behavioral SRL in upper elementary grades did also find mixed findings. For example, teachers' perceptions of the promotion of learning and differentiation (i.e., instructional support) and managing and organizing classroom activities (i.e., classroom organization) was not related to students' perceived academic engagement (Opdenakker & Minnaert, 2011). However, when teachers had provided sufficient instructional skills according to themselves, students were also more likely to feel academically engaged in the learning tasks. The latter is in line with an observational study, which found that basic instruction and performance feedback had a medium-sized positive relationship with students' social monitoring (Neitzel & Davis, 2014). Larger effect sizes were found in a longitudinal study that found positive associations between classroom organization and emotional support with behavioral engagement (Skinner & Belmont, 1993). This study showed that when students perceived their teachers to provide structure in the classroom, involvement into their lives, and autonomy support at the beginning of the schoolyear, they were more behaviorally engaged later in that year. In addition, Patrick et al. (2007) also reported in their cross-sectional study that student perceived emotional support could improve task-related interactions.

In the first grade of elementary schools, observed classroom organization resulted in higher levels of observed and teacher reported behavioral engagement (Cadima et al., 2015). These relationships had large effect sizes, which indicates that at an early age students may benefit from high-quality emotional support for the development of behavioral regulation. Dyadic relationships seem also important in this age period, as can be obtained from multiple longitudinal studies that included students from different age levels. They found that close relationships positively predicted

how behaviorally engaged lower and higher grade students were, based on teacher reports, student interviews and observations (Hughes et al., 2012; Yang & Lamb, 2014). However, a single study showed that teacher reported close relationships with their students in fifth grade, was not related to students perceived behavioral engagement (Heatly & Votruba-Drzal, 2019). More consistent were findings that revealed that students felt less behaviorally engaged when their teachers reported high levels of conflict in daily interactions (Heatly & Votruba-Drzal, 2019; Hughes et al., 2012; Yang & Lamb, 2014).

Conclusion About the Regulation of Behavior

The findings on the regulation of behavior appear to be mixed at the classroom level and more consistent at the dyad level. This is similar to the findings on students' motivation, and not completely in line with our expectations that the domains of the TTI-framework would have a consistent positive relationship with the regulation of behavior. It seems that the design of the studies may have played a role in these findings. Studies that used a combination of measures tend to find different results than those that only used self-reports. Additionally, most studies focus on upper elementary school students, while a study in the lower grades shows that there can indeed be positive relationships between classroom organization and behavioral regulation. This suggest that more research is needed to establish definitive conclusions, especially in the lower grades of elementary school.

Turning to the dyad level, findings are more consistent. Three longitudinal studies support the idea that conflictual relationships may hamper students' regulation of behavior throughout elementary school. These findings are therefore in line with our expectations. Two of the three studies showed that when students and teachers had close relationships, students were more likely to regulate their behavior at a higher level, as we expected. However, a single study also provides evidence that teacher reported close relationships may not promote students' regulation of behavior in the fifth grade. Additional research seems necessary to explain this divergent result.

Discussion

The aim of the current study was to provide a narrative review of the relations between the quality of teacher–student interactions and SRL. Our review builds on and extends current reviews (e.g., Cumming et al., 2020; Dignath et al., 2008; Dignath & Veenman, 2021; Vandenbroucke et al., 2018) by including: (1) both classroom- and dyad-level teacher–student interactions as predictors; (2) different components of SRL as outcome variables; and (3) elementary school students rather than high-schoolers. In this section, we present the main results of this review as well as the current state of the field.

Classroom-Level Interactions and Metacognition and the Regulation of Cognition

Relationships between teacher–student interactions and the cognitive and metacognitive components of SRL have mainly been described within the instructional support domain in upper elementary classrooms. However, it is noteworthy that only two studies focused on the relationships between instructional support and the regulation of cognition. This is surprising given that previous research has shown that teachers tend to focus most on the cognitive component of SRL in their instruction (Dignath & Veenman, 2021). The two studies demonstrated that some aspects of instructional support, such as scaffolding, may be positively associated with the regulation of cognition, whereas other aspects were negatively associated with the cognitive component of SRL. The negative association between teachers' instructional support and the regulation of cognition may be due to the rather small sample size of this particular study, which may have made the results less stable (Neitzel & Davis, 2014). Moreover, instructional support was merely focused on strategy and process information. Prior research suggests that it should also incorporate prior cognitive knowledge and real-life examples to offer students sufficient opportunities to demonstrate current skills, expand their knowledge and develop new cognitive and metacognitive skills (Veenman, 2017). Based on the results of the two studies, it is impossible to draw definitive conclusions about whether the relationship between instructional support and the regulation of cognition is positive or negative.

A little more evidence supports the association between instructional support and metacognition. More specifically, teachers' high-quality instructional support, such as monitoring, scaffolding, strategy and process instruction, and formative feedback, is likely to result in higher levels of students' metacognition. These findings are perhaps not surprising, given that these forms of instructional support, compared to basic instruction or corrective feedback, are relatively well-tailored to the outcome of interest. This may increase the predictive merit of the quality of instructional support for this particular component of SRL (cf. Bandura, 2006).

The number of studies that have examined the relationship of the cognitive and metacognitive components with classroom organization and emotional support with is considerably smaller than the number of studies that enquired the relationship with instructional support. We only found some initial evidence that (aspects of) teachers' emotional support stimulate the regulation of cognition, and that (most aspects of) emotional support and classroom organization are likely to be positively related to metacognition. The positive associations of emotional support and classroom organization with metacognition appeared to be less strong than the associations of instructional support with metacognition. These findings were expected based on the TTI-framework. Teachers' classroom organization and emotional support are predominantly aimed at affective- and behavioral process within the classroom, such as creating a safe and positive learning environment, redirecting students' misbehaver, and daily routines to maximize learning time (Hamre et al., 2013). Instructional support, on the other hand, is particularly well tailored to students' metacognition, by providing students' with high-quality feedback and scaffolding and the explicit training of higher-order thinking skills. Because instructional support is so well-tailored

to students' metacognition, it is not surprising that we found the strongest associations with (meta)cognition within this domain.

Classroom-Level Interactions and the Regulation of Motivation and Behavior

The majority of included studies has examined relationships of the three domains of the TTI-framework with the regulation of motivation and behavior in upper elementary schools. The findings were mixed, which did align with our expectation that students who experienced high levels of instructional support, classroom organization, and particularly emotional support, would also report higher levels of motivation and behavior. Instead, it appeared, for example, that emotionally supportive teachers did not always have students that regulated their motivation and behavior at a higher level. In addition, the associations between emotional support and the regulation of motivation and behavior were not stronger than the relationships with instructional support and classroom organization. An explanation for these findings may be that measures of students' motivation and behavior tap student behavior that is more inner-directed, including effort and persistence, and also feelings and beliefs in relation to tasks (e.g. 'I enjoy doing my classwork' and 'Because I want the teacher to say nice things about me', Ryan and Connell, 1989). Such aspects of SRL are difficult to observe or measure directly and might therefore also be more difficult to influence through classroom-level interactions.

Moreover, it seemed that only specific aspects of instructional support (e.g., academic emphasis), classroom organization (e.g., classroom management), and emotional support (e.g., autonomy support) were positively associated with the regulation of motivation and behavior. However, most findings were inconsistent, which might be attributed to differences in measures of SRL, such as self-reports or a combination of measures, and the age group of participants including lower versus upper elementary school students. Only a few studies incorporated other measurement techniques in addition to self-reports, and thereby provided a more comprehensive view of teacher–student interactions and SRL (Rimm-Kaufman et al., 2014; Schenke, 2018). Additionally, students at different ages probably require different forms of teacher support to develop effective forms of SRL (Dignath et al., 2008). Currently there is very little knowledge about how to provide effective classroom-level support to young students in the lower grades of elementary school, thereby adding to the inconsistency of the findings across age groups.

Dyad-Level Interactions and Components of SRL

There were relatively little studies on the relationships between dyad level interactions and the components of SRL, but the results were highly consistent. Generally, students who enjoyed warm and close relationships were more likely to regulate their, motivation and behavior better and had higher levels of metacognition. Students who experienced conflictual relationships, on the other hand, were more likely to report lower levels of metacognition, and were less effective in regulating their motivation and behavior. The results suggest that one-to-one interactions, in which warmth and

support prevail, assist students in learning how to regulate different components of SRL.

According to social-cognitive theory (Bandura, 1997), students have the potential to acquire valuable knowledge on regulating their metacognition, motivation, and behavior by observing and modeling their teachers. This learning process may be particularly effective when teachers, as effective role models, possess the requisite skills, be perceived as credible by their students, and have warm and supportive relationships with their students (cf. Bandura, 1986). It is possible that the presence of such a nurturing relationship serves as ample motivation for elementary school students to regulate their metacognition, motivation, and behavior, and achieve at higher levels. To some extent, this would be in line with prior meta-analytic evidence (Roorda et al., 2017), in which students' cognitive, behavioral, and emotional engagement were found to mediate the link between student-teacher relationship quality and academic achievement.

Current State of Research and Future Directions

Our review revealed several conceptual and methodological limitations in prior research that future studies can address. One limitation is that 21 out of the 30 included studies (70%) relied exclusively on student self-reports to measure SRL components (see Online Resource 1). This predominance of these measures was also found in the excluded studies, indicating that self-reports are still the primary type of measurement to establish SRL in research. However, solely relying on self-reports may lead to different results than using a combination of measures, such as observations, teacher and student reports, and interviews (Schunk & Greene, 2018). These methods provide a more comprehensive view compared to the predominant self-report approaches, which may, in turn, lead to more information about relationships. Our review demonstrated that the type of measure might play a role in the direction of the relationships. Findings showed, for instance, that studies relying solely on self-reports did find positive associations between teachers' support and the regulation of students' behavior, whereas the studies that used multiple measures did not (Rimm-Kaufman et al., 2014; Schenke, 2018). Thus, for future studies it seems advisable to use a combination of methods to measure students' SRL (Vandevelde et al., 2013).

Second, and probably a consequence of the overreliance on self-reports, is that most studies have been conducted in upper elementary schools. Young students still struggle to reflect on complex skills and may not yet be able to validly report on SRL (Bell, 2007). The limited evidence available for younger students is unfortunate, especially given that recent meta-analytic findings show that students in the early years of elementary school can vastly benefit from high-quality instructional support (Dignath et al., 2008). Specifically, these younger students tend to be more open to being taught and have not yet established their own, potentially less efficient methods. Studies on adequate teacher support for younger students therefore require different measurement methods, such a classroom observations and task-specific think-aloud protocols, where students can verbalize their thinking while working on a specific task (Greene et al., 2018).

Third, measures of SRL for elementary school children often focus on a narrow subset of strategies, such as mastery goal orientation (e.g., PALS, Midgley et al., 1998). Often the multiple component structure of SRL is not adequately captured. As a result, there is a paucity of studies in which the different relations of the quality of the teacher-student interactions with the components of SRL are directly compared.

Fourth, research shows that there can be discrepancies between teachers' and students' perceptions of the quality of dyadic interactions and the level of SRL (Koomen & Jellesma, 2015; McCombs et al., 2008). A primary reason for these discrepancies is that teachers and children, based on their own attachment histories and personal characteristics, develop mental representational models of their mutual relationships that are entirely unique and can steer their perceptions of the self, the other, and the self in relation to the other in the relationship (Zee & Koomen, 2017). Because these mental models are unique, it is possible that the relationship are not reciprocal. For example, a teacher may experience conflict in the relationship, while a student may experience closeness. Future research should include multiple informants (teacher and student), and thereby provide additional information on teacher and student-perceived dyadic relationships and their associations with SRL.

Fifth, our search highlights a paucity of research on relationships between the quality of teacher–student interactions and the regulation of emotions. At the dyad level, we did not find studies on relation with cognition either. This might reflect the orientation in this field on the affective components in teacher-student relationships. With respect to the regulation of emotions, most socio-cognitive models do not involve this component. This might explain why the emotional component has been seldomly included in studies on SRL (Panadero, 2017; see as an exception Boekaerts, 2011). Another explanation may be that researchers often consider the regulation of emotions as a component of motivational regulation (Boekaerts, 2011). However, the regulation of emotions entails students' capacity to understand, temper, or modify their emotions, such as anxiety or shame, in order to prevent their negative influence on learning goals (Boekaerts, 2011). In contrast, the regulation of motivation, on the other hand, refers to the regulation of motivational beliefs, such as self-efficacy and interests (Pintrich, 2004; Usher & Schunk, 2018). Thus, the regulation of motivation and emotion are clearly separable components of SRL and the latter clearly deserves more interest in research in SRL.

Sixth, we found only one study on the relationship between students' dependency on the teacher and their SRL (Zee et al., 2020). This findings is in line with other studies on dyadic relationships, which often did not include student-teacher dependency as a separate variable either (Koomen et al., 2012). A reason could be that it might be difficult to measure dependency reliably. For example, the subscale dependency of the Student-Teacher Relationship Scale (Pianta, 2001), which is most often used to measure dyadic relationships, has poor internal consistency (Koomen et al., 2012). Moreover, relationships between teacher–student dependency and students' outcomes are inconsistent and effects are different across age, culture, and students with different temperaments (Rudasill, 2020). It seems important that future research includes teacher-student dependency as a separate predictor variable for SRL, since dependency is expected to be related to negative educational and social outcomes (Verschueren & Koomen, 2020). Future findings on teacher-student dependency

could therefore provide further understanding of how dyadic relationships, and especially dependency, can help or hamper SRL-development.

Seventh, studies that included items on the phases of SRL are scarce in our sample. We only found one study that used an instrument that covered both the cognitive, metacognitive, and behavioral components of SRL and the three phases (Baas et al., 2015; Vandevelde et al., 2013). The results showed that scaffolding and feedback can enhance metacognitive skills in the preparatory and performance phase, but not fully in the evaluation phase. Thus teachers tend to use different types of interactions to support their students' self-regulated learning in the different phases of the learning process. However, due to the lack of research on the phases of SRL, it is still largely unknown whether these phases require different regulatory abilities and whether self-regulated learners follow a clear sequential path when working on a learning task or that the various phases occur more dynamically within the learners (e.g., Boekaerts, 2011). More empirical work seems therefore necessary to test the theoretical idea of a cyclic process that is central in the socio-cognitive models of SRL.

Eight and last, our review showed that there is still a lack of cross-cultural studies on students' SRL. Cross-cultural comparison across studies included in the current review did not show clear differences. One obvious explanation is that our sample consisted of 30 studies, which is relatively small. Moreover, cross-cultural differences among the studies were minimal, as both included and excluded studies were predominantly conducted in the United States and Western-Europe. In addition, most of the studies used self-report measures which were developed for Western-oriented countries and might not capture culturally specific phenomena of SRL involved in other cultures (McInerney & King, 2018). Therefore, there is a need for studies that adopt a cross-cultural perspective to examine the generalizability and validity of findings across different cultures and contexts.

Limitations

The results of our review should be interpreted with three limitations in mind. First, just as in every review study, we might have missed studies that are relevant to our research question. However, we should mention that we used very broad search parameters that have resulted in a large amount of studies in the first step of the selection process. It seems unlikely that there are many more studies that could have been included into our review. But we acknowledge that our search criteria required studies that were written in English, and we cannot exclude the possibility that we missed relevant non-English studies. These non-English studies could be included in future research. Moreover, it is possible that unpublished studies employing different approaches to measuring SRL were missed. These studies could have offered additional insights into the relationships of interaction quality and SRL. This file drawer problem may require a collective effort from researchers and the wider scientific community to promote transparency, open access, and a culture that values the dissemination of all research outcomes.

Second, the relationships between teacher support and SRL that are described in the current review are correlational in nature. Causal relationships could have been found if we had also included intervention studies. However, we focused on day-

to-day classroom practices by elementary school teachers, as research shows that interventions to promote SRL are often difficult to implement in regular classrooms (Dignath et al., 2008). Our focus on day-to-day practices provides insight into what teachers do by themselves and within their own classroom to support SRL.

Third, the current review is predominantly based on SRL-models from the socio-cognitive tradition. These models place considerable emphasis on both the motivational and emotional components of SRL, in comparison to models from other research traditions (Panadero, 2017). Despite being very suitable for reviewing elementary school contexts (Dignath et al., 2008; Puustinen & Pulkkinen, 2001), the emphasis on motivational and emotional self-regulation might have resulted in an overrepresentation of studies focusing on motivational aspects of SRL. However, if we had focused on (meta)cognitively driven SRL-models (e.g., Winne, 2011), we would likely have used similar search criteria as social-cognitive models also include cognitive and metacognitive components of SRL.

Conclusion

A major finding of the current review is that the three domains of teacher-student interaction at the classroom-level were particularly effective in stimulating metacognition in the upper elementary grades. We did not find consistent relationships between the domains of classroom-level teacher support and the regulation of motivation and behavior.

A novel feature of the current review was that the dyadic level was also considered. At this level, we found a consistent association between the high-quality of dyadic relationships and students' regulation of motivation. Less consistent were the relationships with metacognition and we only found some associations with the regulation of behavior. Studies on the regulation of cognition were absent at the dyadic level.

The review also revealed gaps in current research on SRL, such as the paucity of studies on the regulation of emotions, the dominant use of self-reports, and the absence of cross-cultural research. These gaps might be worthwhile to address in future studies.

Declarations

Competing interests We have no known conflict of interest to disclose.

References

Baas, D., Castelijns, J., Vermeulen, M., Martens, R., & Segers, M. (2015). The relation between Assessment for Learning and elementary students' cognitive and metacognitive strategy use. *British Journal of Educational Psychology*, *85*(1), 33–46. https://doi.org/10.1111/bjep.12058.

Bandura, A. (1986). *Social Foundations of Thought & Action: A Social Cognitive Theory*. Pearson Education.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W.H. Freeman.

Bandura, A. (2006). Guide for constructing self-efficacy scales. In F. Pajares, & T. Urdan (Eds.), *Self-efficacy beliefs of adolescents* (5 vol., pp. 307–337). CT: Information Age.

Bell, A. (2007). Designing and testing questionnaires for children. *Journal of Research in Nursing*, *12*(5), 461–469. https://doi.org/10.1177/1744987107079616.

Blair, C., & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Development and Psychopathology*, *20*, 899–911. https://doi.org/10.1017/S0954579408000436.

Boekaerts, M. (2011). Emotions, emotion regulation, and self-regulation of learning. In B. J. Zimmerman, & D. H. Schunk (Eds.), *Handbook of Self-Regulation of Learning and Performance* (pp. 408–425). Routledge/Taylor & Francis Group.

Bronfenbrenner, U., & Morris, P. A. (1998). The Ecology of Developmental Processes. In L. R.M. (Ed.), *Handbook of child psychology: Vol 1. Theory* (5th ed., pp. 106–112).

Cadima, J., Doumen, S., Verschueren, K., & Buyse, E. (2015). Child engagement in the transition to school: Contributions of self-regulation, teacher-child relationships and classroom climate. *Early Childhood Research Quarterly*, *32*, 1–12. https://doi.org/10.1016/j.ecresq.2015.01.008.

Cadima, J., Enrico, M., Ferreira, T., Verschueren, K., Leal, T., & Matos, P. M. (2016a). Self-regulation in early childhood: The interplay between family risk, temperament and teacher–child interactions. European Journal of Developmental Psychology, 13(3), 341–360. https://doi.org/10.1080/17405629.2016a.1161506.

Cadima, J., Verschueren, K., Leal, T., & Guedes, C. (2016b). Classroom interactions, Dyadic teacher–child Relationships, and self–regulation in socially disadvantaged Young Children. Journal of Abnormal Child Psychology, 44(1), 7–17. https://doi.org/10.1007/s10802-015-0060-5.

Carreira, J. M., Ozaki, K., & Maeda, T. (2013). Motivational model of English learning among elementary school students in Japan. *System*, *41*(3), 706–719. https://doi.org/10.1016/j.system.2013.07.017.

Choi, J. Y., Castle, S., Williamson, A. C., Young, E., Worley, L., Long, M., & Horm, D. M. (2016). *Early Education and Development Teacher-Child Interactions and the Development of Executive Function in Preschool-Age Children Attending Head Start*. https://doi.org/10.1080/10409289.2016.1129864.

Chung, M. K. (2000). The development of self-regulated learning. *Asia Pacific Education Review*, *1*(1), 55–66. https://doi.org/10.1007/bf03026146.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge. https://doi.org/10.4324/9780203771587.

Cumming, M. M., Bettini, E., Pham, A. V., & Park, J. (2020). School-, Classroom-, and Dyadic-Level Experiences: A literature review of their relationship with students' executive Functioning Development. *Review of Educational Research*, *90*(1), 47–94. https://doi.org/10.3102/0034654319891400.

Diamond, A. (2016). Why improving and assessing executive functions early in life is critical. In J. A. Griffin, P. McCardle, & L. S. Freund (Eds.), *Executive function in preschool-age children: Integrating measurement, neurodevelopment, and translational research* (pp. 11–43). American Psychological Association. https://doi.org/10.1037/14797-002

Dignath, C., & Veerman, M. V. J. (2021). The role of direct strategy instruction and indirect activation of self-regulated learning – evidence from Classroom Observation Studies. *Educational Psychology Review*, *33*(2), 389–533. https://doi.org/10.1007/s10648-020-09534-0.

Dignath, C., Buettner, G., & Langfeldt, H. (2008). How can primary school students learn self-regulated learning strategies most effectively? A meta-analysis on self-regulation training programmes. *Education Research Review*, *3*(2), 101–129. https://doi.org/10.1016/j.edurev.2008.02.003.

Domen, J., Hornstra, L., Weijers, D., van der Veen, I., & Peetsma, T. (2020). Differentiated need support by teachers: Student-specific provision of autonomy and structure and relations with student motivation. *British Journal of Educational Psychology*, *90*(2), 403–423. https://doi.org/10.1111/bjep.12302.

Greene, J. A., Deekens, V. M., Copeland, D. Z., & Yu, S. (2018). Capturing and modeling self-regulated learning using think-aloud protocols. In D. H. Schunk, & J. A. Greene (Eds.), *Handbook of Self-Regulation of Learning and Performance* (2nd ed., pp. 83–106). Routledge/Taylor & Francis Group. Issue Januaryhttps://doi.org/10.4324/9781315697048-6.

Guay, F., Roy, A., & Valois, P. (2017). Teacher structure as a predictor of students' perceived competence and Autonomous Motivation: The moderating role of differentiated instruction. *British Journal of Educational Psychology*, *87*(2), 224–240. https://doi.org/10.1111/bjep.12146.

Hadwin, A., & Oshige, M. (2011). Self-regulation, coregulation, and socially shared regulation: Exploring perspectives of social in self-regulated learning theory. *Teachers College Record*, *113*(2), 240–264.

Hadwin, A., Järvelä, S., & Miller, M. (2018). Self-Regulation, Co-Regulation, and Shared Regulation in Collaborative Learning environments. In I. January (Ed.), *Handbook of Self-Regulation of Learning and Performance* (2(nd ed., pp. 83–106). Routledge/Taylor & Francis Group. https://doi.org/10.4324/9781315697048-6.

Hamre, B. K., & Pianta, R. L. (2010). Classroom environments and developmental processes. In J. L. Meece, & J. S. Eccles (Eds.), *Handbook of research on schools, schooling, and human development* (pp. 25–41). Routledge.

Hamre, B. K., Pianta, R. C., Downer, J. T., Decoster, J., Mashburn, J., Jones, S. M., Brown, J. L., Cappella, E., Atkins, M., Susan, E., Brackett, M. A., Hamagami, A., & Atkins, M. (2013). Testing a Developmental Framework of Teacher Effectiveness in over 4000 classrooms. *The Elementary School Journal*, *113*(4), 461–487. https://doi.org/10.1086/669616.

Havik, T., & Westergård, E. (2020). Do Teachers Matter? Students' perceptions of Classroom interactions and Student Engagement. *Scandinavian Journal of Educational Research*, *64*(4), 488–507. https://doi.org/10.1080/00313831.2019.1577754.

Heatly, M. C., & Votruba-Drzal, E. (2019). Developmental precursors of engagement and motivation in fifth grade: Linkages with parent- and teacher-child relationships. *Journal of Applied Developmental Psychology*, *60*, 144–156. https://doi.org/10.1016/j.appdev.2018.09.003.

Hornstra, L., Bakx, A., Mathijssen, S., & Denissen, J. J. A. (2020). Motivating gifted and non-gifted students in regular primary schools: A self-determination perspective. *Learning and Individual Differences*, *80*, 101871. https://doi.org/10.1016/j.lindif.2020.101871.

Hoyle, R. H., & Dent, A. L. (2018). Developmental trajectories of skills and abilities relevant for self-regulation of learning and performance. In D. H. Schunk, & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (2nd ed., pp. 49–63). Routledge/Taylor & Francis Group.

Huang, C. F. (2010). *An examination of relations among Taiwanese Elementary-Aged children's Effortful Control, Social Relationships, and Adjustment at School*. ProQuest LLC.

Hughes, C. (2011). Changes and challenges in 20 years of research into the development of executive functions. *Infant and child Development*, *20*(3), 251–271. https://doi.org/10.1002/icd.736

Hughes, J. N., Wu, J. Y., Kwok, O. M., & Johnson, V. V., A. Y (2012). Indirect Effects of Child reports of teacher-student relationship on achievement. *Journal of Educational Psychology*, *104*(2), 350–365. https://doi.org/10.1037/a0026339.

Keith, T. Z. (2006). *Multiple regression and beyond*. Boston, MA: Allyn & Bacon.

Koo, T. K., & Li, M. Y. (2016). A Guideline of selecting and reporting Intraclass correlation coefficients for Reliability Research. *Journal of Chiropractic Medicine*, *15*(2), 155–163. https://doi.org/10.1016/j.jcm.2016.02.012.

Koomen, H. M. Y., & Jellesma, F. C. (2015). Can closeness, conflict, and dependency be used to characterize students' perceptions of the affective relationship with their teacher? Testing a new child measure in middle childhood. *British Journal of Educational Psychology*, *85*(4), 479–497. https://doi.org/10.1111/bjep.12094.

Koomen, H. M. Y., Verschueren, K., van Schooten, E., Jak, S., & Pianta, R. C. (2012). Validating the student-teacher relationship scale: Testing factor structure and measurement invariance across child gender and age in a dutch sample. *Journal of School Psychology*, *50*(2), 215–234. https://doi.org/10.1016/j.jsp.2011.09.001.

Lee, J. C. K., Wan, Z. H., Hui, S. K. F., & Ko, P. Y. (2019). More student trust, more self-regulation strategy? Exploring the effects of self-regulatory climate on self-regulated learning. *Journal of Educational Research*, *112*(4), 463–472. https://doi.org/10.1080/00220671.2018.1553840.

McCombs, B. L., Daniels, D. H., & Perry, K. E. (2008). Children's and teachers' perceptions of learner-centered practices, and student motivation: Implications for early schooling. *Elementary School Journal*, *109*(1), 16–35. https://doi.org/10.1086/592365.

McInerney, D. M., & King, R. B. (2018). Culture and Self-Regulation in Educational Contexts. In D. H. Schunk, & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (2nd ed., pp. 485–502). Routledge/Taylor & Francis Group.

Midgley, C., Kaplan, A., Middleton, M., Maehr, M. L., Urdan, T., Anderman, L. H., Anderman, E., & Roeser, R. (1998). The development and validation of scales assessing students' achievement goal orientations related papers. *Contemporary Educational Psychology*, *23*, 113–131. https://doi.org/10.1006/ceps.1998.0965.

Neitzel, C., & Connor, L. (2017). Messages from the Milieu: Classroom instruction and context influences on Elementary School Students' Self-Regulated learning behaviors. *Journal of Research in Childhood Education*, *31*(4), 548–560. https://doi.org/10.1080/02568543.2017.1347113.

Neitzel, C., & Davis, D. (2014). Direct and Indirect Effects of teacher instruction and feedback on student adaptive help-seeking in Upper-Elementary literacy classrooms. *Journal of Research in Education*, *24*(1), 53–68.

Nigg, J. T. (2017). Annual Research Review: On the relations among self-regulation, self-control, executive functioning, effortful control, cognitive control, impulsivity, risk-taking, and inhibition for developmental psychopathology. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *58*(4), 361–383. https://doi.org/10.1111/jcpp.12675.

Opdenakker, M. C., & Minnaert, A. (2011). Relationship between learning Environment characteristics and Academic Engagement. *Psychological Reports*, *109*(1), 259–284. https://doi.org/10.2466/09.10.11.PR0.109.4.259-284.

Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan-a web and mobile app for systematic reviews. *Systematic Reviews*, *5*(1), https://doi.org/10.1186/s13643-016-0384-4.

Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for Research. *Frontiers in Psychology*, *8*, 1–28. https://doi.org/10.3389/fpsyg.2017.00422.

Patrick, H., Ryan, A. M., & Kaplan, A. (2007). Early Adolescents' perceptions of the Classroom Social Environment, motivational beliefs, and Engagement. *Journal of Educational Psychology*, *99*(1), 83–98. https://doi.org/10.1037/0022-0663.99.1.83.

Perry, N. E., Hutchinson, L. R., Yee, N., & Määttä, E. (2018). Advances in understanding Young Children's self-regulation of learning. In D. H. Schunk, & J. A. Greene (Eds.), *Handbook of Self-Regulation of Learning and Performance* (2nd ed., pp. 457–472). Routledge/Taylor & Francis Group.

Pianta, R. C. (2001). *STRS: Student-teacher relationship scale: Professional Manual*. Psychological Assessment Resources.

Pianta, R. C. (2004). Enhancing relationships between children and teachers. *Enhancing relationships between children and teachers*. American Psychological Association. https://doi.org/10.1037/10314-000.

Pianta, R. C., Hamre, B., & Stuhlman, M. (2003). Relationships between teachers and children. In W. M. Reynolds, & G. E. Miller (Eds.), *Handbook of psychology: Educational psychology* (7 vol.). John Wiley & Sons.

Pianta, R. C., Hamre, B. K., & Mintz, S. (2012). *Classroom Assessment Scoring System*. Teachstone.

Pintrich, P. R. (2004). A conceptual Framework for assessing motivation and self-regulated learning in College Students. *Educational Psychology Review*, *16*(4), 385–407. https://doi.org/10.1007/s10648-004-0006-x.

Pintrich, P. R., & de Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, *82*(1), 33–40. https://doi.org/10.1037/0022-0663.82.1.33.

Pitzer, J., & Skinner, E. (2017). Predictors of changes in students' motivational resilience over the School Year: The roles of teacher support, Self-Appraisals, and emotional reactivity. *International Journal of Behavioral Development*, *41*(1), 15–29. https://doi.org/10.1177/0165025416642051.

Polanin, J. R., Tanner-Smith, E. E., & Hennessy, E. A. (2016). Estimating the difference between published and unpublished effects sizes. *Review of Educational Research*, *86*, 207–236. https://doi.org/10.3102/0034654315582067.

Portilla, X. A., Ballard, P. J., Adler, N. E., Boyce, W. T., & Obradovic, J. (2014). An integrative view of School Functioning: Transactions between Self-Regulation, School Engagement, and teacher-child relationship quality. *Child Development*, *85*(5), 1915–1931. https://doi.org/10.1111/cdev.12259.

Puustinen, M., & Pulkkinen, L. (2001). Models of self-regulated learning: A review. *Scandinavian Journal of Educational Research*, *45*(3), 269–286. https://doi.org/10.1080/00313830120074206.

Rieser, S., Fauth, B. C., Decristan, J., Klieme, E., & Büttner, G. (2013). The connection between primary school students' self-regulation in learning and perceived teaching quality. *Journal of Cognitive Education and Psychology*, *12*(2), 138–156. https://doi.org/10.1891/1945-8959.12.2.138.

Rimm-Kaufman, S. E., Baroody, A. E., Larsen, R. A. A., Curby, T. W., & Abry, T. (2014). To what extent do teacher–student interaction quality and student gender contribute to fifth graders' engagement in mathematics learning? *Journal of Educational Psychology*, *107*(1), 170–185. https://doi.org/10.1037/a0037252.

Roorda, D. L., Jak, S., Zee, M., Oort, F. J., & Koomen, H. M. (2017). Affective teacher–student relationships and students' engagement and achievement: A meta-analytic update and test of the mediating role of engagement. *School psychology review*, *46*(3), 239–261. https://doi.org/10.17105/SPR-2017-0035.V46-3.

Roorda, D. L., Zee, M., & Koomen, H. M. Y. (2020). Don't forget student-teacher dependency! A Meta-analysis on associations with students' school adjustment and the moderating role of student and teacher characteristics. *Attachment and Human Development*, *00*(00), 1–14. https://doi.org/10.1080/14616734.2020.1751987.

Roy Rosenzweig Center for History and New Media (2020). *Zotero*. www.zotero.org/download.

Rudasill, K. M. (2020). Child-teacher dependency: The state of the research. *Attachment and Human Development*, *00*(00), 1–9. https://doi.org/10.1080/14616734.2020.1751991.

Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology*, *57*(5), 749–761. https://doi.org/10.1037/0022-3514.57.5.749.

Ryan, R. M., & Deci, E. L. (2002). Handbook of self-determination research. In E. L. Deci, & R. M. Ryan (Eds.), *Handbook of Self-Dtermination Research* (1st ed., pp. 3–33). The University of Rochester Press.

Schenke, K. (2018). From structure to process: Do students' own construction of their classroom drive their learning? *Learning and Individual Differences*, *62*, 36–48. https://doi.org/10.1016/j.lindif.2018.01.006.

Schiefele, U. (2017). Classroom management and mastery-oriented instruction as mediators of the effects of teacher motivation on student motivation. *Teaching and Teacher Education*, *64*, 115–126. https://doi.org/10.1016/j.tate.2017.02.004.

Schunk, D. H., & Greene, J. A. (2018). Historical, contemporary, and future perspectives on self-regulated learning and performance. In D. H. Schunk, & J. A. Greene (Eds.), *Handbook of Self-Regulation of Learning and Performance* (2nd ed., pp. 1–15). Routledge/Taylor & Francis Group. https://doi.org/10.4324/9781315697048.

Skinner, E. A., & Belmont, M. J. (1993). Motivation in the Classroom - reciprocal effects of teacher-behavior and Student Engagement across the School Year. *Journal of Educational Psychology*, *85*(4), 571–581. https://doi.org/10.1037/0022-0663.85.4.571.

Snilstveit, B., Oliver, S., & Vojtkova, M. (2012). Narrative approaches to systematic review and synthesis of evidence for international development policy and practice. *Journal of development effectiveness*, *4*(3), 409–429. https://doi.org/10.1080/19439342.2012.710641.

Thoonen, E. E. J., Sleegers, P. J. C., Peetsma, T. T. D., & Oort, F. J. (2011). Can teachers motivate students to learn? *Educational Studies*, *37*(3), 345–360. https://doi.org/10.1080/03055698.2010.507008.

Usher, E. L., & Schunk, D. H. (2018). Social cognitive theoretical perspective of self-regulation. In D. H. Schunk, & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (2nd ed., pp. 19–35). Routledge/Taylor & Francis Group.

van Dijk, W., Gage, N. A., & Grasley-Boy, N. (2019). The relation between Classroom Management and Mathematics Achievement: A Multilevel Structural equation Model. *Psychology in the Schools*. https://doi.org/10.1002/pits.22254.

Vandenbroucke, L., Spilt, J., Verschueren, K., Piccinin, C., & Baeyens, D. (2018). The classroom as a developmental context for cognitive development: A meta-analysis on the importance of teacher–student interactions for children's executive functions. *Review of Educational Research*, *88*(1), 125–164. https://doi.org/10.3102/0034654317743200.

Vandevelde, S., van Keer, H., & Rosseel, Y. (2013). Measuring the complexity of upper primary school children's self-regulated learning: A multi-component approach. *Contemporary Educational Psychology*, *38*(4), 407–425. https://doi.org/10.1016/j.cedpsych.2013.09.002.

Veenman, M. V. J. (2017). Assessing Metacognitive deficiencies and effectively instructing metacognitive skills. *Teachers College Record*, *119*(13), 1–20. https://doi.org/10.1177/016146811711901303.

Veenman, M. V. J., Van Hout-Wolters, B. H. A. M., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and methodological considerations. *Metacognition and Learning*, *1*, 3–14. https://doi.org/10.1007/s11409-006-6893-0.

Vernon-Feagans, L., Willoughby, M., & Garrett-Peters, P. (2016). Predictors of behavioral regulation in kindergarten: Household chaos, parenting, and early executive functions. *Developmental Psychology*, *52*(3), 430–441. https://doi.org/10.1037/dev0000087.

Verschueren, K., & Koomen, H. M. Y. (2012). Teacher-child relationships from an attachment perspective. *Attachment and Human Development*, *14*(3), 205–211. https://doi.org/10.1080/14616734.2012.672260.

Verschueren, K., & Koomen, H. M. Y. (2020). Dependency in teacher–child relationships: Deepening our understanding of the construct. *Attachment and Human Development*, *00*(00), 1–9. https://doi.org/10.1080/14616734.2020.1751986.

Wilson, T. M., Zheng, C., Lemoine, K. A., Martin, C. P., & Tang, Y. (2016). Achievement Goals during Middle Childhood: Individual differences in motivation and Social Adjustment. *Journal of Experimental Education*, *84*(4), 723–743. https://doi.org/10.1080/00220973.2015.1094648.

Winne, P. H. (2011). A cognitive and metacognitive analysis of self-regulated learning. In B. J. Zimmerman, & D. H. Schunk (Eds.), *Handbook of Self-Regulation of Learning and Performance* (pp. 15–32). Routledge Taylor & Francis Group.

Winne, P. H. (2018). Cognition and metacognition within self-regulated learning. In D. H. Schunk, & J. A. Greene (Eds.), *Handbook of Self-Regulation of Learning and Performance* (2nd ed., pp. 36–48). Routledge/Taylor & Francis Group.

Yang, P. J., & Lamb, M. E. (2014). Factors Influencing Classroom behavioral Engagement during the First Year at School. *Applied Developmental Science*, *18*(4), 189–200. https://doi.org/10.1080/10888691.2014.924710.

Zee, M., & de Bree, E. (2017). Students' self-regulation and achievement in basic reading and math skills: The role of student-teacher relationships in middle childhood. *European Journal of Developmental Psychology*, *14*(3), 265–280. https://doi.org/10.1080/17405629.2016.1196587.

Zee, M., & Koomen, H. M. Y. (2017). Similarities and dissimilarities between teachers' and students' relationship views in upper elementary school: The role of personal teacher and student attributes. *Journal of School Psychology*, *64*, 43–60. https://doi.org/10.1016/j.jsp.2017.04.007.

Zee, M., Rudasill, K. M., & Bosman, R. J. (2020). A cross-lagged study of students' motivation, academic achievement, and relationships with teachers from kindergarten to 6th grade. *Journal of Educational Psychology*, *113*(6), 1208–1226. https://doi.org/10.1037/edu0000574.

Zhou, L. H., Ntoumanis, N., & Thogersen-Ntoumani, C. (2019). Effects of perceived autonomy support from social agents on motivation and engagement of chinese primary school students: Psychological need satisfaction as mediator. *Contemporary Educational Psychology*, 323–330. https://doi.org/10.1016/j.cedpsych.2019.05.001.

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice*, *41*(2), 64–70. https://doi.org/10.1207/s15430421tip4102.

Zimmerman, B. J., & Moylan, A. R. (2009). Self-regulation: Where metacognition and motivation intersect. In D. J. Hacker, J. Dunlosky, A. C. Graesser, B. J. Zimmerman, & A. R. Moylan (Eds.), *Self-Regulation from: Handbook of Metacognition in Education* (1e ed., pp. 311–328). Routledge. https://doi.org/10.4324/9780203876428.ch16.