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A Cross-Lagged Study of Students' Motivation, Academic Achievement, and Relationships With Teachers From Kindergarten to 6th Grade

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This 3-wave longitudinal study explored the complex ways in which students' motivation (motivational attitudes and beliefs), relationships with teachers (closeness, conflict, and dependency), and academic achievement (reading comprehension and math performance) inform one another from kindergarten through 6th grade. The sample included students ($N = 1,267$; 49.3% boys) and 207 teachers participating in the Dutch triennial COOL cohort study. At all waves, teachers reported on relationship quality and students' motivational attitudes, and students completed nationally normed reading comprehension and math tests. Students also reported on their motivational beliefs (self-efficacy and task motivation) and levels of closeness with their teachers at Waves 2 and 3. Cross-lagged panel models revealed robust support for 4 transactional models of teacher- and student-reported closeness, and teacher-reported conflict and dependency. These models generally indicated that student–teacher closeness, conflict and dependency, students' motivation, and academic achievement informed each other across the elementary grades.

Educational Impact and Implications Statement

Research on student–teacher relationships and academic adjustment continues to rapidly expand, but we have a limited understanding about how students' relationships with teachers and academic adjustment inform one another from kindergarten through sixth grade. In this large-scale longitudinal study, we found evidence for transactional models in which student–teacher relationship quality, students' motivational attitudes and beliefs, and their achievement were reciprocally linked across the elementary years. Thus, not only do student–teacher relationships portend academic success, they are also a mechanism by which students feel more confident and engaged in academic content. Teaching teachers skills for fostering high-quality relationships with their students will likely deliver a valuable return on investment in terms of student success.

Keywords: student–teacher relationships, motivational attitudes and beliefs, academic achievement, transactional models

One of the basic ingredients of students' successful academic adjustment (i.e., motivational attitudes, beliefs, and academic achievement) in elementary school is a warm, high-quality rela-

tionship with their teachers. When there is a sense of trust and secure relatedness with their teachers, students tend to feel more self-efficacious and motivated in their school tasks (Hughes & Chen, 2011), display higher levels of on-task behavior (De Laet et al., 2015), and show greater academic engagement (Roorda, Koomen, Spilt, & Oort, 2011) than classmates with relatively conflictual or dependent relationships with their teachers. Moreover, several longitudinal and meta-analytic studies have suggested that high-quality relationships between students and teachers may provide an important foundation for students' academic outcomes, including their reading and math skills (e.g., Hughes, 2011; Hughes & Cao, 2018; Roorda et al., 2011; Rucinski, Brown, & Downer, 2018).

Although empirical work on the association between student–teacher relationships and students' academic adjustment continues to rapidly expand, research in this area is limited in three ways.

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First, empirical studies have fallen short of revealing the complex ways in which students' motivational attitudes and beliefs, their academic achievement, and relationships with teachers inform one another throughout the elementary school years. Most empirical findings in this area are consistent with the attachment-based premise that emotional security arising from high-quality student-teacher relationships may promote better academic performance in students, and that students' motivational attitudes and beliefs may be the mechanisms explaining this association (e.g., Roorda, Jak, Zee, Oort, & Koomen, 2017; Zee, Koomen, & Van der Veen, 2013). Following Pianta's (1999) developmental systems model, however, scholars have increasingly speculated that student-teacher relationships are likely to be a product of individual teacher and child features that reciprocally influence one another (e.g., Pianta, Hamre, & Stuhlman, 2003; Rudasill & Rimm-Kaufman, 2009). From this point of view, students' academic performance and motivational attitudes and beliefs may evoke reactions in their teachers that guide the quality of relationships with them and affect students' adjustment in the long run (cf. Nurmi, 2012). Yet, to our knowledge, this possibility has been rarely investigated empirically.

Second, in most research on student-teacher relationship quality, different subject areas (e.g., math, reading), motivational beliefs and attitudes (e.g., academic self-efficacy, task motivation, work attitudes, effort), and relationship dimensions (closeness, conflict, dependency) have been combined to form broadband factors of motivation, academic achievement, or relationship quality (cf. Roorda et al., 2011, 2017; Zee et al., 2013). As such, less is known about how the direction of associations between student-teacher relationships and students' academic adjustment may vary across different dimensions of motivational beliefs, academic subjects, and relationship quality.

Third, studies of students in the elementary grades have typically relied on teachers to provide information about the quality of the student-teacher relationship (e.g., Hughes, Luo, Kwok, & Loyd, 2008), and on students to report on their motivational attitudes, beliefs, and academic achievement (e.g., Woolley, Kol, & Bowen, 2009). Yet, research has demonstrated a fairly high level of disagreement among teachers and students about the quality of their mutual relationship and students' academic adjustment problems (e.g., Koomen & Jellesma, 2015; Zee & Koomen, 2017). Consideration of multiple informants' perspectives may provide a more accurate picture of the complex associations between student-teacher relationships and academic adjustment.

To address these limitations, we used longitudinal data and multiple informants (teachers and students) to evaluate three possible theoretical models of the associations between the quality of the student-teacher relationship (closeness, conflict, and dependency), students' motivational attitudes and beliefs (motivational [work] attitudes, task motivation, and self-efficacy), and students' academic achievement (reading comprehension and math performance) from kindergarten through Grade 6 in a nationally representative sample of students in the Netherlands. In the *relationship-driven* model, we evaluated the commonly held idea that students' motivational beliefs and attitudes mediate the association between student-teacher relationship quality and students' academic achievement. In the *student-driven* model, we explored the notion that students' motivational attitudes and beliefs mediate the association between their academic achievement and student-

teacher relationship quality. In the *transactional* model, we investigated the possibility that students' motivational beliefs, academic performance, and the quality of the student-teacher relationship mutually inform one another across the elementary years. Theoretical and empirical support for each of these models (see Figure 1) is provided in the next sections.

A Relationship-Driven Model of Student-Teacher Relationships and Academic Adjustment

Empirical research on the links among student-teacher relationships, students' motivational attitudes and beliefs, and their academic achievement has been commonly embedded in a tradition that extends an attachment perspective to the bond between teacher and student (Bowlby, 1969; Hamre & Pianta, 2001). Central to this work is the notion that relationships in which teachers communicate warmly and openly with their students (high *closeness*), experience little negativity or unpredictability (low *conflict*), and are not concerned about students' overreliance (low *dependency*) may help students feel emotionally secure. Conceivably, this secure base is a key prerequisite for students' academic adjustment, which generally refers to students' *motivational values* and *expectancies*, which ultimately result in their academic success (e.g., Hornstra, Van der Veen, Peetsma, & Volman, 2013; Roorda et al., 2011; Wigfield & Eccles, 2000). Generally, motivational values comprise a variety of factors, including task value, interest, and goal orientation (Hornstra et al., 2013; Pintrich, 2000). In this study, we focus specifically on students' motivational attitudes, reflecting the extent to which students are oriented toward increasing their competence and understanding. Expectancies echo students' predictions for future outcomes, including their academic self-efficacy, or beliefs about their capability to organize and execute the actions needed to complete academic tasks. Prior research has indicated that both students' motivational values and expectancies, more than any other motivational aspects, strongly contribute to students' achievement over time (cf. Bandura, 1997; Hornstra et al., 2013; Wigfield & Cambria, 2010). Hence, the extended attachment framework gives rise to a relationship-driven model, in which the quality of student-teacher relationships indirectly contributes to students' academic achievement via their motivational beliefs about and attitudes toward learning.

A compilation of cross-sectional and longitudinal evidence points to high-quality student-teacher relationships as resources for students to develop positive motivational attitudes and beliefs about themselves as learners, including their academic efficacy, goal orientations, effort, and work attitudes (e.g., Furrer & Skinner, 2003; Hughes, 2011; Hughes & Chen, 2011; Zee & de Bree, 2017). When students are treated by their teachers with care and affection, they are, for instance, more likely to respond with greater effort, set higher goals for themselves, and exhibit greater compliance with teachers' expectations (e.g., Furrer & Skinner, 2003; Wang & Holcombe, 2010; Wentzel, 2002). Additionally, path analytic findings from Patrick, Ryan, and Kaplan (2007) indicated that teachers' emotional support may encourage fifth-graders' focus on mastery goals and feelings of academic efficacy. Some studies have suggested that teachers' relatedness to their students may be one of the strongest predictors of students' academic motivation and engagement in class (e.g., Skinner & Belmont, 1993). Empirical research suggests that students with high

Figure 1. Hypothesized models for the longitudinal associations among student-teacher relationship quality, students' motivational attitudes and beliefs, and their academic achievement.

expectations, academic efficacy beliefs, and positive work attitudes tend to perform well on academic tasks, and classmates with poorer motivational beliefs are more likely to fail academically (e.g., DiLalla, Marcus, & Wright-Phillips, 2004; Komaraju & Nadler, 2013). These findings have been replicated across different grade levels and subjects, including math, literacy, reading, and science (Singh, Granville, & Dika, 2002; Zee et al., 2013).

Although the majority of prior research seems to support the premise that motivational attitudes and beliefs mediate the link between student-teacher relationship quality and academic achievement, only a few studies have investigated this indirect relationship (e.g., Lam et al., 2012; Roorda et al., 2017). The results of these studies have been somewhat inconsistent, though. For instance, results from a large-scale study among 8,545 Dutch sixth-grade students indicated that the association between student-perceived, but not teacher-perceived, closeness and students' reading and math achievement was fully mediated by their motivational beliefs, including their academic efficacy and task motivation (Zee et al., 2013). Of the negative relationship dimensions, only teacher-reported dependency was both directly and indirectly related to students' academic achievement through their motivational beliefs. Similarly, Hughes, Wu, Kwok, Villarreal,

and Johnson (2012) found that teacher-rated behavioral engagement and students' math competence beliefs explained the positive association between students' perceptions of closeness and math achievement from Grades 3 through 5. Teacher ratings of student engagement also mediated the relationship between student-perceived conflict and reading and math achievement. Hence, these studies provide no clear guidance about which specific motivational beliefs partially or fully mediate the association between student-teacher relationship quality and achievement in various subjects, and whether these results vary across different informants and relationship qualities.

A Student-Driven Model of Student-Teacher Relationships and Academic Adjustment

In addition to studies in which student-teacher relationship quality is perceived as the central driver for learning are those in which particular student characteristics are believed to determine whether teachers and students are likely to develop a high-quality relationship. Specifically, following Darley and Fazio's (1980) theory on teacher-student expectancy confirmation in social interactions, it is likely that teachers act toward individual students in

ways that are in line with their biased expectations about the specific behaviors and capabilities of these students. Various scholars (e.g., Babad, 1996; Rudasill & Rimm-Kaufman, 2009) have provided support for this student-driven model. In this model, students' academic achievement is likely to evoke affective reactions in their teachers that influence their mutual relationship, either directly or indirectly, through their motivational attitudes and beliefs. In a study of 2,475 upper elementary school students, Babad (1996) found that students felt their teachers provided more learning support to low achievers, but more emotional support (i.e., closeness) to high achievers. This is in line with results from Justice, Cottone, Mashburn, and Rimm-Kaufman (2008), whose results pointed to a positive association between preschoolers' language comprehension and teacher-reported closeness in the relationship, and Rudasill and Rimm-Kaufman (2009) who found a longitudinal association between preschoolers' effortful control and teacher-reported closeness (positive) and conflict (negative) in first grade. Longitudinal results from Jerome, Hamre, and Pianta (2009) also revealed positive associations between academic achievement and teacher-perceived closeness from kindergarten through Grade 3. After Grade 3, however, this relationship disappeared.

Most studies also seem to point to a negative association between various achievement-related measures, such as academic competence and performance, and negative relationship quality (e.g., Ladd, Birch, & Buhs, 1999; Murray & Greenberg, 2000). For example, Hamre, Pianta, Downer, and Mashburn's (2008) study suggested that teachers experience less conflict in relationships with preschoolers displaying better academic skills. This association was no longer statistically significant, however, after students' problem behaviors were controlled. Similarly, Jerome et al. (2009) found that students with poorer academic skills have more conflict with their teachers than students with better academic skills. Hence, similar to the relationship-driven model, the results with respect to this student-driven model are equivocal at best.

A Transactional Model of Student-Teacher Relationships and Academic Adjustment

Recently, studies with relatively more dynamic ecological and developmental systems views on how students' achievement, motivational attitudes and beliefs, and relationships with teachers inform one another across time have gained attention (cf. Pianta et al., 2003; O'Connor, 2010; Rimm-Kaufman & Pianta, 2000). These transactional models posit that students' and teachers' characteristics (e.g., students' motivational attitudes and beliefs), as well as the interactions between them, shape the environment in which students develop (Nurmi, 2012; O'Connor, 2010). Transactional links between student-teacher relationships and students' academic adjustment have been rarely studied, however. We are aware of only five studies (Hajovsky, Mason, & McCune, 2017; Košir & Tement, 2014; McKinnon & Blair, 2019; Skinner & Belmont, 1993; Spilt, Koomen, & Harrison, 2015) including student-teacher relationships with either students' motivational attitudes and beliefs or achievement, and none has investigated the possibility of mediating relationships. Among the most compelling evidence assembled to date are findings from a longitudinal investigation of 144 students in Grades 3 through 5 (Skinner & Belmont, 1993) where teachers who perceived their students as

initially engaged responded with more involvement, autonomy support, contingency, and consistency. In turn, these positive interactions, which are important for the formation of high-quality student-teacher relationships, were positively associated with students' subsequent engagement in class. Hence, their study provided tentative evidence for the dynamic systems view that student characteristics may evoke reactions from teachers that shape subsequent relationships between them.

Besides transactional links between motivation-related behaviors and student-teacher relationships, there is also some evidence of reciprocal relationships between achievement and relationship quality. For instance, a recent cross-lagged panel investigation among 759 children (McKinnon & Blair, 2019) revealed that higher levels of conflict at both fall and spring of kindergarten predicted lower levels of reading, but not math, performance in Grade 1. Yet, students' reading performance did not longitudinally predict student-teacher conflict and no evidence was found for longitudinal, bidirectional associations of closeness with reading and math achievement. Somewhat different findings were reported by Hajovsky et al. (2017) and Spilt et al. (2015). Whereas the cross-lagged panel models of Hajovsky and colleagues (2017) revealed small-to-medium direct effects between math achievement (but not reading achievement) on subsequent student-teacher conflict and closeness, similar models by Spilt et al. (2015) indicated bidirectional associations between teacher-child closeness and receptive language development after controlling for peer interaction quality and child behavioral functioning.

In another study, Košir and Tement (2014) addressed potential cross-lagged associations between student-teacher relationships and overall achievement in a sample of 816 Slovenian students in elementary and secondary school. A single-item measure was used to evaluate teacher-perceived relationship quality (i.e., teacher acceptance) and a four-item measured student-perceived relationship quality (i.e., teacher support). Additionally, teachers were asked to provide information about students' GPA in both the previous and current school years. Results of this study suggested reciprocal links between both teacher- and student-perceived relationship quality and academic achievement. Moreover, student-perceived relationship quality partially mediated the association between teacher-reported relationship quality and achievement in both directions, but only when students' age was not accounted for.

Overall, the majority of research in this area seems to provide evidence for potential transactional links of motivation-related behaviors with student-teacher relationships, and of academic achievement and relationship quality. Yet, no empirical studies thus far have tested these complex transactional links within one model. As such, it remains to be explored how the direction of associations between student-teacher relationships, students' motivational attitudes and beliefs, and academic achievement may vary across different motivational beliefs, subjects, and relationship dimensions.

Present Study

Despite burgeoning evidence pointing to links between the quality of student-teacher relationships and students' academic adjustment, much remains to be learned about the complex ways in which students' motivational attitudes and beliefs, academic out-

comes, and relationships with teachers inform one another across the elementary school years. Guided by extended attachment theory, expectancy confirmation theory, and dynamic systems theory, this study is an exploration of three competing models—a relationship-driven, a student-driven, and a transactional model—in a sample that is nationally representative of teachers and students from kindergarten through Grade 6 in the Netherlands. Our study departed from previous work using this representative dataset (e.g., Bosman, Roorda, van der Veen, & Koomen, 2018; Hornstra et al., 2013; Hornstra, van der Veen, Peetsma, & Volman, 2015; Zee et al., 2013) in three essential ways. First, we extended Hornstra and colleagues' (2013, 2015) work on motivation and achievement by exploring the essential role of student–teacher relationship quality in these constructs over the entire elementary school period. Second, given that mediation essentially is a statement of change (Little, 2013), we did not rely on a limited cross-sectional sample of sixth graders only (Zee et al., 2013), but instead used three waves of data to test our hypothesized models, controlling for prior levels of relationship quality and academic adjustment. Last, rather than identifying and predicting different trajectories of closeness, conflict, and dependency using a person-centered approach (cf. Bosman et al., 2018), we took a variable-centered approach to explore the direction and strength among student–teacher relationship quality and academic adjustment.

To minimize common method variance (Roorda et al., 2011), we used teacher and student reports of the quality of the student–teacher relationship and students' motivational beliefs and attitudes, and nationally normed tests to evaluate students' academic achievement. This approach allowed us to evaluate whether the associations of interest varied across informants. In addition, we included various motivational beliefs and behaviors (i.e., academic self-efficacy, task motivation, and motivational [work] attitudes), relationship dimensions (i.e., closeness, conflict, and dependency) and subjects (i.e., reading comprehension and math achievement) to explore whether the direction of associations in our models were dependent upon motivational domains, relationship qualities, or specific subjects. Apart from its theoretical relevance, the results of this study may provide valuable information about whether interventions aimed at improving students' learning should target students themselves, the quality of the relationships with their teachers, or both (cf. Roorda, Verschueren, Vancraeyveldt, Van Craeyveldt, & Colpin, 2014).

Method

Study Context and Participants

Data on student–teacher relationships, students' motivational attitudes and beliefs, and their academic achievement was derived from the Dutch Cohort Study Education Careers among students aged 5–18 (COOL^{5–18}; Driessen, Mulder, Ledoux, Roeleveld, & van der Veen, 2007). COOL is one of the largest nationally representative triennial cohort studies on students' school careers, which has been commissioned and approved by the Dutch Ministry of Education, Culture, and Sciences (Driessen et al., 2007). Between April 2007 and June 2014, 10,069 students and their teachers from 400 regular elementary schools across the Netherlands were selected based on the socioethnic composition of the school's student population, province, denomination, and urbanic-

ity to ensure the representativeness of the sample. From this sample, extensive information about motivation, background characteristics, and academic outcomes were collected in kindergarten, Grade 3, and Grade 6 (see Table 1 for an overview). Thus far, various studies have used COOL to address theoretical and empirical issues regarding students' motivation (e.g., Hornstra et al., 2013, 2015), student–teacher relationship quality (Bosman et al., 2018), and students' academic adjustment (e.g., Zee et al., 2013) across the elementary school period. As such, this dataset, which is representative in terms of province, urbanicity, denomination, and school composition, is particularly suitable for testing the three hypothesized models proposed in this study.

In the Netherlands, elementary education—intended for 4- to 12-year-old students—is organized by eight age-level cohorts, or groups, in which students typically have the same classroom teacher throughout the school day. Whereas the first two groups focus on learning through play, social skills, and gradual preparation for mathematics and literacy, actual (formal) learning does not start until Group 3 (kindergarten), when students are on average 6 years old. Compulsory content, including reading, writing, and mathematics, are not taught by subject matter teachers, but delivered on a daily basis by students' classroom teacher. This has the advantage that the teachers who taught the participating students literacy and math could also report on their relationship experiences with these students as well as assess their motivational attitudes. On average, teachers completed these questionnaires for six students in their classrooms (range = 1–23 students), depending on whether students' parents consented to their child's participation in this study.

For the present study, we only included students with complete data on more than one measurement occasion. Dropout was mainly caused by schools dropping out of the study after the first measurement occasion or students transferring from participating schools to other schools (Driessen et al., 2007). Importantly, this substantial subsample did not differ significantly from the total sample in mean scores on relationship quality, motivational domains, achievement scores, or background characteristics at each measurement occasion ($ps > 0.05$, Cohen's d : 0–0.08; see Bosman et al., 2018).

The final sample comprised 1,267 students and 207 teachers in 109 schools across the Netherlands. As is common practice in the Netherlands, these students changed teachers every year, indicating that they were taught by different teachers at kindergarten, Grade 3, and Grade 6. Sample demographics indicated that 49.3% of the students were boys, and their mean age was 5.6 years ($SD = 0.43$) at the start of the study, 9.6 years ($SD = 0.43$) at Wave 2, and 11.6 years ($SD = 0.43$) at Wave 3. Information about students' background characteristics was provided by school administrators. Based on mothers' country of origin, 87.7% of the students were identified as ethnically Dutch, and half of students' mothers (52.2%) had finished senior secondary vocational education and a quarter (24.2%) had completed higher education. In 20.7% of the cases, mothers completed only secondary prevocational education or primary education. Thus, students' socioeconomic status was relatively normally distributed in this sample (CBS Statline, 2019). No information was available about teachers' demographic characteristics.

Table 1
Overview of Research Variables

Wave	Grade	N	Measures	Informant
1 (2007–2008)	Kindergarten (second year)	1,267	Relationship quality: o STRS	Teacher
			Motivational behaviors and beliefs: o Motivational attitude	Teacher
			Academic achievement: o CITO language for toddlers	National test
			o CITO mathematics	National test
2 (2010–2011)	3	1,248	Relationship quality: o STRS	Teacher
			o Well-being in relation to teacher	Student
			Motivational behaviors and beliefs: o Motivational attitude	Teacher
			o Task motivation scale	Student
			o Academic efficacy scale	Student
			Academic achievement: o CITO reading comprehension	National test
			o CITO mathematics	National test
3 (2013–2014)	6	1,097	Relationship quality: o STRS	Teacher
			o Well-being in relation to teacher	Student
			Motivational behaviors and beliefs: o Motivational attitude	Teacher
			o Task motivation scale	Student
			o Academic efficacy scale	Student
			Academic achievement: o CITO reading comprehension	National test
			o CITO mathematics	National test

Note. STRS = Student–Teacher Relationship Scale; CITO = Dutch National Institute for Educational Measurement.

Instruments

Teacher-perceived relationship quality. Teachers' perceptions of the quality of their relationships with individual students were measured using a short form of the authorized Dutch translated version of the Student–Teacher Relationship Scale (STRS; Koomen, Verschueren, & Pianta, 2007). Originally, this 28-item instrument represents three distinct relationship patterns of closeness (warmth, openness, and proximity), conflict (discordance and distrust), and dependency (students' overreliance on the teacher). For the short version of the STRS, however, five items for each relationship dimension were selected on the basis of the highest factor loadings reported in earlier research (Koomen, Verschueren, Van Schooten, Jak, & Pianta, 2012; Zee et al., 2013). Example items are “I share an affectionate and warm relationship with this child,” “This child and I always seem to be struggling,” and “This child reacts strongly to separation from me,” for closeness, conflict, and dependency, respectively. All 15 items were rated on a 5-point Likert-type scale, ranging from 1 (*definitely does not apply*) to 5 (*definitely applies*). Researchers have reported satisfactory reliability and construct validity for scores on the STRS, from preschool to upper elementary school, and across gender and age (e.g., Koomen et al., 2007, 2012). Additionally, in a previous study, the psychometric properties of the short form of the Dutch version of the STRS have been demonstrated to be adequate for all subscales (Zee et al., 2013; Zee & Koomen, 2017), with internal consistencies ranging from 0.86 to 0.93, and factor loadings >0.50 . In this study, Cronbach's alphas were .83, .82, and .84 for Closeness; .92, .92, and .95 for Conflict; and .90, .92, and .92 for Dependency at Waves 1, 2, and 3, respectively.

Student-perceived relationship quality. In Grades 3 and 6, students answered seven questions concerning the welfare of their relationship with their teacher, focusing on positive aspects of the student–teacher relationship (Peetsma, Wagenaar, & De Kat, 2001). This student-reported closeness scale was rated on a 5-point Likert-type scale, ranging from 1 (*definitively not true*) to 5 (*definitively true*). Example statements are “Usually, my teacher knows how I feel” and “I have a good relationship with my teacher.” Cronbach's alpha of this scale was satisfactory ($\alpha = .79$ and $\alpha = .80$ at Waves 2 and 3, respectively).

Students' motivational beliefs. To capture the multifaceted nature of students' motivational beliefs, we considered both their goals and expectancies. Students' motivational goals were measured using the Task Motivation Scale (Seegers, Van Putten, & De Brabander, 2002). This 5-item instrument, rated on a 5-point Likert scale ranging from 1 (*definitively not true*) to 5 (*definitively true*), measures the extent to which students focus on mastering learning tasks and learning opportunities in the school context. Example items are “I feel satisfied when I have learned something in school that makes sense to me,” and “I feel satisfied when I have learned something new in school.” Support for the construct validity of this scale across time, gender, ethnicity, and socioeconomic status has been provided by Hornstra and colleagues (2013). Cronbach's alpha in this study was .74 at Wave 2 and .75 at Wave 3.

Students rated their expectancies about their capability to perform academic tasks in the classroom using a translated version of the Academic Efficacy subscale from the Patterns of Adaptive Learning Survey (PALS; Midgley et al., 2000). The six items of this scale were scored on a 5-point Likert scale, ranging from 1

(*definitively not true*) to 5 (*definitively true*). An example item is "I'm certain I can figure out how to do the most difficult class-work" In prior research the Academic Efficacy subscale has been demonstrated to have sufficient reliability, construct validity, and predictive validity (Midgley et al., 2000). In the present sample, Cronbach's alpha of this measure was .78 at Wave 2 and .79 at Wave 3.

Students' motivational attitudes. During each wave, teachers were administered a short, 3-item School Investment measure from COOL student profiles (Jungbluth, Peetsma, & Roeleveld, 1996) that assessed the extent to which individual students exert effort and persist at school tasks (i.e., work attitudes). An example item is "This student gives up easily when things get hard" (reversed). Prior research using this measure has demonstrated evidence for its measurement invariance across time, gender, ethnicity, and socioeconomic status (Hornstra et al., 2013). Cronbach's alpha for this measure at Waves 1, 2, and 3 were .82, .82, and .83, respectively.

Students' academic achievement. Students' academic achievement was obtained from their performance on individually administered nationally normed tests for reading and mathematics, developed by the Dutch National Institute for Educational Measurement (CITO). At Wave 1, students' language abilities were evaluated using the Language for Kindergartners test, normed for students in kindergarten (age 4–6), which includes 54 items that tap aspects of conceptual and metalinguistic awareness, including passive vocabulary, auditory synthesis, sounds, and rhymes. At Waves 2 and 3, students completed the CITO Reading Comprehension test, comprising 55 items to evaluate students' proficiency in conceptual reasoning and practical reading ability. The total number of correct answers provides a general score of students' reading comprehension (Driessen et al., 2007).

Students' math abilities at Wave 1 were evaluated using the Math for Kindergartners test, which includes 47 items that measure students' ability to classify, seriate, and compare. At Waves 2 and 3, students completed the CITO Mathematics test, which comprises 96 exercises on important aspects of math, such as geometry, multiplication, and addition (Driessen et al., 2007). The total of correct answers provides a general score of students' math ability (Driessen et al., 2007). Raw scores of each test were transformed to ability scores which are standardized on a continuous scale ranging from 0 to 150. Previous studies have provided evidence for the predictive and construct validity of the CITO Reading Comprehension and Math tests, and reliabilities, ranging from .89 to .92, for these tests were adequate (Janssen, Verhelst, Engelen, & Scheltens, 2010; Lansink & Hemker, 2010; van Berkel et al., 2010).

Procedure

Data were collected from teachers and students in three waves (see Table 1) with a 3-year time interval. Three steps were followed in the process of data collection. First, between April and September 2007, 2,800 schools received a formal letter of invitation and an active consent form to take part in the COOL cohort study. After schools agreed to participate, informed consent was obtained from the parents by providing them with a written account of the study's purposes and a permission form that could be returned to schools. In the second step (September 2007), exten-

sive data about students' background characteristics (e.g., age, gender, ethnicity) were obtained from school administrators based on student records provided by parents. Third, during each wave when students were in kindergarten (January–April 2008), Grade 3 (January–April 2011), and Grade 6 (January–April 2014), students' scores on mathematics and reading comprehension were obtained through teachers' classroom databases. Additionally, questionnaires on student–teacher relationship quality and students' motivational attitudes were administered to teachers by research assistants during planned school visits during each wave. Research has indicated that the quality of relationships between students and teachers has been sufficiently crystallized during the second half of the school year (Roorda et al., 2014). Given that the data were collected in the second semester of the school year, it is likely that the teachers and students in our study have had enough time to get to know each other. On average, teachers completed these questionnaires for six students in their classrooms (range = 1–23 students). Due to the complexity of the questionnaires, students only reported about their motivational beliefs and relationships with teachers in Grades 3 and 6 (Driessen et al., 2007). Both students and teachers completed these questionnaires in their own classrooms.

Data Analysis

To investigate the longitudinal associations between student–teacher relationship quality, students' motivational attitudes and beliefs, and their academic achievement, we conducted cross-lagged panel modeling using *Mplus* 7.11 (Muthén & Muthén, 1998–2012). This technique enabled us to specify covariances among the predictors in our models and to include multiple outcome variables (Kline, 2011) to estimate within-time and across-time associations between the variables in one model and specify autoregressive paths between time-adjacent measures of each construct (Little, 2013). The dependency among the sampled observations within clusters was taken into account by employing the complex analysis option in *Mplus*. This feature handles the nested data structure by adjusting both chi-squares and standard errors of the estimated coefficients (Muthén & Muthén, 1998–2012). Missing data across the three waves (see Table 1) ranged from 0.0% to 15.8% ($M = 7.0\%$) and was mainly due to schools dropping out of the study after the first measurement occasion or students transferring to another school. These missing data patterns were handled using full information maximum likelihood, after uncovering no statistically significant deviations from randomness using Little's MCAR test, $p = .859$ (Tabachnick & Fidell, 2007).

Modeling procedure. To ensure adequate statistical power, separate cross-lagged panel models were estimated for each of the student–teacher relationship dimensions (student- and teacher-perceived closeness, conflict, and dependency). Models were specified in four steps. First, each construct's stability across time as well as contemporaneous correlations were freely estimated. To investigate whether or not the constructs of interest were stable across the elementary grades, we subsequently constrained the unstandardized stability paths from kindergarten to Grade 3, and from Grade 3 and Grade 6 to be equal across time. As these constraints did not deteriorate the model's fit, these more parsimonious stability models provided the basis for all other nested models.

Second, we fitted a relationship-driven model (see Figure 1) including paths from each relationship dimension at kindergarten to students' motivational attitudes and beliefs at Grade 3, and from students' motivational attitudes and beliefs at Grade 3 to their reading comprehension and math achievement at Grade 6. Third, we fitted a student-driven model (see Figure 1) in which paths were added to the stability model that modeled the hypothesized associations between students' achievement scores at kindergarten to their motivational attitudes beliefs at Grade 3, and between these motivational measures and each of the relationship dimensions at Grade 6. Finally, we added reciprocal paths among student-teacher relationship dimensions, motivational attitudes and beliefs, and achievement scores across time to test the hypothesized transactional model (see Figure 1).

After estimating all models, we employed the Monte Carlo simulation approach, developed by MacKinnon, Lockwood, and Williams (2004), to test the statistical significance of potential mediation effects. This method involves directly spawning sample statistics based on the joint asymptotic distribution of the component statistics to obtain multiple estimates of the mediating pathways (Little, 2013). This method resembles other recommended approaches for testing the significance of the indirect effects, including bootstrap estimation (Preacher & Hayes, 2008), which cannot be used in combination with robust maximum likelihood estimation. We reported 90% confidence intervals for all models based on 5,000 simulated draws for the indirect effects. If the confidence interval around the (unstandardized) point estimate of the indirect effect includes zero this effect can be considered nonsignificant.

Model goodness-of-fit. All models were fitted in Mplus 7.11, using robust maximum likelihood estimation (MLR; Muthén & Muthén, 1998–2012). This estimation method offers a mean-adjusted model χ^2 , which is asymptotically equivalent to the T2 test-statistic (Yuan & Bentler, 2000), and adjusted standard errors that are robust for non-normality (Muthén & Muthén, 1998–2012). Generally, nonsignificant χ^2 tests are indicative of good model fit (Kline, 2011; Little, 2013). Yet, given that trivial discrepancies between the expected and the observed model may lead to the model's rejection (Chen, 2007), other fit indices were calculated as well. These included the root mean square error of approximation (RMSEA) with values ≤ 0.05 reflecting close fit, and ≤ 0.08 signifying reasonable fit (Browne & Cudeck, 1993), and the comparative fit index (CFI) with values ≥ 0.90 indicating satisfactory fit, and values ≥ 0.95 indicating close fit (Bentler, 1992). Modification indices, residual correlations, and their associated summary statistic SRMR (standardized root-mean-square residual) were used to evaluate component fit. Values ≤ 0.08 indicate good fit of the model to the data (Kline, 2011). To compare alternative models, we employed the Satorra-Bentler scaled chi-square difference test (TRd; Satorra & Bentler, 2010), and ΔCFI , with CFI changes ≥ 0.02 being indicative of model nonequivalence (Cheung & Rensvold, 2002).

Results

Descriptive Statistics

Means, standard deviations, and zero-order correlations among all study variables are displayed in Table 2. Correlations suggested

weak to moderate stability of each construct across elementary school. We also found evidence for potential transactional pathways. At most waves, teacher-reported relationship quality was modestly associated with students' reading comprehension and students' motivational attitudes. Yet, correlations of teacher-reported relationship quality with students' math achievement, self-efficacy, and task motivation were generally weak and nonsignificant. Modest correlations were also noted among student-reported closeness at kindergarten and Grade 3 and their motivational attitudes and motivational beliefs at Grade 6 only. Across waves, reading comprehension, but not math achievement, was also positively associated with students' reports of closeness in sixth grade. Last, reading comprehension and math achievement were generally associated with their motivational attitudes and beliefs. Because there were also small-to-moderate correlations with the study's main variables, we included students' gender and ethnicity as covariates in all subsequent models.

Cross-Lagged Panel Analyses

Model fit statistics. Model fit information for all models is provided in Table 3. For all relationship dimensions, fit statistics suggest a relatively poor model fit for all but the transactional model. The statistically significant Satorra-Bentler scaled chi-square difference test, CFI differences, and relatively better component fit statistics (i.e., CFI values $\geq .90$ and SRMR $\leq .08$) point to the transactional models as having the best fit to the data. Thus, the transactional models, which suggest that teacher-student closeness, conflict, and dependency, students' motivational attitudes and beliefs, and academic achievement informed each other across the elementary grades, were used for subsequent analyses.

Teacher-perceived closeness. Figure 2 shows the standardized path coefficients of the model of teacher-perceived closeness. All stability paths were positive and statistically significant, ranging from .19 to .63. Controlling for covariates and rank-order stability within the constructs, we found significant, positive paths from closeness at kindergarten to students' task motivation at Grade 3, from students' motivational attitudes at kindergarten to their reading comprehension and math scores in Grade 3, from students' reading comprehension to their motivational attitudes, and from math to students' self-efficacy. From third to sixth grade, we noted significant, positive pathways from reading comprehension to motivational attitudes and self-efficacy, from math to self-efficacy, and from closeness to motivational attitudes and task motivation. Additionally, students with more positive motivational attitudes and self-efficacy beliefs were likely to have better reading comprehension and, for motivational attitudes, better math grades. Table 4 provides the Monte Carlo confidence limits of the relevant indirect effects of this final transactional model for teacher-perceived closeness.

Student-perceived closeness. Figure 3 shows the standardized path coefficients of the model of student-perceived closeness. Stability paths ranged from .16 to .62. Controlling for prior levels of student-perceived closeness, motivation, and achievement, we noted modest, though significant, positive pathways from students' motivational attitudes at kindergarten to reading comprehension and math achievement, from reading comprehension to motivational attitudes, and from math to self-efficacy at Grade 3. Reading comprehension scores predicted positive changes in student-

Table 2
Zero-Order Correlations, Means, and Standard Deviations

Study variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Covariates:																										
1. Gender W1																										
2. Ethnicity W1	-.05																									
Relationship quality:																										
3. Closeness W1	.18**	-.07*																								
4. Closeness W2	.14**	-.08**	.23*																							
5. Closeness W3	.14**	-.11**	.12**	.16**																						
6. Closeness W2	.10**	-.03	.04	.21**	.11**																					
7. Closeness W3	.04	-.05	.11**	.11**	.25**	.25**																				
8. Conflict W1	-.14**	.06	-.38**	-.12**	-.05	-.10**	-.10**																			
9. Conflict W2	-.20**	.05	-.08**	-.30**	-.06	-.21**	-.15**	.35**																		
10. Conflict W3	-.16**	.11**	-.09**	-.08**	-.38**	-.12**	-.32**	.23**	.29**																	
11. Dependency W1	-.02	.04	-.20**	-.06	.01	-.04	-.02	.43**	.13**	.05																
12. Dependency W2	.03	-.01	-.00	.02	-.02	-.02	-.02	.17**	.40**	.20**	.21**															
13. Dependency W3	.01	.05	-.01	.02	-.10**	.00	-.04	.16**	.23**	.45**	.13**	.32**														
Motivation:																										
14. Attitudes W1	.25**	-.00	.26**	.06*	.06*	.06*	.09**	-.34**	-.20**	-.12**	-.34**	-.16**	-.15**													
15. Attitudes W2	.26**	.02	.10**	.22**	.10**	.16**	.10**	-.23**	-.45**	-.24**	-.09**	-.39**	-.25**	.38**												
16. Attitudes W3	.26**	-.02	.12**	.18**	.30**	.13**	.21**	-.24**	-.35**	-.44**	-.10**	-.24**	-.36**	.30**	.51**											
17. Task Mot. W2	.01	.07*	.07*	.11**	.05	.39**	.13**	.04	-.12**	-.00	-.03	-.08**	-.03	.05	.12**	.10**										
18. Task Mot. W3	.01	.14**	.04	.07*	.10**	.20**	.36**	-.06*	-.12**	-.08*	-.08*	-.09**	-.09**	.11**	.17**	.21**	.23**									
19. Self-Efficacy W2	-.07*	.06	.05	.06*	-.00	.21**	.03	-.00	-.04	.01	-.02	-.16**	-.07*	.05	.11**	.10**	.46**	.19**								
20. Self-Efficacy W3	-.13**	.07*	.05	.01	0.05	.12**	.31**	-.06*	-.10**	-.01	-.09**	-.14**	-.12**	.13**	.16**	.17**	.20**	.53**	.30**							
Achievement:																										
21. Read W1	.08**	-.24**	.15**	.06*	.03	.01	.09**	-.05	-.04	-.04	-.15**	-.13**	-.07*	.20**	.16**	.11**	.01	.04	.08*	.15**						
22. Read W2	.16**	-.11**	.12**	.10**	.09*	.04	.10**	-.10**	-.16**	-.14**	-.13**	-.18**	-.20**	.25**	.33**	.31**	.05	.14**	.10**	.25**	.38**					
23. Read W3	.06*	-.07*	.07*	.08**	.11**	.03	.07*	-.08**	-.12**	-.18**	-.15**	-.21**	-.27**	.26**	.33**	.36**	.06*	.17**	.17**	.27**	.30**	.64**				
24. Math W1	.06	-.13**	.13**	.03	-.00	-.02	.03	-.10**	-.06*	-.02	-.14**	-.17**	-.12**	.28**	.20**	.15**	.06	.08**	.16**	.49**	.39**	.33**				
25. Math W2	-.14**	-.13**	.04	-.00	.01	-.02	-.02	-.07*	-.05	-.04	-.19**	-.30**	-.22**	.22**	.28**	.22**	.04	.11**	.22**	.29**	.27**	.51**	.44**			
26. Math W3	-.10**	-.05	.01	.03	.06*	-.02	.05	-.08**	-.12**	-.09**	-.17**	-.32**	-.26**	.27**	.35**	.33**	.04	.20**	.18**	.34**	.25**	.44**	.65**	.39**	.74**	
<i>M</i>	—	—	3.86	3.71	3.74	3.81	3.80	1.68	1.62	1.51	2.12	2.13	1.79	3.51	3.44	3.62	4.15	3.97	3.85	3.69	75.41	28.90	56.46	60.81	73.61	111.44
<i>SD</i>	—	—	0.58	0.61	0.66	0.56	0.63	0.71	0.75	0.74	0.74	0.86	0.78	0.83	0.95	0.94	0.62	0.62	0.64	0.64	9.06	14.02	18.91	12.08	14.86	12.28

Note. W1, W2, W3: Wave 1, 2, or 3; Gender: 0 = boy, 1 = girl; Ethnicity: 0 = ethnic Dutch, 1 = minority background; Closeness_t = teacher-perceived closeness; Closeness_s = student-perceived closeness; Task Mot. = task motivation; Read = reading comprehension.

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

Table 3

Fit Indices of Estimated Cross-Lagged Models for Closeness, Conflict, and Dependency

Models	χ^2 (df)	RMSEA (90% CI)	CFI	SRMR	TRd (df)	Δ CFI
Model teacher-reported closeness						
Stability model	732.74 (98)***	.071 [.067, .076]	.85	.114	n/a	n/a
Relationship-driven model	643.39 (89)***	.070 [.065, .075]	.87	.103	vs. Stability: 90.37 (9)***	.02
Student-driven model	700.39 (89)***	.074 [.069, .079]	.86	.109	vs. Stability: 19.79 (9)*	.01
Transactional model	473.80 (60)***	.074 [.068, .080]	.91	.069	vs. Stability: 257.01 (38)*** vs. Relationship-driven: 166.46 (29)*** vs. Student-driven: 226.57 (29)***	.06 .04 .05
Model student-reported closeness						
Stability model	714.51 (84)***	.077 [.072, .082]	.86	.119	n/a	n/a
Relationship-driven model	631.56 (78)***	.075 [.069, .080]	.87	.108	vs. Stability: 81.23 (6)***	.01
Student-driven model	680.15 (75)***	.080 [.074, .085]	.86	.114	vs. Stability: 27.03 (9)**	.00
Transactional model	453.06 (51)***	.079 [.072, .086]	.91	.070	vs. Stability: 260.39 (33)*** vs. Relationship-driven: 175.45 (27)*** vs. Student-driven: 227.23 (24)***	.05 .04 .05
Model teacher-reported conflict						
Stability model	737.42 (98)***	.072 [.067, .077]	.86	.120	n/a	n/a
Relationship-driven model	654.76 (89)***	.071 [.066, .076]	.87	.109	vs. Stability: 82.69 (9)***	.01
Student-driven model	701.59 (89)***	.074 [.069, .079]	.86	.114	vs. Stability: 32.17 (9)**	.00
Transactional model	453.48 (60)***	.072 [.066, .078]	.91	.069	vs. Stability: 283.99 (38)*** vs. Relationship-driven: 201.57 (29)*** vs. Student-driven: 247.01 (29)***	.05 .04 .05
Model teacher-reported dependency						
Stability model	713.73 (98)***	.070 [.066, .075]	.86	.122	n/a	n/a
Relationship-driven model	632.72 (89)***	.069 [.064, .075]	.88	.112	vs. Stability: 81.74 (9)***	.02
Student-driven model	683.19 (89)***	.073 [.068, .078]	.87	.117	vs. Stability: 27.70 (9)*	.01
Transactional model	442.97 (60)***	.071 [.065, .077]	.91	.065	vs. Stability: 254.80 (38)*** vs. Relationship-driven: 174.37 (29)*** vs. Student-driven: 223.99 (29)***	.05 .03 .04

Note. df = degrees of freedom; RMSEA = root mean square error of approximation; 90% CI = 90% confidence interval; CFI = comparative fit index; SRMR = standardized root mean square residual; TRd = Sattora-Bentler scaled chi-square difference.

* $p < .05$. ** $p < .01$. *** $p < .001$.

reported closeness, motivational attitudes, and self-efficacy at the end of sixth grade, whereas students' math scores at Grade 3 only predicted positive changes in self-efficacy at Grade 6. Also, the positive pathways from closeness at Grade 3 to motivational attitudes, task motivation, and self-efficacy at Grade 6, from motivational attitudes to reading comprehension and math, and from self-efficacy to reading comprehension and math deviated significantly from zero. Table 4 provides the Monte Carlo confidence limits of the relevant indirect effects for the student-perceived closeness model.

Teacher-perceived conflict. Figure 4 shows the teacher-perceived conflict model. Stability paths ranged from .19 to .63. After taking the covariates and rank-order stability within the constructs into account, we found a significant, negative path from conflict at kindergarten to students' motivational attitudes, and significant pathways from motivational attitudes to conflict, reading comprehension, and math. Also statistically significant were the small but positive paths from reading comprehension to motivational attitudes, and from math to self-efficacy at Grade 3. In turn, higher reading comprehension at Grade 3 predicted less conflict with teachers and more positive motivational attitudes and self-efficacy beliefs at Grade 6. Also, more positive motivational attitudes and self-efficacy beliefs at Grade 3 predicted better reading comprehension, and, in the case of motivational attitudes, less conflict and higher math scores in Grade 6. Last, conflict in Grade 3 predicted poorer motivational attitudes and task motivation in Grade 6. Table 4 provides the Monte Carlo confidence

limits of the relevant indirect effects. These findings provide initial support for transactional pathways between student-teacher conflict and students' academic adjustment.

Teacher-perceived dependency. Figure 5 displays the stability coefficients for the dependency model, ranging from .19 to .61. After controlling for covariates and rank-order stability within the constructs, we found significant, negative transactional pathways from dependency at kindergarten to math in third grade and vice versa. Also, positive motivational attitudes in kindergarten and Grade 3 predicted lower levels of dependency and improved reading comprehension and math scores at subsequent time points. Reading comprehension also predicted better motivational attitudes in Grade 3. Next, better reading comprehension skills in Grade 3 predicted less dependency as well as more positive motivational attitudes and self-efficacy beliefs in Grade 6 and vice versa. Last, math in Grade 3 was positively linked to students' self-efficacy in Grade 6. Table 4 provides the Monte Carlo confidence limits of the relevant indirect effects. Again, these cross-time associations suggest that student characteristics and relationship quality mutually inform one another.

Discussion

Using a three-wave, cross-lagged panel design, we were able to add to the ever-growing body of literature on student-teacher relationship quality by investigating (a) the complex ways in which students' motivational attitudes and beliefs, academic out-

Figure 2. Transactional model for teacher-perceived closeness. Standardized robust maximum likelihood parameter estimates are reported. For reasons of parsimony, nonsignificant paths are not reported. Dashed line represent within-time correlations. All within-time correlations were weak to moderate and in the expected direction. Student gender: 0 = boy, 1 = girl; Student ethnicity: 0 = Dutch, 1 = migration background. * $p < .05$. ** $p < .01$. *** $p < .001$.

comes, and relationships with teachers inform one another from kindergarten through Grade 6; (b) whether the direction of associations between student–teacher relationships and students’ academic adjustment are dependent upon motivational domains, relationship quality, or specific subjects; and (c) whether these associations vary across teacher and student reports of relationship quality. The findings of each of these aims will be discussed in turn.

Transactional Links Between Student–Teacher Relationships and Academic Adjustment

Theoretical models of the complex associations between relationship quality and students’ academic adjustment have been prominent in the literature (e.g., Pianta et al., 2003; Roorda et al., 2017), but empirical evaluations of these models have been less available. This study is one of the first to corroborate and extend these theoretical models by indicating that students’ academic adjustment and their relationships with teachers, especially those that are free of conflict and dependency, are likely to inform one another across time. Compared to the relationship- and student-driven models, the transactional models with partially bidirectional pathways between the relationship dimensions and students’ motivational attitudes and beliefs provided the best fit to the data. After taking the weak-to-moderate stability in relationship quality, motivation, and achievement into account, these models generally

revealed that students whose teachers reported high-quality, non-conflictual relationships in kindergarten were more likely to have positive motivational attitudes and beliefs in third grade. In turn, those attitudes and beliefs were indicative of better academic performance at the end of elementary school. These findings are generally consistent with Roorda et al. (2017) whose meta-analytic findings clearly suggest that indicators of motivation, including effort, persistence, and involvement, might be the mechanism explaining the association between student–teacher relationship quality and students’ academic achievement. Moreover, they can be understood in relation to research based on extended attachment theory in which warm and conflict-free student–teacher relationships have been considered a necessary precondition for students’ exploration of the environment and motivation for learning (Hamre & Pianta, 2001; Roorda et al., 2011).

Next to these more relationship-driven pathways, students’ motivational attitudes in kindergarten also seemed to play a modest, positive role in their academic achievement 3 years later. Better achievement outcomes in Grade 3, in turn, predicted positive motivational attitudes and beliefs in Grade 6, and, in the case of reading comprehension, higher quality student–teacher relationships. Findings from previous longitudinal studies spanning shorter periods of time (e.g., Košir & Tement, 2014; McKinnon & Blair, 2019) reporting cross-lagged paths between indicators of students’ school adjustment and relationships with teachers are

Table 4

Indirect Effects of Estimated Cross-Lagged Models for Closeness, Conflict, and Dependency

Model	Indirect effect	Estimate	Monte Carlo 90% CI
Teacher-reported closeness	MA K → RC grade 3 → MA grade 6	.028*	[.014, .042]
	RC K → MA grade 3 → RC grade 6	.026	[−.001, .052]
Student-reported closeness	MA K → RC grade 3 → Closeness grade 6	.014*	[.002, .026]
	MA K → RC grade 3 → MA grade 6	.031*	[.016, .045]
	RC K → MA grade 3 → RC grade 6	.025	[−.002, .051]
	Math K → Self-efficacy grade 3 → Math grade 6	.004	[.000, .009]
Teacher-reported conflict	Conflict K → MA grade 3 → RC grade 6	−.440*	[−.79, −.10]
	Conflict K → MA grade 3 → Math grade 6	−.267*	[−.49, −.06]
	Conflict K → MA grade 3 → Conflict grade 6	.008	[.000, .017]
	MA K → RC grade 3 → Conflict grade 6	−.015*	[−.028, −.001]
	MA K → RC grade 3 → MA grade 6	.025*	[.012, .038]
	MA K → Conflict grade 3 → MA grade 6	−.001*	[−.002, .000]
	Dependency K → Math grade 3 → Self-efficacy grade 6	−.016*	[−.028, −.005]
Teacher-reported dependency	MA K → Dependency grade 3 → MA grade 6	.005	[−.001, .012]
	MA K → Dependency grade 3 → Math grade 6	.086	[−.018, .189]
	MA K → RC grade 3 → MA grade 6	.030*	[.015, .045]
	MA K → RC grade 3 → Dependency grade 6	−.011	[−.024, .001]
	Math K → Dependency grade 3 → MA grade 6	.001*	[.000, .001]
	Math K → Dependency grade 3 → Math grade 6	.009*	[.001, .017]

Note. Unstandardized coefficients are reported. MA = motivational attitudes; K = kindergarten; RC = reading comprehension; 90% CI = 90% confidence interval.

* $p < .05$.

similar in magnitude to the coefficients reported in this study. However, as far as we know, no studies to date have provided support for the complex pathways among relationship quality, motivational domains, and achievement within a single set of analyses. By unveiling those processes, our study extends the theoretical notion that teachers who perceive their students as motivated and academically self-efficacious may also react to these students with more warmth and involvement in the long run (Pianta et al., 2003; Roorda et al., 2011).

Differences in Pathways Across Motivational Domains, Relationship Quality, and Achievement in Specific Subjects

Our findings provided initial support for potential similarities and differences in pathways across motivational domains, relationship quality, and academic subjects. First, consistent with prior meta-analytic findings (Roorda et al., 2011, 2017), all models pointed to an independent positive contribution of teacher-reported motivational (work) attitudes at kindergarten and students' reading comprehension and math achievement at third grade. These direct associations were replicated in later grades, suggesting that students' effort and persistence, beyond the stability of covariates, relationship quality, and academic adjustment across time, remain relevant for their achievement throughout the elementary school years. The value of these findings is substantial, given that various motivational resources, including academic motivation and effortful engagement, may help students cope more effectively with the cognitive demands of the upper elementary years and can even foretell eventual school completion versus dropout (Hughes & Cao, 2018; Skinner, Pitzer, & Steele, 2016; Wang & Peck, 2013).

Between third and sixth grade, students' motivational attitudes also seemed to play a role in the degree of conflict and dependency, but not closeness, in the student-teacher relationship. The-

oretically, this finding accords well with the previously suggested decreases in academic motivation and achievement prior to the onset of puberty, which tend to coincide with decreases in the quality of the student-teacher relationship during this period (e.g., Hughes & Cao, 2018). It is also congruent with empirical research suggesting that positive relationship aspects, including closeness, are less stable across time than negative aspects of student-teacher relationships, which tend to be more student-driven and more strongly related to student characteristics such as behavior and engagement (Rudasill & Rimm-Kaufman, 2009).

Yet, these findings must also be explained in the light of some methodological and contextual concerns. To be more specific, students only had the opportunity to report on the degree of closeness in the relationship with their teacher in third and sixth grade. Prior research has indicated that students' perceptions of closeness tend to be less dependent on their judgments of conflict than those of teachers, suggesting that students, while experiencing high levels of conflict, may still perceive their teachers as emotionally supportive (Hughes, 2011). Furthermore, there is robust empirical evidence that students' and teachers' agreement on the level of closeness in the relationship is lower than their agreement on the degree of conflict (Hughes, 2011; Mantzicopoulos & Neuhauser-Pritchett, 2003), even when mathematically equal constructs are used to measure both relationship views (Zee & Koomen, 2017). This raises the question of whether students in this sample were able to reliably report on the degree of closeness in the relationship, especially because teachers' emotional availability is more difficult to observe and understand than teachers' anger and discordance in the relationship. Therefore, more longitudinal research using both multidimensional student and teacher reports of relationship quality is evidently needed.

It is also possible that personal or contextual factors have influenced why students' motivational attitudes only played a role

Figure 3. Transactional model for student-perceived closeness. Standardized robust maximum likelihood parameter estimates are reported. For reasons of parsimony, nonsignificant paths are not reported. Dashed lines represent within-time correlations. All within-time correlations were weak to moderate and in the expected direction. Student gender: 0 = boy, 1 = girl; Student ethnicity: 0 = Dutch, 1 = migration background. * $p < .05$. ** $p < .01$. *** $p < .001$.

in the degree of conflict and dependency. For instance, there is some evidence to suggest that children's socioeconomic status, gender, ethnicity, and learning difficulties may all be factors contributing to their relationships with teachers and their academic adjustment (e.g., Hughes & Cao, 2018; McCormick, O'Connor, & Horn, 2017; Roorda et al., 2011). Conceivably, negative, conflictual relationships with teachers may be particularly burdensome for at-risk children, further weakening their academic adjustment across time (Roorda et al., 2011). These findings highlight the importance of considering personal and contextual variables when investigating longitudinal links among student-teacher relationships and students' academic adjustment.

Apart from these results, it should be noted that students' self-efficacy seemed to be somewhat more important for their academic achievement than task motivation. Whereas none of the pathways, either directional or reciprocal, from students' task motivation to their academic achievement were significant, their self-efficacy beliefs appeared to play a modest role in their reading comprehension, and, in the student-reported closeness model, their math performance. Specifically, when students reported a high level of confidence in their capability to perform at school in Grade 3, they were likely to get better in reading comprehension and, to a lesser extent in math, 3 years later. The reverse, however, was also true: Students with high scores on reading comprehension and mathematics in third grade felt more self-efficacious in sixth grade. These interesting findings support the social-cognitive

view that successful academic performance serves as an important enactive mastery experience that provides robust evidence of whether students can muster whatever it takes to succeed (Bandura, 1997). Moreover, it suggests that self-referent thoughts, more than any other type of motivational belief, are crucial contributors to the acquisition of knowledge, because these thoughts may regulate motivation by shaping confidence, aspirations, and expected outcomes for students' efforts (ibid.).

Second, and somewhat related to the above, the complex pathways between the quality of the student-teacher relationship and students' academic adjustment seemed to differ across positive and negative aspects of the relationship. Controlling for early relationship quality and indicators of academic adjustment, no evidence was found for transactional pathways from closeness to students' academic adjustment. However, largely in line with the common social-motivational view that fulfillment of students' need for emotional teacher support leads to positive changes in motivation (cf. Roorda et al., 2017; Skinner & Belmont, 1993), our (transactional) closeness models did support a more relationship-driven hypothesis. This suggests that students who experience high levels of warmth and open communication in the relationship with their teachers are likely to exert more effort in their school tasks and feel more self-efficacious over the course of elementary school than classmates with less close relationships.

Our reported relationship-driven pathways were generally in contrast to longitudinal studies that have shown a reciprocal pat-

Figure 4. Transactional model for teacher-perceived conflict. Standardized robust maximum likelihood parameter estimates are reported. For reasons of parsimony, nonsignificant paths are not reported. Dashed line represent within-time correlations. All within-time correlations were weak to moderate and in the expected direction. Student gender: 0 = boy, 1 = girl; Student ethnicity: 0 = Dutch, 1 = migration background. * $p < .05$. ** $p < .01$. *** $p < .001$.

tern between closeness and adjustment measures, including achievement and motivation (e.g., Skinner & Belmont, 1993; Spilt et al., 2015). A reasonable explanation for this discrepancy is that most previous research did not use a cross-lagged design and, thus, did not specifically evaluate the direction of (in)direct associations between relationship quality and academic adjustment. Of those that did, four studies solely focused on associations among relationship dimensions and academic achievement (Hajovsky et al., 2017; Košir & Tement, 2014; McKinnon & Blair, 2019; Spilt et al., 2015), and one focused on the association between relationship quality and engagement (Skinner & Belmont, 1993). Moreover, these studies typically spanned 2 to 3 years, with shorter time intervals than in our study. Thus, it is possible that relationship-driven pathways rather than student-driven or transactional pathways exist, but over longer time periods.

In contrast to closeness, our models suggested the presence of several reciprocal pathways and transactional cascades between negative aspects of the student-teacher relationship and students' adjustment. Regarding conflict, we found reciprocal pathways between teacher-reported conflict and teacher-reported motivational (work) attitudes, suggesting that students' lack of effort and persistence during learning tasks and their teachers' feelings of anger, discordance, and distrust in the relationship may mutually reinforce each other throughout the elementary years. This is alarming given that students with increasing levels of conflict across time are at risk for higher levels of underachievement (Spilt,

Hughes, Wu, & Kwok, 2012). Next to these reciprocal relationships, transactional cascades from conflict to achievement emerged among teacher-student dyads. Teachers' experiences of conflict in the relationship at kindergarten contributed to less positive motivational attitudes in Grade 3, which subsequently translated into lower achievement in math and reading comprehension in Grade 6. Together, these data patterns are in line with a developmental model of student-teacher relationships as dynamic systems in which both teachers and their individual students respond to and initiate behavioral and emotional changes in one another (Pianta et al., 2003; O'Connor, 2010; Rudasill, 2011).

Markedly, none of the three motivational factors appeared to play a mediating role in the longitudinal association between dependency and students' achievement. Instead, we found evidence for a partially transactional pathway in which students' overdependent behavior and math performance seemed to cast a reciprocal influence during the first year of elementary school, suggesting that dependency may be more crucial for young students' achievement than for their motivation. Additionally, kindergartners who were overreliant on their teachers tended to perform worse in math in third grade which, in turn, eroded their self-efficacy beliefs in Grade 6.

Although dependency is commonly seen by teachers as a negative aspect of the relationship, it is possible that students' overreliance on the teacher, especially in kindergarten, helps them alleviate emotional and cognitive distress arising from such high-

Figure 5. Transactional model for teacher-perceived dependency. Standardized robust maximum likelihood parameter estimates are reported. For reasons of parsimony, nonsignificant paths are not reported. Dashed line represent within-time correlations. All within-time correlations were weak to moderate and in the expected direction. Student gender: 0 = boy, 1 = girl; Student ethnicity: 0 = Dutch, 1 = migration background. * $p < .05$. ** $p < .01$. *** $p < .001$.

stakes subjects as math, and to a lesser extent, other subjects such as reading. Yet, social-motivational theories (e.g., Roorda et al., 2017) as well as our findings suggest that highly dependent relationships may hamper the confidence and autonomy students need to explore the environment and perform academically in the long run. Although more evidence is needed, these findings provide further explanation for the relatively inconsistent and understudied role of dependency in students' academic adjustment reported in the literature. Specifically, it supports the developmental view that young children's overly clingy behaviors are likely to pose an obstacle to engaging in the type of interactions with teachers that foster their academic achievement and help them explore the classroom environment (Pianta et al., 2003).

Last, the longitudinal associations between the quality of the student-teacher relationship and students' academic adjustment seemed to differ across students' math performance and reading comprehension. Specifically, students' math achievement was only positively and directly related to their self-efficacy beliefs, whereas reading comprehension was reciprocally linked to students' motivation work attitudes across the entire elementary school period. Moreover, from Grade 3 onward, students' reading comprehension predicted students' motivational attitudes and beliefs as well as the quality of their relationships with teachers.

These associations held even after taking prior levels of motivation and achievement into account. Prior studies with younger elementary schoolchildren have also indicated that reading

achievement may be more relevant for relationship quality and motivation than math (e.g., McKinnon & Blair, 2019). It is possible, for instance, that teachers spend more instructional time on reading than math, as reading skills are considered core to all other learning activities in class (Hajovsky et al., 2017; Hughes et al., 2012). This may boost their motivation for reading long term. Another hypothesis is that children with better language skills, including reading, develop better relationships with teachers and are more motivated to learn, as they have the skills necessary to engage in positive interactions with their teachers (cf. Spilt et al., 2015).

Differences in Pathways Across Informants

Prior studies have generally indicated that students' and teachers' reports of their relationships are only weakly to moderately correlated (e.g., Koomen & Jellesma, 2015). This poor teacher-student agreement has brought into question whether teacher and student reports of the relationship have similar associations with students' adjustment (cf. Hughes, 2011). In this study, we included both student and teacher reports of closeness to address this question. Overall, the sequence of linkages between closeness and indicators of adjustment appeared to be largely similar across teachers and students: Both students' and teachers' perceptions of closeness in Grade 3 resulted in positive changes in students' motivational attitudes, task motivation, and in the case of student

reports, self-efficacy in Grade 6, after the stability in both constructs was controlled. Additionally, students' reading comprehension scores in Grade 3 predicted a higher degree of student-reported, but not teacher-reported, closeness in Grade 6. One explanation for these small differences is that some of the variance shared between closeness and motivation and reading comprehension might be attributed to source effects. Whereas students reported about their own motivational beliefs, teachers reported about students' attitudes, which might have led to a slight overestimation of effects.

Although we only included two waves of data on students' self-reports, our findings suggest that students' experiences of closeness in the relationship may have implications for their academic adjustment. Students who feel cared for are more likely to see themselves as academically capable. Presumably, such a positive sense of self may foster commitment to school and, ultimately, achievement (Furrer & Skinner, 2003). Yet, future research is needed to further disentangle these effects.

Limitations and Future Directions

Although our study has various strengths, including the use of three time points, exploration of transactional effects, and multiple reporters, there are several limitations that limit the inferences that can be drawn. A first important limitation pertains to the data-analytical methods used in this study. Similar to other studies in this field (e.g., Spilt et al., 2015), we made use of cross-lagged panel modeling to examine transactional associations among students' relationships with teachers, their motivational attitudes and beliefs, and academic performance. Yet, recent research suggests that such models might produce biased estimates, as they do not disaggregate changes between students from fluctuations within students across time (Hamaker, Kuiper, & Grasman, 2015). Controlling for time-invariant trait-like differences is, however, crucial in research on individual students' relationships and academic adjustment, as the application of findings from the aggregate (i.e., between-student) level to transactional effects on the student level may lead to an ecological fallacy (Curran & Bauer, 2011). Hence, it may very well be possible that the small-to-moderate pathways in our models might not hold for individual students as well. Given that such techniques require at least three time points for each variable in the model (Hamaker et al., 2015), we were unable to split the variance in stable traits between students and fluctuations within students. Therefore, it is strongly recommended to replicate the present study's findings at the within-person level, using random intercept cross-lagged panel modeling with at least three waves of data.

Second, although this study demonstrates temporal evidence of causality, we do not have experimental or quasiexperimental conditions allowing for causal inferences. We controlled for students' gender and ethnicity in this study, but there may be other important variables, including teachers' background characteristics, beliefs, and attitudes, as well as developmental factors, that might have affected the results of our study. These and other potentially relevant factors and processes may warrant consideration in future longitudinal studies, especially because different teachers rated the participating students at each wave. By using a unified framework of longitudinal models for reciprocal relations, in which cross-lagged paths and latent growth trajectories are combined (Usami,

Murayama, & Hamaker, 2019), a more informative portrayal of the hypothesized associations in our models may be obtained.

Third, the methods of data collection used in this study may also have influenced the findings. Although we did not exclusively rely on teacher reports for characterizing the quality of student-teacher relationships, only student-reported measures of closeness were available. However, these student reports appeared to be somewhat less reliable than teachers' perceptions of the degree of closeness in the relationship. Methodologically, the lower, but still sufficient reliability of the student-reported measure can be ascribed to the notion that experiences of warmth and affection are not easy to recognize, as this requires a greater sense of knowing the feelings and needs of the teacher within the dyad (cf. Hughes, 2011; Zee & Koomen, 2017). As students' awareness of their own and their teachers' thoughts, beliefs, desires, and emotions may not yet be fully developed, it might have been quite difficult for them to identify such internalized qualities of the relationship. Moreover, differences in reliability may also stem from the fact that teachers rated multiple students, but multiple students rated a single teacher. Therefore, it is recommended that future research should take account of multidimensional measures of relationship quality, including not only closeness but also conflict and dependency, or use observational measures to explain potential differences in the complex pathways from relationship quality to school adjustment.

Last, it should be noted that we had student-reported data in Grades 3 and 6 only. This lack of data in kindergarten is due to the generally low reliability and validity of reports of students below age 8 and young students' inability to answer abstract questions with respect to relationship quality and motivation (cf. Hughes, 2011). Several researchers have argued, however, that at least three time points are necessary to establish mediating pathways (Little, 2013). In any attempt to replicate the results it is therefore recommended that future researchers consider using different measures that can be used in samples of young children as well, such as the Young Children's Appraisals of Teacher Support (Y-CATS; Mantzicopoulos & Neuharth-Pritchett, 2003), in order to gain insight into young children's perceptions of relationship quality.

Implications for Research and Practice

Findings reported here have significant implications for practice not only in the Netherlands, but also more broadly as they are congruent with research conducted in educational settings in the Western world. First, this study is probably one of the first to empirically support the dynamic systems view that the quality of student-teacher relationships, students' motivational attitudes and beliefs, and their academic achievement inform one another across time (Pianta et al., 2003; O'Connor, 2010). Thereby, this study builds on the growing body of work pointing to the important role that positive student-teacher relationships have for students' school success across the elementary years. Not only do student-teacher relationships portend academic success, they are also a mechanism by which students feel more confident and engaged in academic content. Thus, teaching teachers' skills for fostering high-quality relationships with their students will likely deliver a valuable return on investment in terms of student success. We also see from these results that student-teacher relationships appear to have impact across the elementary grades, so interventions and

professional development for teachers that promote improved relationship quality would be beneficial at any grade level.

Second, our findings extend prior theory and empirical research on student–teacher relationship quality by illustrating how the direction of associations between students’ relationships with teachers and their academic adjustment vary across informants and different dimensions of motivational beliefs, academic subjects, and relationship quality. Whereas there were no notable differences in how teachers’ and students’ perceptions of closeness are related to students’ academic adjustment, we did find some support for potential differences in pathways across motivational domains, relationship quality, and academic subjects. Most importantly, our models did support the presence of transactional pathways among negative, but not positive aspects of the student–teacher relationship and students’ adjustment. These findings support the idea that closeness, conflict, and dependency each assess unique aspects of the student–teacher relationship quality, instead of falling along an underlying continuum (Verschuere & Koomen, 2012) and are therefore likely to be differently associated with students’ academic achievement.

Hence, to advance understanding of how students’ relationships with teachers, their motivational attitudes and beliefs, and academic achievement inform one another across the elementary school years, future studies should consider different aspects of the student–teacher relationship.

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