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Teacher–Student Support, Effortful Engagement, and Achievement: A 3-Year Longitudinal Study

Jan N. Hughes, **Wen Luo**, **Oi-Man Kwok**, and **Linda K. Loyd**
Department of Educational Psychology, Texas A&M University.

Abstract

Measures of teacher–student relationship quality (TSRQ), effortful engagement, and achievement in reading and math were collected once each year for 3 consecutive years, beginning when participants were in 1st grade, for a sample of 671 (53.1% male) academically at-risk children attending 1 of 3 school districts in Texas. In separate latent variable structural equation models, the authors tested the hypothesized model, in which Year 2 effortful engagement mediated the association between Year 1 TSRQ and Year 3 reading and math skills. Conduct engagement was entered as a covariate in these analyses to disentangle the effects of effortful engagement and conduct engagement. Reciprocal effects of effortful engagement on TSRQ and of achievement on effortful engagement were also modeled. Results generally supported the hypothesized model. Year 1 variables had a direct effect on Year 3 variables, above year-to-year stability. Findings suggest that achievement, effortful engagement, and TSRQ form part of a dynamic system of influences in the early grades, such that intervening at any point in this nexus may alter children's school trajectories.

Keywords

student–teacher relationship; academic engagement; reading; math; elementary grades

Children's academic achievement in the early grades forecasts academic and mental health outcomes throughout their school years and into early adulthood (Alexander, Entwisle, & Horsey, 1997; Campbell, Helms, Sparling, & Ramey, 1998; Entwisle & Alexander, 1988; Finn, 1989; Roeser, Eccles, & Freedman-Doan, 1999; Stevenson & Newman, 1986). Given the importance of a good academic start to school, many researchers have investigated factors that affect children's school readiness skills and early academic trajectories (for reviews, see Future of Children, 2005; Perry & Weinstein, 1998; Shonkoff & Phillips, 2000). Whereas researchers previously focused on child and family contributors to early achievement, recent investigations have assessed the impact of aspects of the classroom and school context that promote or impede children's achievement (Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002; Crosnoe, Johnson, & Elder, 2004; National Institute of Child Health and Human Development Early Child Care Research Network, 2003; Rimm-Kaufman & Pianta, 2000; Roeser et al., 1999). Teacher–student relationship quality (TSRQ) has emerged as an important aspect of the elementary classroom context that has implications for children's concurrent and future academic and social adjustment in school (Birch & Ladd, 1997, 1998; Howes, Hamilton, & Matheson, 1994; Pianta, Steinberg, & Rollins, 1995).

Researchers employing longitudinal designs have found that students who experience teacher–student interactions characterized by high levels of warmth and support or low levels of conflict

Correspondence concerning this article should be addressed to Jan N. Hughes, Texas A&M University, 701 Harrington Building, 4225 TAMU, College Station, TX 77843-4225. E-mail: E-mail: jhughes@tamu.edu.

gain more in achievement (Connell & Wellborn, 1991; Hamre & Pianta, 2001; Hamre, Pianta, & Downer, 2006; Ladd, Birch, & Buhs, 1999; Pianta & Stuhlman, 2004; Skinner, Zimmer-Gembeck, & Connell, 1998). However, to capitalize on the potential of this classroom resource for improving young children's achievement trajectories, it is important to identify the more proximal mechanisms by which the teacher–student relationship affects achievement. Several investigators have suggested that students who experience an accepting and warm relationship with their teachers will be more capable and motivated to comply with classroom rules and teacher expectations (Brophy, 1983; Furrer & Skinner, 2003; Gest, Welsh, & Domitrovich, 2005; Wentzel, 1998). This increased engagement in classroom learning activities, in turn, is expected to lead to greater achievement gains.

Despite the intuitive appeal of this reasoning, the empirical support for such an indirect model of the effects of TSRQ in the early grades is limited in several ways. First, few studies have employed longitudinal designs that maintain temporal precedence consistent with the hypothesized causal pathways (i.e., TSRQ → engagement → achievement) and statistical controls for prior levels of both engagement and achievement (Skinner et al., 1998). These methodological limitations reduce confidence in conclusions about mediating processes because alternative causal linkages cannot be ruled out (Cole & Maxwell, 2003). Second, the few studies that have been conducted with children in the early school grades have employed measures of classroom engagement that combine different types of engagement (Ladd et al., 1999), thereby making it impossible to disentangle the unique contribution of each type (Fredricks, Blumenfeld, & Paris, 2004). Third, studies have failed to test for the reciprocal effect of engagement on TSRQ. Consistent with transactional (Sameroff, 1975) and developmental systems (Lerner, 1989, 1998) theories, developmental change results from the dynamic interaction between individuals and contexts. Thus, unidirectional models are likely to be inadequate representations of developmental processes.

The purpose of this study was to test an indirect model of the effect of TSRQ on first-grade children's academic achievement over a 3-year period, beginning when children were in first grade. The conceptual model, presented in Figure 1, predicted that TSRQ at Year 1 would affect achievement at Year 3 and that this effect would be mediated by the effect of TSRQ at Year 1 on effortful engagement (i.e., persistence, effort, attention) at Year 2. The model included reciprocal causal paths from effortful engagement to TSRQ and from achievement to effortful engagement. To test the unique contribution of effortful engagement to achievement, above the effects of antisocial or conduct engagement, the model also controlled for the effects of prior levels of conduct engagement on Year 3 achievement. Before we review the theoretical and empirical bases for the hypothesized model, we address the multifarious definitions of classroom engagement and the importance of distinguishing between different types of engagement.

Definitions and Types of Classroom Engagement

Although an extensive literature dating from the 1960s has investigated school and classroom engagement, the construct of engagement has experienced something of a revival in recent years, stimulated by the growing recognition that student disaffection with school increases with additional years in school and is a major factor in student achievement and dropping out of school (Fredricks et al., 2004). In their thorough review of school engagement, Fredricks et al. (2004, p. 60) identified three broad types of school and classroom engagement: *behavioral engagement* (involvement in academic and social or extracurricular activities), *emotional engagement* (positive and negative reactions to people and activities at school), and *cognitive engagement* (similar to the ideas of investment in learning and intrinsic motivation). Whereas emotional and cognitive engagement have been emphasized in research with middle school and high school students (Connell & Wellborn, 1991; Finn, 1989; Midgley, Feldlauffer, &

Eccles, 1989; Ryan, Stiller, & Lynch, 1994; Skinner & Belmont, 1993), behavioral engagement has tended to be the focus of research with elementary students (Alexander, Entwisle, & Dauber, 1993; Birch & Ladd, 1997; Buhs & Ladd, 2001; Miles & Stipek, 2006) and is the focus of the current study. Fredricks et al. (2004) further divided behavioral engagement into three subtypes: conduct, involvement in learning tasks, and participation in extracurricular activities. Studies with elementary students have focused on the first two subtypes of behavior engagement. Conduct engagement is variously defined in terms of antisocial and prosocial behaviors and compliance with classroom rules (Alexander et al., 1993; Gest et al., 2005; Ladd et al., 1999; Miles & Stipek, 2006; Normandeau & Guay, 1998; Trzesniewski, Moffitt, Caspi, Taylor, & Maughan, 2006; Wentzel, 1998). Involvement in learning has been variously defined by "time on task" (Gettinger, 1985; Greenwood, 1991; Rimm-Kaufman, La Paro, Downer, & Pianta, 2005) and by effort, attention, self-direction, and persistence in the classroom (Connell & Wellborn, 1991; Furrer & Skinner, 2003; Ladd et al., 1999; Normandeau & Guay, 1998; Skinner & Belmont, 1993).

Because researchers studying the effects of school and classroom engagement on achievement have differed in their definitions and measures of engagement, it is difficult to integrate findings across studies. Often, researchers incorporated a wide variety of constructs in their measurement of engagement, an inclusiveness that makes it difficult to determine the unique precursors and consequences of different types of engagement. In the current study, we assess both conduct engagement and effortful engagement, a construct similar to involvement in learning. *Effortful engagement* refers to the volitional, or effortful, aspect of involvement in instructional activities and includes trying hard, not giving up in the face of difficulty, and directing one's attention to instructional activities. Similar to effortful control (Rothbart & Ahadi, 1994; Rothbart & Bates, 1998; Rothbart & Jones, 1998), effortful engagement is viewed as having a basis in an individual's temperamental impulsivity and attentional capacities yet emerging as a result of the transactions between the child and his or her environment across time. Thus, we expect that effortful engagement will evince moderate stability across time and contexts. Our particular interest is in the effect of the quality of the teacher–student relationship on changes in children's levels of effortful engagement in the classroom and, consequently, on children's academic achievement.

Effect of Effortful Engagement on Achievement

Longitudinal investigations have documented that high levels of antisocial engagement (or low levels of prosocial behavior) predict declining academic performance (Feldhusen, Thurston, & Benning, 1970; Huesmann, Eron, & Yarmel, 1987; Miles & Stipek, 2006; National Institute of Child Health and Human Development Early Child Care Research Network, 2004; Trzesniewski et al., 2006; Wentzel, 1991). Conversely, high levels of effortful engagement predict improving academic performance (Alexander et al., 1993; Greenwood, 1991; Skinner et al., 1998). However, few researchers have investigated the relative or unique associations between these two types of engagement and achievement (Alexander et al., 1993). Recently, researchers (Miles & Stipek, 2006; Trzesniewski et al., 2006) have speculated that the often found association between antisocial or aggressive conduct and achievement may be due to a "third variable" related both to aggression and achievement, such as cognitive self-control or self-regulated learning behaviors. To the extent that measures of conduct and self-regulated (i.e., effortful) engagement are correlated, the third variable explanation is more plausible. In samples of primary-grade children, Ladd et al. (1999) reported a correlation of .64 between cooperative participation and self-regulated participation, and Normandeau and Guay (1998) reported a correlation of – .51 between aggressive behavior and cognitive self-control, a construct similar to effortful engagement. In their longitudinal study, Normandeau and Guay (1998) found that the effect of conduct engagement in kindergarten on grades 1 year later was accounted for by the effect of conduct engagement on teacher-rated cognitive self-control (e.g.,

the student sticks to what he or she is doing until finished, persists in face of failure, has to be reminded several times to do something before doing it). On the basis of these findings and the reasoning that effortful engagement in school learning is more directly related to student mastery of subject matter content than is conduct engagement, we expected that only effortful engagement would uniquely predict subsequent achievement.

Effect of TSRQ on Effortful Engagement

Researchers have drawn from diverse theoretical conceptualizations in explaining the processes that account for the effect of TSRQ on students' effortful engagement and achievement. On the basis of attachment theory perspectives (Bowlby, 1980), a close and supportive relationship with one's teacher would be expected to promote a child's emotional security and confidence. A secure relationship with the teacher may serve as a resource that permits young students to actively explore their environment and to cope more effectively with novel academic and social demands (Howes et al., 1994; Pianta & Steinberg, 1992). Drawing from this reasoning, Little and Kobak (2003) expected and found that among elementary children, emotional security with the teacher attenuated children's stress reactivity to negative teacher and peer events in the classroom.

Also on the basis of parenting and motivational literature, children who experience warm and close parent–child relationships are more motivated to please their parents and more likely to internalize their parents' values (Dix, 1991; Grusec & Kuczynski, 1997). In a short-term longitudinal study of children in Grades 3–5, teacher support predicted students' liking for school and buffered children with externalizing problems from becoming disaffected with school (Gest et al., 2005). Presumably, children who experience warm and close relationships with their teachers are more likely to identify with school and invest in the school's agenda. Finally, literature on the development of self-regulation (Eisenberg et al., 2005) also supports the view that TSRQ influences children's attention and self-regulation in the classroom. A negative teacher–student relationship might elicit negative emotions in children that interfere with attention and self-regulation (Blair, 2002), whereas a supportive teacher–student relationship might elicit positive moods that promote effective problem solving, regulation, and interactions with others (Isen, Daubman, & Norwicki, 1987; Pianta, 2006).

Reciprocal Effects Among TSRQ, Effortful Engagement, and Achievement

Consistent with transactional models of development (Sameroff, 1975, 1989), we believe achievement in the early grades is the result of the unfolding of reciprocal processes, such that children's engagement both influences and is influenced by TSRQ and academic competencies. Previous researchers have demonstrated an effect of student antisocial conduct on TSRQ (Birch & Ladd, 1997, 1998; Ladd et al., 1999; Pianta & Steinberg, 1992; Pianta & Stuhlman, 2004). Similarly, it is reasonable to expect that teachers will also find it easier to show support and affection to students who try hard and attend to instructions. It is also likely that children's academic achievement affects, and is affected by, their effortful engagement. For example, Miles and Stipek (2006) found that poor literacy skills in first grade predicted antisocial conduct in third grade. Also supportive of the view that academic performance affects classroom engagement is the finding that academically focused interventions result in improvements in conduct as well as academic skills (Ayllon & Roberts, 1974; Coie & Krehbiel, 1984).

Study Hypotheses and Approach

The primary purpose of this study was to test an indirect model of the effects of TSRQ on reading and math achievement via the direct effect of TSRQ on effortful engagement over a 3-year period (beginning when children were in first grade). As Cole and Maxwell (2003) asserted, "a fundamental requirement for one variable to cause another is that the cause must

precede the outcome in time" (p. 559). Thus, in testing mediational models with structural equation modeling (SEM), the researcher would ideally collect data on the cause, the mediator, and effect at each of three or more time points (or waves). Such a design not only permits strong assumptions about indirect effects but also permits testing of stationarity and stability of effects, lag effects, and reciprocal causal pathways across children's first 3 years of postkindergarten education.

Stationarity implies that the degree to which one set of variables produces change in another set remains the same over time. Perhaps TSRQ in first grade is more important to engagement in Year 2 than TSRQ in Year 2 is to engagement in Year 3. A finding of stronger structural relations between TSRQ and engagement earlier versus later in students' first 3 years of school would be consistent with the view that the quality of children's relationships with their teachers at the beginning of their formal schooling sets in motion patterns of engagement that quickly become self-sustaining. *Stability of effects* refers to the degree to which the within-wave correlations are of the same magnitude at different points in development. *Lag effects* refers to the direct effects of Year 1 variables on Year 3 variables, above the year-to-year stability in the variables. For example, perhaps children's relationships with their first-grade teachers continue to influence their social relatedness with future teachers, above the year-to-year stability in teacher relatedness. Finding such a lag effect for TSRQ would be consistent with the view that children's early relationships with teachers are carried forward as mental representations (Bretherton, 1985) to subsequent relationships with teachers and might explain, in part, the long-term prediction of achievement on the basis of TSRQ in first grade (Pallas, Entwisle, Alexander, & Cadigan, 1987).

The decision to test separate models with reading and math achievement as outcomes instead of using a latent or a composite measure of achievement was based on previous findings that behavior problems predicted reading achievement more strongly than math achievement (Adams, Snowling, Hennessy, & Kind, 1999; DuPaul et al., 2004; Joussemet, Koestner, Lekes, & Landry, 2005). Additionally, because much more time is spent in literacy than in math instruction in early elementary classrooms (National Institute for Child Health and Human Development Early Child Care Research Network, 2003), TSRQ and child engagement might be more predictive of reading than of math achievement.

We also tested whether gender or ethnicity moderated the structural relations in the SEM. Some researchers have found that minority and/or low-socioeconomic status children (Burchinal et al., 2002; Meehan, Hughes, & Cavell, 2003) and boys (Skinner et al., 1998) benefited more from a supportive teacher–student relationship than did majority children or girls. Other researchers, however, have found no evidence that these demographic variables moderate the relationship between TSRQ and child outcomes (Pianta & Stuhlman, 2004; Silver, Measelle, Armstrong, & Essex, 2005).

We investigated these questions in a culturally and linguistically diverse sample of academically at-risk first-grade children. Children were deemed academically at risk on the basis of scoring below their school district median on a measure of literacy given at the beginning of first grade. Children with relatively low literacy skills in first grade are likely to experience more relational and academic stressors (Ladd et al., 1999; A. J. Reynolds & Bezruczko, 1993). When provided a supportive teacher presence, these children are expected to cope better with stressors and to participate more actively and appropriately in classroom activities, consequently gaining more in achievement. For these reasons, students with low literacy skills represent a population of considerable importance with respect to the effect of teacher support on children's behavioral engagement and academic achievement.

Previously published findings with this longitudinal sample have reported associations between TSRQ, effortful engagement, and achievement using two waves of data (Hughes & Kwok, 2006, 2007). Hughes and Kwok (2006) also reported a mediating role for TSRQ in accounting for the association between students' African American status and effortful engagement. The current study extends these findings by assessing each construct at each of three waves (years) of data, which permits a strong test of mediation, reciprocal effects, and stationarity and stability of effects. Additionally, the current study investigates the unique effects of two types of behavioral engagement, conduct and effortful engagement, on achievement.

Method

Participants

Participants were drawn from a larger sample of children participating in a longitudinal study examining the impact of grade retention on academic achievement. Participants were recruited from three school districts in Texas (one urban and two small city) across two sequential cohorts in first grade during the fall of 2001 and 2002. The composition of the urban school was 41% White non-Hispanic, 37% economically disadvantaged, and 11% limited English proficient. Enrollment of one of the small city schools was 40% White non-Hispanic, 61% economically disadvantaged, and 11% limited English proficient. The enrollment of the second small city school was 69% White non-Hispanic, 24% economically disadvantaged, and 5.2% limited English proficient. Children were eligible to participate in the longitudinal study if they scored below the median on a state-approved, district-administered measure of literacy; spoke either English or Spanish; were not receiving special education services; and had not been previously retained in first grade. School records identified 1,374 children as eligible to participate. Because teachers distributed consent forms to parents via children's weekly folders, the exact number of parents who received the consent forms cannot be determined. Incentives, in the form of small gifts to children and the opportunity to win a larger prize in a drawing, were instrumental in obtaining 1,200 returned consent forms, of which 784 (65%) provided consent.

Analyses on a broad array of archival variables, including performance on the district-administered test of literacy (standardized within district, because of differences in test used), age, gender, ethnicity, eligibility for free or reduced-price lunch, bilingual class placement, cohort, and school context variables (i.e., percentage ethnic/racial minority, percentage economically disadvantaged), did not indicate any difference between children with and without consent. Although we cannot rule out differences between consenters and nonconsenters on variables not included in our data, we can conclude that the resulting sample of 784 participants (52.6% male) closely resembles the eligible sample on demographic and literacy variables relevant to students' educational performance. Of the 784 recruited children, 350 (44.6%) had complete data on all analysis variables assessed at all three occasions (i.e., first grade and 1 and 2 years later), and 671 (85.6 %) had data on at least one of the analysis variables at each occasion. Attrition analyses showed that the 350 children with complete data did not differ from the 434 without complete data on demographic variables or study variables at baseline, which supports the assumption that data were missing at random. The overall rate of missingness for the 671 participants with some data at each assessment wave was 12.7%. The 671 participants did not differ from the remaining 113 participants on demographic or study variables at baseline. On the basis of these findings, we imputed the missing value based on these 671 children using SAS PROC MI.

Of these 671 participants, 356 (53.1%) were male, and the racial/ethnic composition was 34.9% White, 36.7% Hispanic, 23.5% African American, and 4.9% Asian/Pacific Islander. At entrance to first grade, children's mean age was 6.57 (SD = 0.38) years. Children's mean score for intelligence as measured with the Universal Nonverbal Intelligence Test (McCallum &

Bracken, 1997) was 92.89 (*SD* = 14.43). On the basis of family income, 58.0% of participants were eligible for free or reduced-price lunch. For 35.1%, the highest educational level in the household was a high school certificate or less. The ethnic/racial composition for the 337 teachers (94.1% female) completing the teacher questionnaires was 81.3% White, 14.5% Hispanic, 2.7% African American, and 1.5% other ethnicities. The mean teaching experience was 4.42 years (*SD* = 1.82), and 100% of teachers held teacher certification. All teachers had at least a bachelor's degree; 57.6% had done at least some graduate work.

Design Overview

Assessments were conducted annually for 3 years, beginning when participants were in first grade. Teacher questionnaires assessing teachers' perceptions of the student–teacher relationship and of child engagement were administered in the spring of each year. Teachers received $25 for completing and returning the questionnaires. Measures of math and reading achievement were individually administered at school at varying times during the school year, with the constraint that at least 8 months separated each annual assessment.

Measures

Academic achievement—The Woodcock–Johnson III (WJ-III) Tests of Achievement (Woodcock, McGrew, & Mather, 2001) is an individually administered measure of academic achievement for individuals 2 years of age to adulthood. The WJ-III Broad Reading age standard scores (Letter–Word Identification, Reading Fluency, and Passage Comprehension subtests) and the WJ-III Broad Math age standard scores (Calculations, Math Fluency, and Math Calculation Skills subtests) were used. Extensive research documents the reliability and construct validity of scores on the WJ-III and its predecessor (Woodcock & Johnson, 1989; Woodcock et al., 2001).

The Batería Woodcock–Muñoz: Pruebas de Aprovechamiento—Revisada (Batería-R; Woodcock & Muñoz-Sandoval, 1996) is the comparable Spanish version of the Woodcock–Johnson Tests of Achievement—Revised (Woodcock & Johnson, 1989), the precursor of the WJ-III. If children or their parents spoke any Spanish, children were administered the Woodcock–Muñoz Language Test (Woodcock & Muñoz-Sandoval, 1993) to determine the child's language proficiency in English and Spanish and selection of either the WJ-III or the Batería-R. The Woodcock Compuscore (Woodcock & Muñoz-Sandoval, 2001) program yields scores for the Batería-R that are comparable to scores on the Woodcock–Johnson Tests of Achievement—Revised. The Broad Reading and Broad Mathematics WJ-III scores were used in this study.

Effortful engagement—The teacher-report, 10-item effortful engagement scale was composed of 8 items from the Conscientiousness scale of the Big Five Inventory (John & Srivastava, 1999) and 2 items taken from the Social Competence Scale (Conduct Problems Prevention Research Group, 2004) that were consistent with our definition of academic engagement (effort, attention, persistence, and cooperative participation in learning). Although the Big Five Inventory is conceptualized as a measure of personality traits, the selected items from the Conscientiousness scale are similar to items used by other researchers to assess academic engagement (Ladd et al., 1999; Ridley, McWilliam, & Oates, 2000). Items were rated on a 1–5 Likert-type scale. The internal consistency of these 10 items for our sample was .95.

Conduct engagement—The teacher-rated measure of conduct (antisocial) engagement was derived from a 24-item questionnaire adapted from the California Child Q-Sort, a language-simplified personality inventory for use by nonprofessionals (Caspi, Block, Block, & Klopp, 1992). Our modification involved use of a rating scale versus Q-sort methodology and a reduction in the number of items from 100 to 24. These 24 items were selected on the basis of

previous research demonstrating that they were consistently rated as prototypical of children with high levels of impulsivity and externalizing behaviors (Funder, Block, & Block, 1983). All items were rated on a 1–5 Likert scale.

We applied a cross-validation approach to examine the underlying structure because of the unclear factor structure of the measure (B. Thompson, 2004). The Year 1 data set (n = 344) was randomly split into two even halves. We performed an exploratory factor analysis using principal-axis factoring with Promax rotation for the first half of the data; this resulted in a 15-item measure with four factors (9 items were deleted because of high cross-loadings). We then cross-validated the factor structure found from this analysis by performing confirmatory factor analysis on the second half data. Results of the confirmatory factor analysis confirmed the four-factor model, $\chi^2(112, n = 339) = 225.7$, $p < .001$ (comparative fit index [CFI] =.97, root-mean-square error of approximation [RMSEA] = .05, standardized root-mean-square residual [SRMR] = .04), and this four-factor model fitted a second sample adequately, $\chi^2(112, n = 301) = 241.0$, $p < .001$ (CFI = .96, RMSEA = .06, SRMR = .05). The four factors were as follows: Prosocial, Antisocial, Ego Resiliency, and Ego Brittle. Model fit was invariant across cohorts and across Waves 1 and 2. Because the Prosocial (4 items; $\alpha = .93$) and Antisocial (4 items; $\alpha = .86$) scales were strongly correlated (standardized path coefficient = .90), we computed a single conduct scale as the mean of the Antisocial and Prosocial (reverse coded) scales. Example Prosocial items included “considerate and thoughtful” and “gets along well with other children.” Example Antisocial items included “physical or verbal aggression” and “tries to take advantage of others.”

Teacher-reported teacher–student relationship—The 22-item Teacher Student Relationship Inventory (TSRI; Hughes, Cavell, & Willson, 2001) is based on the Network of Relationships Inventory (Buhrmester & Furman, 1987). Teachers indicate on a 5-point Likert-type scale their level of support (16 items) or conflict (6 items) in their relationships with individual students. An exploratory factor analysis using principal-axis factoring with Promax rotation on 335 first-grade participants from the second cohort suggested three factors: Support (13 items), Intimacy (3 items), and Conflict (6 items). Results of confirmatory factor analysis on 449 first-grade participants from the first cohort found that the three-factor model provided an adequate fit for the data, $\chi^2(204) = 697.803$, $p < .001$ (CFI = .92; RMSEA = .074). Furthermore, the null hypothesis of factor invariance across cohorts and times could be retained at the .01 level. Because the Intimacy scale was deemed less relevant to TSRQ, only the Support and Conflict scales were used in the current study. Example Support scale items ($\alpha = .94$) included “I enjoy being with this child,” “This child gives me many opportunities to praise him or her,” and “This child talks to me about things he/she doesn’t want others to know.” Example Conflict scale items ($\alpha = .91$) included “This child and I often argue or get upset with each other” and “I often need to discipline this child.” In a longitudinal study of behaviorally at-risk elementary students, the TSRI predicted changes in behavioral adjustment and peer relationships (Meehan et al., 2003).

Results

Sample Descriptive Statistics and Intercorrelations

Using multiple imputation, we generated five complete data sets. For simplicity, the sample statistics are reported only for the first data set. Table 1 presents means and standard deviations for analysis variables broken down by gender and ethnicity. Table 2 presents the correlations among the analysis variables. For all the five imputed data sets, we used Green’s (1992) SEM approach to examine the stability of the within-wave correlations across the assessment periods. Green’s method is an SEM-based method to test whether correlation matrices are different from each other for either independent or dependent samples. We tested two models.

Model 1 was an unconstrained model in which the within-wave correlations were freely estimated. Model 2 was a constrained model in which the within-wave correlations were constrained to be equal across waves. Then we conducted a chi-square difference test to test whether Model 2 was significantly worse than Model 1. The result was nonsignificant, indicating that we could assume the within-wave correlations were equal across waves. All within-wave correlations were invariant over time for the reading and math models.

Gender and Ethnic Differences

Significant gender differences were found on the measured variables on the basis of the results of one-way multivariate analysis of variance. Over the five imputed data sets, the average F (17, 653) was 7.01 with a standard deviation of 0.35, and the significance value was less than .01. Girls performed better than boys on TSRI Support: for Year 1, $F(1, 669) = 13.01$ (SD = 2.91), $p < .001$ (ES = .28); for Year 2, $F(1, 669) = 18.23$ (SD = 1.80), $p < .001$ (ES = .33); and for Year 3, $F(1, 669) = 13.67$ (SD = 2.79), $p < .001$ (ES = .28). Girls also outperformed boys on TSRI Conflict: for Year 1, $F(1, 669) = 33.16$ (SD = 5.60), $p < .001$ (ES = .44); for Year 2, $F(1, 669) = 31.54$ (SD = 4.15), $p < .001$ (ES = .43); and for Year 3, $F(1, 669) = 47.85$ (SD = 4.97), $p < .001$ (ES = .53). In addition, girls scored higher than boys on effortful engagement: for Year 1, $F(1, 669) = 40.36$ (SD = 1.68), $p < .001$ (ES = .49); for Year 2, $F(1, 669) = 29.86$ (SD = 2.97), $p < .001$ (ES = .42); and for Year 3, $F(1, 669) = 38.08$ (SD = 3.76), $p < .001$ (ES = .48). Finally, girls outperformed boys on conduct engagement: for Year 1, $F(1, 669) = 13.73$ (SD = 2.35), $p < .001$ (ES = .29); and for Year 2, $F(1, 669) = 13.87$ (SD = 1.17), $p < .001$ (ES = .29). Girls also had higher reading scores at Time 1, $F(1, 669) = 10.86$ (SD = 0.25), $p < .004$ (ES = .22).

Significant racial/ethnic differences were also found on the measured variables. The average $F(17, 653)$ was 7.49 with a standard error of 0.13, and the significance value was less than .01. Caucasian students performed better on the Time 3 reading test, $F(1, 669) = 16.82$ (SD = 0.72), $p < .001$ (ES = .32), and on math tests at all three time points: for Year 1, $F(1, 669) = 82.29$ (SD = 1.55), $p < .001$ (ES = .70); for Year 2, $F(1, 669) = 72.99$ (SD = 2.93), $p < .001$ (ES = .66); and for Year 3, $F(1, 669) = 51.92$ (SD = 1.13), $p < .001$ (ES = .55).

Measurement Model for TSRQ

Confirmatory factor analyses were used to examine the factor structure for a teacher-only report of TSRQ (N = 671). The latent construct of TSRQ at each occasion was indicated by the TSRI Support and Conflict scales. The items of the Conflict scale were reverse coded so that a high score indicated low conflict between students and their teachers. To account for the dependency among observations (students) within clusters (classrooms), we conducted all analyses using the "complex analysis" feature in Mplus (Version 3.13; Muthén & Muthén, 2004), in which the models were estimated via the maximum likelihood estimation method with robust standard errors (Muthén & Muthén, 2004). The model fitted the data adequately, with the average $\chi^2(7) = 32.54$ (SD = 8.52), $p < .01$, the average CFI = .98 (SD = .01), the average RMSEA = .07 (SD = .01), and the average SRMR = .03 (SD = .004). All the model estimated loadings were significant in a positive direction.

We also examined the invariance of factor loadings of the TSRQ model over time by comparing the chi-square statistics between models with and without constraining the factor loadings of the same indicators to be equal across waves. The difference in chi-square was not significant, $\Delta\chi^2(2) = 0.36$, $p = .83$, suggesting that the relations between the two indicators and the latent construct were invariant over time. On the basis of the above time-invariant model, we further examined the factor loading invariance of the TSRQ model between different gender and ethnic groups using the multiple-group comparison approach under the SEM framework. The chi-square difference was significant between different gender groups, $\Delta\chi^2(1) = 6.21$, $p = .01$. The

average standardized factor loadings of TSRI Conflict and TSRI Support were .90 and .67, respectively, for the girls across waves and .92 and .63, respectively, for the boys across waves. Despite a statistically significant chi-square difference test, the magnitudes of the factor loadings were highly similar for boys and girls, which suggested that the construct of TSRQ was still comparable for girls and boys. There was no significant chi-square difference between different ethnic groups, $\Delta\chi^2(1) = 0.001$, $p = .98$, which suggests that the pattern of relations between the two indicators and the latent construct was no different between the majority and minority students.

Structural Equation Models

Math achievement—We first tested the hypothesized three-wave longitudinal model (see Figure 1) with math achievement as the target outcome. In Figure 1, TSRQ at earlier waves (e.g., TSRQ at Year 1) predicted student effortful engagement at later waves (e.g., engagement at Year 2), with controls for the prior level of effortful engagement (e.g., engagement at Year 1). Similarly, effortful engagement at earlier waves (e.g., engagement at Year 2) predicted student achievement measured at later waves (e.g., achievement at Year 3), with controls for prior levels of achievement (e.g., achievement at Year 2). The model also included reciprocal paths from prior achievement (e.g., achievement at Year 1) to later effortful engagement (e.g., engagement at Year 2) and from prior effortful engagement (e.g., engagement at Year 2) to later TSRQ (e.g., TSRQ at Year 3). Conduct engagement at Wave 1 and conduct engagement at Wave 2 were included in the model as covariates that predicted the achievement at Waves 2 and 3, respectively.

The results of the hypothesized model with math achievement are presented in Figure 2. The errors of within-wave variables were allowed to correlate because they significantly improved the model fit without substantially changing the magnitudes of other parameter estimates (Bentler, 2000). The model of the math achievement fitted the data adequately, with the average $\chi^2(49) = 236.34$ ($SD = 14.34$), $p < .001$, the average CFI = .96 ($SD = .003$), the average RMSEA = .08 ($SD = .003$), and the average SRMR = .06 ($SD = .002$). Next, we conducted a series of chi-square difference tests to investigate stationarity of the effects in the hypothesized model. The effects of prior effortful engagement on later effortful engagement, prior math achievement on later math achievement, prior effortful engagement on later math achievement, and prior math achievement on later effortful engagement exhibited stationarity across Times 1 and 2 as well as Times 2 and 3: (a) engagement at Year 1 → engagement at year 2 versus engagement at Year 2 → engagement at Year 3, $\Delta\chi^2(1) = 1.41$, $p = 24$; (b) math at Year 1 → math at Year 2 versus math at Year 2 → math at Year 3, $\Delta\chi^2(1) = 1.58$, $p = 21$; (c) engagement at Year 1 → math at Year 2 versus engagement at Year 2 → math at Year 3, $\Delta\chi^2(1) = 0.91$, $p = .34$; (d) math at Year 1 → engagement at Year 2 versus math at Year 2 → engagement at Year 3, $\Delta\chi^2(1) = 1.11$, $p = .29$. The effects of prior TSRQ on later TSRQ and effortful engagement and the reciprocal effect of prior effortful engagement on later TSRQ were not stationary: (a) TSRQ at Year 1 → TSRQ at Year 2 versus TSRQ at Year 2 → TSRQ at Year 3, $\Delta\chi^2(1) = 27.09$, $p < .001$; (b) TSRQ at Year 1 → engagement at Year 2 versus TSRQ at Year 2 → engagement at Year 3, $\Delta\chi^2(1) = 28.22$, $p < .001$; (c) engagement at Year 1 → TSRQ at Year 2 versus engagement at year 2 → TSRQ at Year 3, $\Delta\chi^2(1) = 19.34$, $p < .001$.

After taking stationarity into consideration, we obtained a simpler model (i.e., a model with more degrees of freedom because the paths were constrained to be the same across time) that fitted the data equally well, with average $\chi^2(53) = 239.79$ ($SD = 12.56$), $p = .001$, average CFI = .96 ($SD = .003$), average RMSEA = .07 ($SD = .002$), average SRMR = .07 ($SD = .002$). The model with parameter estimates is shown in Figure 2. To provide a clear picture of the major findings, we did not include the covariance estimates between the exogenous variables and the covariance estimates between the residuals within and across waves in Figure 2 but present

these estimates in Table 3. In Figure 2, all the unstandardized parameter estimates and the standardized estimates (presented in the parentheses) were the average values over the five imputed data sets. The unstandardized parameter estimates were tested according to the method developed by Schafer (1997). Nonsignificant paths are indicated by the dashed lines in the figure.

To test the effect of Time 1 TSRQ on Time 3 math achievement mediated by Time 2 effortful engagement, we adopted the method developed by MacKinnon, Lockwood, and Williams (2004) to calculate the confidence interval for the mediation effect. If the confidence interval does not include zero, the mediation effect is significant at $p < .05$. The point estimate of the mediation effect was .45; the 95% confidence interval of the target mediation effect (i.e., TSRQ at Year 1 → engagement at Year 2 → math at Year 3; confidence interval = .22, .75) indicated that this mediation effect was significant. The direct effect between TSRQ at Year 1 and math at Year 3 became nonsignificant after we included engagement at Year 2 in the model, which implies that the effect of teacher student–relationship on math achievement was fully mediated through effortful engagement. To obtain an effect size estimate of the mediation effect, we calculated the change in squared multiple correlation for the model with and without the two paths that constituted the mediation effect ($\Delta R^2 = .01$). The effects of conduct engagement on math (i.e., conduct engagement at Year 1 → math at Year 2; conduct engagement at Year 2 → math at Year 3) were not significant.

Reading achievement—We repeated the above analyses with the reading achievement model and found a very similar pattern of results. The final model as presented in Figure 3 fitted the data adequately, with average $\chi^2(52) = 218.46$ (*SD* = 12.50), $p < .001$, average CFI = .96 (*SD* = .003), average RMSEA = .07 (*SD* = .003), and average SRMR = .06 (*SD* = .004). Note that covariance estimates between exogenous variables and covariance estimates between the residuals within and across waves are presented in Table 4. The effect of Time 1 TSRQ on Time 3 reading achievement was fully mediated through Time 2 effortful engagement (point estimate = .57; 95% confidence interval of the mediation effect = .27, .93). To obtain an effect size estimate of the mediation effect, we calculated the change in squared multiple correlation for the model with and without the two paths that constituted the mediation effect ($\Delta R^2 = .10$). As was the case for math, the effects of conduct engagement on math (i.e., conduct engagement at Year 1 → math at Year 2; conduct engagement at Year 2 → math at Year 3) were not significant.

Moderators

We also examined the possible moderation effects by gender and ethnicity on the transactional relationships among teacher–student relationship, effortful engagement, and achievement. Multiple-group comparison showed that the effects of prior variables on later variables in Figure 2 (i.e., math) and Figure 3 (i.e., reading) were the same for boys and girls: math, $\Delta\chi^2(15) = 23.74$, $p = .07$; reading, $\Delta\chi^2(16) = 25.09$, $p = .07$. An examination of the standardized path coefficients confirmed that the structural paths were highly similar for boys and girls. Majority and minority students were also compared in terms of the structural relations, and no differences were found for either math or reading: math, $\Delta\chi^2(15) = 15.66$, $p = .41$; reading, $\Delta\chi^2(16) = 9.75$, $p = .88$.

Discussion

As predicted, the effect of first-grade TSRQ on reading and math achievement 2 years later was completely mediated by Year 2 effortful engagement. This study offers the strongest data yet for the mediating effect of effortful engagement in accounting for the effect of TSRQ on changes in students' achievement. The assessment of TSRQ, effortful engagement, and

achievement at each of three time periods provides a strong basis for tests of mediation (Cole & Maxwell, 2003) because the design controlled not only for prior levels of the dependent variable but also for prior levels of the independent variable and the mediator. In the test of the effect of the independent variable on the mediator, prior levels of the mediator were also controlled. Additional strengths are the inclusion of a measure of conduct engagement to determine the unique effect of effortful engagement on achievement and the use of an individually administered measure of reading and math achievement that has strong psychometric properties, rather than teacher report of student achievement or grades. The finding that results were nearly identical for models in which the outcome was reading and models in which the outcome was math suggests that the effects were robust across achievement domains. Despite main effects for gender and majority/minority ethnic status, effects were not moderated by gender or ethnicity. Thus, the pattern among these variables and the structural relations were similar for boys and girls and for majority and minority children.

The assessment of study variables at each of three time periods permits strong tests of bidirectional causal pathways. Not only were we able to control for previous levels of each variable in testing each direct effect, we also were able to test these pathways across two time periods. We found support for reciprocal effects between effortful engagement and TSRQ from Year 2 to Year 3 but not from Year 1 to Year 2. This finding might have been due to the higher level of stability for TSRQ from Year 1 to Year 2 than from Year 2 to Year 3.

Reciprocal effects of both math and reading achievement on effortful engagement were invariant across developmental periods. To our knowledge, this is the first study to investigate the effect of achievement on effortful engagement. Children with lower academic skills may become discouraged and believe that their academic success is not attributed to their effort. One of the consequences of academic failure is learned helplessness, which is associated with low persistence and effort (Diener & Dweck, 1978). Researchers investigating the effect of achievement on antisocial behavior have speculated that children with low academic skills become frustrated and respond to their frustration with aggression (Miles & Stipek, 2006). Future research is needed to clarify the effect of achievement on different types of engagement and the processes that mediate the effect.

Evidence for stability of effects (e.g., year-to-year stability in measurement of the same construct) was found for effortful engagement and math achievement. However, the effect of Year 1 TSRQ on Year 2 TSRQ was stronger than the effect of Year 2 TSRQ on Year 3 TSRQ. This finding may be a result, in part, of the lag effect of Year 1 TSRQ on Year 3 TSRQ (see the discussion below). Although math demonstrated stability across years, the effect of Year 1 reading on Year 2 reading was stronger than the effect of Year 2 reading on Year 3 reading. Perhaps at older grades factors not included in our model become more important to reading performance.

As predicted, effortful engagement predicted achievement above the effects of prior levels of both conduct engagement and achievement. Furthermore, the effect of effortful engagement on achievement was invariant across developmental periods for both reading and math. In contrast, conduct engagement did not contribute to achievement when prior levels of academic engagement and achievement were controlled. To our knowledge, this is the first longitudinal study to investigate the independent effects of these two types of classroom engagement on achievement. Both conduct engagement and effortful engagement probably have their origins in temperament-based self-regulatory competence (Blair, 2002; R. A. Thompson, 1999). Our results suggest that the aspects of self-regulatory competence that affect achievement are only those aspects that interfere with children's ability to attend to instruction and to persevere in academic tasks. These findings suggest that results from studies reporting predictive associations between antisocial behavioral styles and achievement (Miles & Stipek, 2006;

Trzesniewski et al., 2006) might be explained by the association between antisocial behavior and constructs similar to our measure of academic engagement. If this is the case, interventions that target student conduct are unlikely to improve academic achievement unless they also improve student academic effort.

This study examined the development of the connections between effortful engagement, achievement, and teacher support in the same children in their first 3 years of formal schooling. Because children's achievement trajectories demonstrate greater stability after third grade (Miles & Stipek, 2006; Skinner et al., 1998), children's patterns of engagement and achievement formed in the first 3 years of formal schooling may have long-lasting impact on their future academic trajectories (Hamre & Pianta, 2001). The lag effect of Year 1 variables (TSRQ, effortful engagement, and achievement) on the corresponding Year 3 variables is consistent with the view that children's early experiences in classrooms launch individual growth trajectories of engagement, achievement, and teacher relatedness. The launch effect may be smaller or disappear as year-to-year changes influence subsequent development. Taken together, these findings suggest that TSRQ in first grade shapes children's patterns of engagement in learning, which leads both to more supportive relationships with subsequent teachers and to higher levels of achievement. Additional years of data collection are needed to determine whether the structural relationships found in the first 3 years of formal schooling persist or whether the associations among teacher support, engagement, and achievement beyond Grade 3 are the result primarily of the stability of each construct.

These results need to be interpreted in the context of study limitations. Because these findings were obtained with a sample of children selected on the basis of scoring below their school district median on a test of early literacy, results may not generalize to children with higher literacy skills. However, the current sample is one of considerable concern to educators and policy makers, given that they scored in the bottom 50% of students in their school districts on a test of literacy. The sample was also ethnically diverse, with an overrepresentation of minority children (65%) relative to the composition of the schools from which these children were selected (58% minority). Thus, study findings point to the potential of interventions in primary grades for reducing racial and ethnic achievement disparities (Hughes & Kwok, 2007).

Another limitation of the study is its reliance on only teacher report for assessment of TSRQ. Initially we had intended to use a multi-informant latent construct of TSRQ based on the TSRI and a peer-nomination measure of teacher–student relationship support (Hughes & Kwok, 2007). Because this measurement model for TSRQ did not fit the data adequately, $\chi^2(24) = 134.00$, $p < .001$ (CFI = .84; RMSEA = .133; SRMR = .093), we resorted to the latent construct based on the two scales of the TSRI.

Finally, the lack of classroom observational data on teacher–student interactions means the mechanisms that account for the observed effect of TSRQ on students' effortful engagement are not clarified in this study. It may be that teachers who establish positive relationships with students differ in other ways that contribute to students' effort and persistence. For example, teachers who establish positive relationships with students may be more effective in structuring instruction or in managing classroom behavior (Hamre & Pianta, 2005).

As is often the case with longitudinal studies of community samples, missing data were a problem. However, several precautions were taken to ensure that results were not skewed by missing data. Attrition analyses supported the assumption that data were missing at random, and the overall level of missingness was low (12.7%). Furthermore, models estimated with data for those 350 participants who had complete data were nearly identical to results obtained with imputed data for the 671 participants with some data at each of the three waves.

It is well established that children who attend quality preschool programs begin their formal schooling with stronger academic and social skills (for a review, see R. Reynolds, Magnuson, & Ou, 2006). These domains operate in synergistic fashion, such that positive movement in one domain is likely to produce positive movement in other domains. The long-term benefit of such program participation may be the result of reciprocal processes between achievement, academic engagement, and TSRQ. Thus, successful interventions at any point in this nexus of influences in the early grades may reverberate in ways that propel positive social and achievement trajectories, and interventions that target all three domains are especially likely to improve achievement.

References

Adams JW, Snowling MJ, Hennessy SM, Kind P. Problems of behaviour, reading, and arithmetic: Assessments of comorbidity using the Strengths and Difficulties Questionnaire. British Journal of Educational Psychology 1999;69:571–585. [PubMed: 10665170]

Alexander KL, Entwisle DR, Dauber SL. First-grade classroom behavior: Its short- and long-term consequences for school performance. Child Development 1993;64:801–814. [PubMed: 8339696]

Alexander KL, Entwisle DR, Horsey CS. From first grade forward: Early foundations of high school dropout. Sociology of Education 1997;70:87–107.

Ayllon T, Roberts M. Eliminating discipline problems by strengthening academic performance. Journal of Applied Behavioral Analysis 1974;7:71–76.

Bentler PM. Judea's parameter overidentification. 2000 September 2;Message posted to SEMNET archived at http://bama.ua.edu/cgi-bin/wa?A2=ind0009&L=semnet&P=R1330&I=1

Birch SH, Ladd GW. The teacher-child relationship and children's early school adjustment. Journal of School Psychology 1997;35:61–79.

Birch SH, Ladd GW. Children's interpersonal behaviors and the teacher–child relationship. Developmental Psychology 1998;34:934–946. [PubMed: 9779740]

Blair C. School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. American Psychologist 2002;57:111–127. [PubMed: 11899554]

Bowlby, J. Attachment and loss. New York: Basic Books; 1980.

Bretherton I. Attachment theory: Retrospect and prospect. Monographs of the Society for Research in Child Development 1985;50:3–38.(1–2, Serial No. 209)

Brophy J. Research on the self-fulfilling prophecy and teacher expectations. Journal of Educational Psychology 1983;75:631–661.

Buhrmester D, Furman W. The development of companionship and intimacy. Child Development 1987;58:1101–1113. [PubMed: 3608659]

Buhs ES, Ladd GW. Peer rejection as an antecedent of young children's school adjustment: An examination of mediating process. Developmental Psychology 2001;37:550–560. [PubMed: 11444490]

Burchinal MR, Peisner-Feinberg E, Pianta R, Howes C. Development of academic skills from preschool through second grade: Family and classroom predictors of developmental trajectories. Journal of School Psychology 2002;40:415–436.

Campbell, FA.; Helms, R.; Sparling, JJ.; Ramey, CT. Early childhood programs and success in school: The Abecedarian study. In: Barnett, WS.; Boocock, SS., editors. Early care and education for children in poverty: Promises, programs and long-term results. New York: State University of New York Press; 1998. p. 145-166.

Caspi A, Block J, Block JH, Klopp B. A "common-language" version of the California Child Q-Set for Personality Assessment. Psychological Assessment 1992;4:512–523.

Coie JD, Krehbiel G. Effects of academic tutoring on the social status of low-achieving, socially rejected children. Child Development 1984;55:1465–1478.

Cole DA, Maxwell SE. Testing mediational models with longitudinal data: Questions and tips in the use of structural equation modeling. Journal of Abnormal Psychology 2003;112:558–577. [PubMed: 14674869]

Conduct Problems Prevention Research Group. Teacher social competence. 2004. Retrieved September 24, 2004, from http://www.fasttrackproject.org/techrept/t/tsc/

Connell, JP.; Wellborn, JG. Competence, autonomy, and relatedness: A motivational analysis of self-system processes. In: Gunnar, M.; Sroufe, LA., editors. Minnesota symposium on child psychology. Vol. Vol. 22. Hillsdale, NJ: Erlbaum; 1991. p. 43-77.

Crosnoe R, Johnson MK, Elder GH. Intergenerational bonding in school: The behavioral and contextual correlates of student-teacher relationships. Sociology of Education 2004;77:60–81.

Diener CI, Dweck CS. An analysis of learned helplessness: Continuous changes in performance, strategy, and achievement cognitions following failure. Journal of Personality and Social Psychology 1978;36:451–462.

Dix T. The affective organization of parenting: Adaptive and maladaptive processes. Psychological Bulletin 1991;110:3–25. [PubMed: 1891517]

DuPaul GJ, Volpe RJ, Jitendra AK, Lutz JG, Lorah KS, Gruber R. Elementary school students with AD/HD: Predictors of academic achievement. Journal of School Psychology 2004;42:285–301.

Eisenberg N, Zhou Q, Spinrad TL, Valiente C, Fabes RA, Liew J. Relations among positive parenting, children's effortful control, and externalizing problems: A three-wave longitudinal study. Child Development 2005;76:1055–1071. [PubMed: 16150002]

Entwisle DR, Alexander KL. Factors affecting achievement test scores and marks of Black and White first graders. Elementary School Journal 1988;88:449–471.

Feldhusen JF, Thurston JR, Benning JJ. Longitudinal analyses of classroom behavior and school achievement. Journal of Experimental Education 1970;38:4–10.

Finn JD. Withdrawing from school. Review of Educational Research 1989;59:117–142.

Fredericks JA, Blumenfeld PC, Paris AH. School engagement: Potential of the concept, state of the evidence. Review of Educational Research 2004;74:59–109.

Funder DC, Block JH, Block J. Delay of gratification: Some longitudinal personality correlates. Journal of Personality and Social Psychology 1983;44:1198–1213.

Furrer C, Skinner E. Sense of relatedness as a factor in children's academic engagement and performance. Journal of Educational Psychology 2003;95:148–162.

Future of Children. School readiness: Closing racial and ethnic gaps. The Future of Children. Vol. Vol. 15. The Woodrow Wilson School of Public and International Affairs at Princeton University and the Brookings Institute; 2005. Retrieved February 15, 2005 from http://www.futureofchildren.org/pubs-info2825/pubs-info_show.htm?doc_id=255946

Gest SD, Welsh JA, Domitrovich CE. Behavioral predictors of changes in social relatedness and liking school in elementary school. Journal of School Psychology 2005;43:281–301.

Gettinger M. Time allocated and time spent relative to time needed for learning as determinants of achievement. Journal of Educational Psychology 1985;77:3–11.

Green JA. Testing whether correlation matrices are different from each other. Developmental Psychology 1992;28:215–224.

Greenwood CR. Longitudinal analysis of time, engagement, and achievement in at-risk versus non-risk students. Exceptional Children 1991;57:521–536. [PubMed: 2070811]

Grusec, JE.; Kuczynski, L. Parenting and children's internalization of values. New York: Wiley; 1997.

Hamre BK, Pianta RC. Early teacher-child relationships and the trajectory of children's school outcomes through eighth grade. Child Development 2001;72:625–638. [PubMed: 11333089]

Hamre BK, Pianta RC. Can instructional and emotional support in the first-grade classroom make a difference for children at risk of school failure? Child Development 2005;76:949–967. [PubMed: 16149994]

Hamre, BK.; Pianta, RC.; Downer, J. Social resources in the classroom and young children's academic and social development; Paper presented at the meeting of the Society for Prevention Research; San Antonio, TX. 2006 May.

Howes C, Hamilton CE, Matheson CC. Children's relationships with peers: Differential associations with aspects of the teacher-child relationship. Child Development 1994;65:253–263. [PubMed: 8131651]

Huesmann LR, Eron LD, Yarmel PW. Intellectual functioning and aggression. Journal of Personality and Social Psychology 1987;52:232–240. [PubMed: 3820075]

Hughes JN, Cavell TA, Willson V. Further support for the developmental significance of the quality of the teacher-student relationship. Journal of School Psychology 2001;39:289–301.

Hughes JN, Kwok O. Classroom engagement mediates the effect of teacher-student support on elementary students' peer acceptance: A prospective analysis. Journal of School Psychology 2006;43:465–480.

Hughes JN, Kwok O. The influence of student–teacher and parent–teacher relationships on lower achieving readers' engagement and achievement in the primary grades. Journal of Educational Psychology 2007;99:39–51. [PubMed: 18084625]

Isen AM, Daubman KA, Norwicki GP. The influence of affect on categorization. Journal of Personality and Social Psychology 1987;47:1206–1217.

John, OP.; Srivastava, S. The Big Five trait taxonomy: History, measurement, and theoretical perspectives. New York: Guilford Press; 1999.

Joussemet M, Koestner R, Lekes N, Landry R. A longitudinal study of the relationship of maternal autonomy support to children's adjustment and achievement in school. Journal of Personality 2005;73:1215–1235. [PubMed: 16138871]

Ladd GW, Birch SH, Buhs ES. Children's social and scholastic lives in kindergarten: Related spheres of influence? Child Development 1999;70:1373–1400. [PubMed: 10621962]

Lerner, RM. Developmental contextualism and the life-span view of person-context interaction. In: Bornstein, MH.; Bruner, JS., editors. Interaction in human development: Crosscurrents in contemporary psychology. Hillsdale, NJ: Erlbaum; 1989. p. 217-239.

Lerner, RM. Theories of human development: Contemporary perspectives. In: Damon, W.; Lerner, RM., editors. Handbook of child psychology. Vol. 5th ed.. Vol. Vol. 1. New York: Wiley; 1998. p. 1-24.

Little M, Kobak R. Emotional security with teachers and children's stress reactivity: A comparison of special-education and regular-education classrooms. Journal of Clinical Child and Adolescent Psychology 2003;32:127–138. [PubMed: 12573938]

MacKinnon DP, Lockwood CM, Williams J. Confidence limits for the indirect effect: Distribution of the product and resampling methods. Multivariate Behavioral Research 2004;39:99–128.

McCallum, RS.; Bracken, BA. The Universal Nonverbal Intelligence Test. In: Flanagan, DP.; Genshaft, JL.; Harrison, PL., editors. Contemporary intellectual assessment: Theories, tests, and issues. New York: Guilford Press; 1997. p. 268-280.

Meehan BT, Hughes JN, Cavell TA. Teacher-student relationships as compensatory resources for aggressive children. Child Development 2003;74:1145–1157. [PubMed: 12938710]

Midgley C, Feldlauffer H, Eccles J. Student/teacher relations and attitudes toward mathematics before and after the transition to junior high school. Child Development 1989;60:981–992. [PubMed: 2758891]

Miles SB, Stipek D. Contemporaneous and longitudinal associations between social behavior and literacy achievement in a sample of low-income elementary school children. Child Development 2006;77:103–117. [PubMed: 16460528]

Muthén, LK.; Muthén, BO. Mplus user's guide. Los Angeles: Muthén & Muthén; 2004.

National Institute of Child Health and Human Development Early Child Care Research Network. Social functioning in first grade: Associations with earlier home and child care predictors and with current classroom experiences. Child Development 2003;74:1639–1662. [PubMed: 14669887]

National Institute of Child Health and Human Development Early Child Care Research Network. Trajectories of physical aggression from toddlerhood to middle childhood. Monographs of the Society for Research in Child Development 2004;69(4, Serial No. 2780)

Normandeau S, Guay F. Preschool behavior and first-grade school achievement: The mediational role of cognitive self-control. Journal of Educational Psychology 1998;90:111–121.

Pallas AM, Entwisle DR, Alexander KL, Cadigan D. Children who do exceptionally well in first grade. Sociology of Education 1987;60:257–271.

Perry KE, Weinstein RS. The social context of early schooling and children's school adjustment. Educational Psychologist 1998;33:177–194.

Pianta, RC. Teacher-child relationships and early literacy. In: Dickinson, D.; Neuman, S., editors. Handbook of early literacy research. Vol. Vol. 2. New York: Guilford Press; 2006. p. 149-162.

Pianta RC, Steinberg MS. Teacher-child relationships and the process of adjusting to school. New Directions for Child Development 1992;57:61–80.

Pianta RC, Steinberg MS, Rollins KB. The first two years of school: Teacher-child relationships and deflections in children's classroom adjustment. Development and Psychopathology 1995;7:295–312.

Pianta RC, Stuhlman MW. Teacher-child relationships and children's success in the first years of school. School Psychology Review 2004;33:444–458.

Reynolds AJ, Bezruczko N. School adjustment of children at risk through fourth grade. Merrill-Palmer Quarterly 1993;39:457–480.

Reynolds, R.; Magnuson, K.; Ou, SR. PK-3 education: Programs and practices that work in children's first decade. 2006. Retrieved April 23, 2006, from the Foundation for Child Development Web site: http://www.fcd-us.org/pdfs/PK-3EducationProgramsandPracticesthatWork.pdf

Ridley SM, McWilliam RA, Oates CS. Observed engagement as an indicator of child care program quality. Early Education and Development 2000;11:133–146.

Rimm-Kaufman SE, La Paro KM, Downer JT, Pianta RC. The contribution of classroom setting and quality of instruction to children's behavior in kindergarten classrooms. Elementary School Journal 2005;105:377–394.

Rimm-Kaufman SE, Pianta RC. An ecological perspective on the transition to kindergarten: A theoretical framework to guide empirical research. Journal of Applied Developmental Psychology 2000;21:491–511.

Roeser RW, Eccles JS, Freedman-Doan C. Academic functioning and mental health in adolescence: Patterns, progressions, and routes from childhood. Journal of Adolescent Research 1999;14:135–174.

Rothbart MK, Ahadi S. Temperament and the development of personality. Journal of Abnormal Psychology 1994;103:55–66. [PubMed: 8040481]

Rothbart, MK.; Bates, JE. Temperament. In: Damon, W.; Eisenberg, N., editors. Handbook of child psychology: Vol. 3. Social, emotional, and personality development. Vol. 5th ed.. New York: Wiley; 1998. p. 105-176.(Series Ed.) (Vol. Ed.)

Rothbart MK, Jones L. Temperament, self-regulation, and education. School Psychology Review 1998;27:479–491.

Ryan RM, Stiller JD, Lynch JH. Representations of relationships to teachers, parents, and friends as predictors of academic motivation and self-esteem. Journal of Early Adolescence 1994;14:226–249.

Sameroff AJ. Transactional models in early social relations. Human Development 1975;18:65–79.

Sameroff, AJ. Principles of development and psychopathology. In: Sameroff, A.; Emde, R., editors. Relationship disturbances in early childhood. New York: Basic Books; 1989. p. 17-32.

Schafer, JL. Analysis of incomplete multivariate data. London: Chapman & Hall; 1997.

Shonkoff, JP.; Phillips, D., editors. From neurons to neighborhoods: The science of early childhood development. Washington, DC: National Academy Press; 2000.

Silver RB, Measelle JR, Armstrong JM, Essex MJ. Trajectories of classroom externalizing behavior: Contributions of child characteristics, family characteristics, and the teacher-child relationship during the school transition. Journal of School Psychology 2005;43:39–60.

Skinner E, Belmont M. Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year. Journal of Educational Psychology 1993;85:571–581.

Skinner EA, Zimmer-Gembeck MJ, Connell JP. Individual differences and the development of perceived control. Monographs of the Society for Research in Child Development 1998;63(2–3, Serial No. 254)

Stevenson HW, Newman RS. Long-term prediction of achievement and attitudes in mathematics and reading. Child Development 1986;57:646–659. [PubMed: 3720396]

Thompson, B. Exploratory and confirmatory factor analysis: Understanding concepts and applications. Washington, DC: American Psychological Association; 2004.

Thompson, RA. The individual child: Temperament, emotion, self, and personality. In: Bornstein, MH.; Lamb, ME., editors. Developmental psychology: An advanced textbook. Vol. 4th ed.. Mahwah, NJ: Erlbaum; 1999. p. 377-410.

Trzesniewski KH, Moffitt TE, Caspi A, Taylor A, Maughan B. Revisiting the association between reading achievement and antisocial behavior: New evidence of an environmental explanation from a twin study. Child Development 2006;77:72–88. [PubMed: 16460526]

Wentzel KR. Social competence at school: Relation between social responsibility and academic achievement. Review of Educational Research 1991;61:1–24.

Wentzel K. Social relationships and motivation in middle school: The role of parents, teachers, and peers. Journal of Educational Psychology 1998;90:202–209.

Woodcock, RW.; Johnson, MB. Woodcock–Johnson Psycho-Educational Battery—Revised. Allen, TX: DLM Teaching Resources; 1989.

Woodcock, RW.; McGrew, KS.; Mather, N. Woodcock–Johnson III Tests of Achievement. Itasca, IL: Riverside Publishing; 2001.

Woodcock, RW.; Muñoz-Sandoval, AF. Woodcock–Muñoz Language Survey. Chicago: Riverside; 1993.

Woodcock, RW.; Muñoz-Sandoval, AF. Batería Woodcock–Muñoz: Pruebas de Aprovechamiento—Revisada. Itasca, IL: Riverside Publishing; 1996.

Woodcock, RW.; Muñoz-Sandoval, AF. Woodcock–Muñoz Language Survey Normative Update scoring and reporting program. Itasca, IL: Riverside Publishing; 2001. [Computer software]

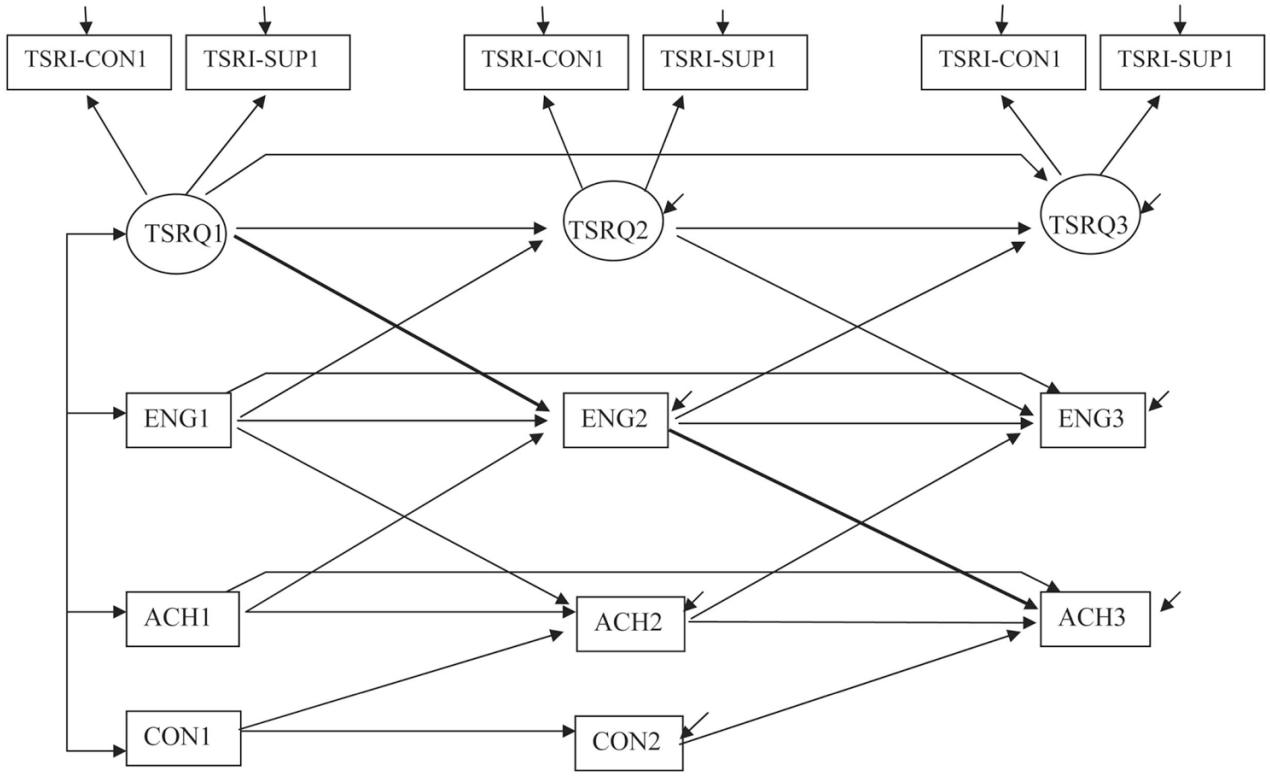

Figure 1.
Hypothetical model. The bold lines represent target indirect effects. TSRI-CON = Teacher Student Relationship Inventory Conflict subscale; TSRI-SUP = Teacher Student Relationship Inventory Support subscale; TSRQ = teacher–student relationship quality; ENG = effortful engagement; ACH = either math or reading achievement; CON = conduct engagement.

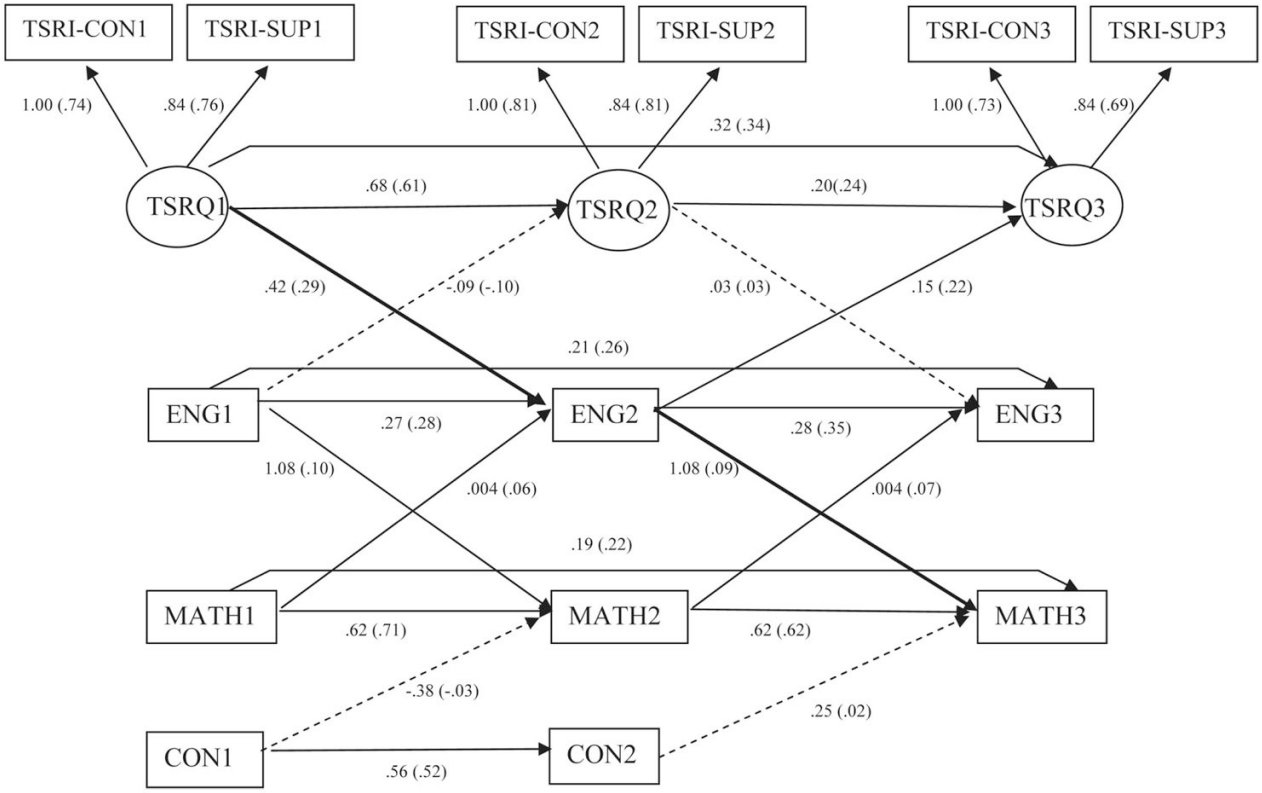

Figure 2.

Model of math achievement. The bold lines represent target indirect effects. The within-wave correlated residuals are not included in the figure for purposes of presentation clarity. Values are unstandardized parameter estimates, with standardized estimates in parentheses. TSRI-CON = Teacher Student Relationship Inventory Conflict subscale; TSRI-SUP = Teacher Student Relationship Inventory Support subscale; TSRQ = teacher–student relationship quality; ENG = effortful engagement; MATH = math performance; CON = conduct engagement.

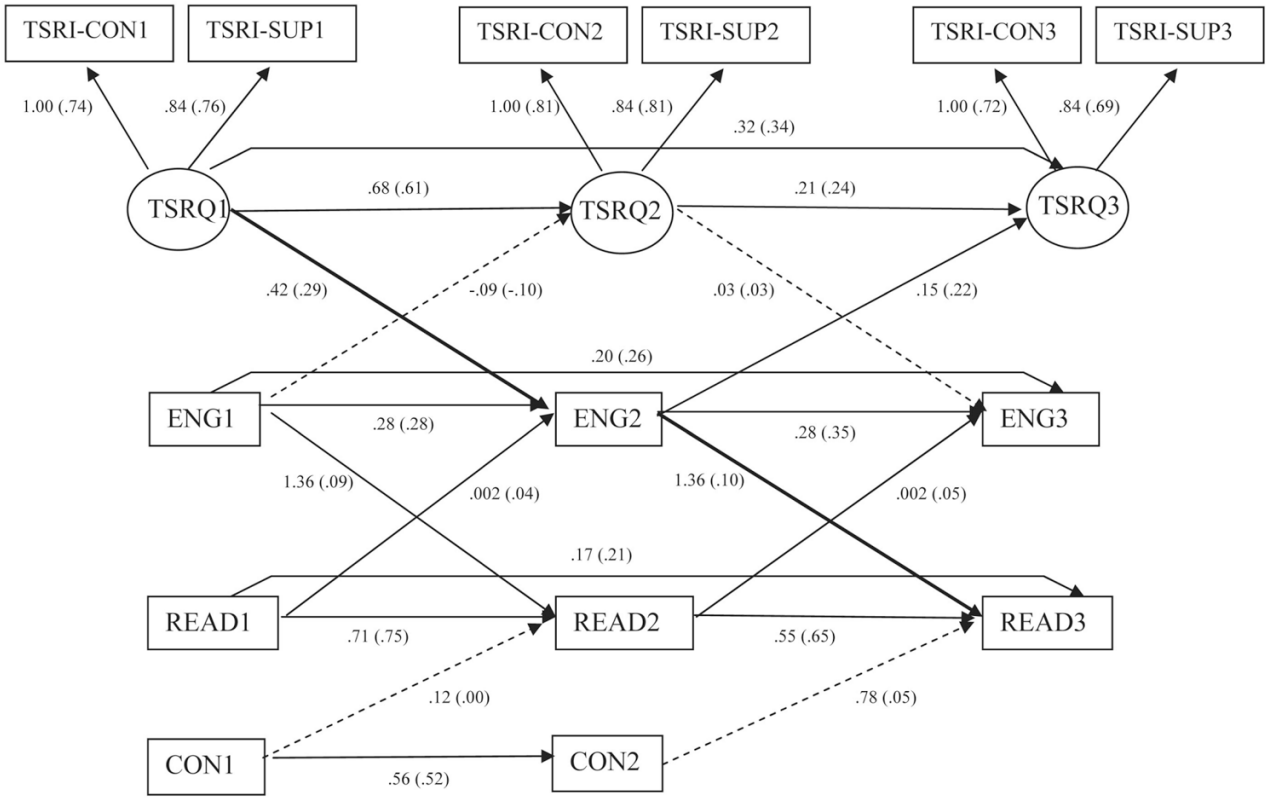

Figure 3.

Model of reading achievement. The bold lines represent target indirect effects. The within-wave correlated residuals are not included in the figure for purposes of presentation clarity. Values are unstandardized parameter estimates, with standardized estimates in parentheses. TSRI-CON = Teacher Student Relationship Inventory Conflict subscale; TSRI-SUP = Teacher Student Relationship Inventory Support subscale; TSRQ = teacher–student relationship quality; ENG = effortful engagement; READ = reading performance; CON = conduct engagement.

Table 1

Means and Standard Deviations of Analysis Variables by Gender and Ethnicity

	Total (*N* = 671)		Girls (*n* = 315)		Boys (*n* = 356)		Majority (Caucasian; *n* = 234)		Minority (*n* = 437)	
Scale	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
TSRI-CON1	4.10	1.06	4.32	0.91	3.90	1.14	4.18	1.02	4.05	1.08
TSR1-SUP1	4.01	0.80	4.11	0.77	3.79	0.90	4.05	0.78	3.99	0.81
ENG1	3.19	1.09	3.47	1.01	2.95	1.10	3.19	1.05	3.20	1.11
CON1	2.18	0.88	2.05	0.83	2.29	0.90	2.10	0.84	2.22	0.90
READ1	96.36	18.01	98.80	18.15	94.20	17.64	98.61	15.91	95.15	18.95
MATH1	100.62	13.86	100.22	11.96	101.05	13.06	106.89	12.64	97.27	13.32
TSRI-CON2	4.16	1.05	4.40	0.88	3.95	1.13	4.21	0.98	4.14	1.08
TSR1-SUP2	3.92	0.86	4.07	0.79	3.79	0.90	3.95	0.85	3.91	0.87
ENG2	3.35	1.11	3.61	1.06	3.13	1.10	3.46	1.13	3.29	1.09
CON2	0.80	0.96	0.94	0.90	0.67	0.99	0.88	0.92	0.75	0.98
READ2	97.05	16.95	98.95	17.17	95.36	16.60	99.60	14.74	95.68	17.89
MATH2	100.66	12.55	100.22	11.96	101.05	13.06	105.91	12.32	97.85	11.76
TSRI-CON3	4.24	1.00	4.52	0.86	3.99	1.06	4.40	0.91	4.15	1.04
TSRI-SUP3	3.96	0.90	4.11	0.89	3.84	0.89	4.07	0.84	3.91	0.93
ENG3	3.39	0.86	3.61	0.82	3.20	0.84	3.47	0.79	3.35	0.88
READ3	95.30	14.35	97.04	13.52	93.76	14.89	98.43	12.35	93.62	15.06
MATH3	100.83	12.30	100.94	12.29	100.74	12.32	105.38	11.44	98.40	12.05

Note. The numbers in the row headings refer to the timing of assessment. TSRI-CON = Teacher Student Relationship Inventory Conflict subscale (teacher perception of conflict); TSRI-SUP = Teacher Student Relationship Inventory Support subscale (teacher perception of warmth); ENG = teacher perception of child academic engagement; CON = conduct engagement; READ = Woodcock–Johnson III Broad Reading age standard score; MATH = Woodcock–Johnson III Broad Math age standard score.

Table 2

Correlations for All Continuous Analysis Variables

	Scale	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	TSRI-CON1	—																
2.	TSRI-SUP1	.60	—															
3.	ENG1	.52	.52	—														
4.	CON1	.74	.71	.58	—													
5.	READ1	.15	.14	.29	.18	—												
6.	MATH1	.13	.09	.20	.12	.52	—											
7.	TSRI-CON2	.56	.38	.37	.49	.17	.15	—										
8.	TSRI-SUP2	.34	.32	.27	.34	.09	.13	.66	—									
9.	ENG2	.41	.35	.54	.41	.21	.24	.54	.57	—								
10.	CON2	.54	.39	.39	.51	.19	.18	.74	.72	.66	—							
11.	READ2	.15	.15	.28	.17	.78	.45	.17	.11	.24	.19	—						
12.	MATH2	.17	.13	.27	.17	.48	.75	.17	.19	.28	.23	.54	—					
13.	TSRI-CON3	.49	.37	.44	.44	.21	.18	.56	.35	.41	.45	.15	.23	—				
14.	TSRI-SUP3	.30	.22	.38	.34	.20	.19	.32	.28	.34	.28	.12	.17	.49	—			
15.	ENG3	.37	.30	.52	.37	.25	.23	.35	.28	.50	.34	.22	.24	.50	.58	—		
16.	READ3	.16	.13	.32	.19	.73	.43	.15	.10	.28	.17	.83	.51	.18	.14	.29	—	
17.	MATH3	.22	.13	.31	.22	.56	.70	.18	.16	.29	.22	.56	.79	.26	.19	.29	.59	—

Note. The numbers in the row headings refer to the timing of assessment. TSRI-CON = Teacher Student Relationship Inventory Conflict subscale (teacher perception of conflict); TSRI-SUP = Teacher Student Relationship Inventory Support subscale (teacher perception of warmth); ENG = teacher perception of child academic engagement; CON = conduct engagement; READ = Woodcock–Johnson III Broad Reading age standard score; MATH = Woodcock–Johnson III Broad Math age standard score.

Table 3

Parameter Estimates of Covariance in the Model Presented in Figure 2

Parameter	Unstandardized estimate	Standardized estimate
Covariance of exogenous variables		
TSRQ1 with ENG1	0.57	.70
TSRQ1 with MATH1	1.66	.16
TSRQ1 with CON1	0.62	.95
ENG1 with MATH1	3.14	.21
ENG1 with CON1	0.56	.58
MATH1 with CON1	1.47	.12
Covariance of correlated residuals		
TSRQ2 with ENG2	0.37	.41
TSRQ2 with MATH2	0.42†	.04
TSRQ2 with CON2	0.48	.61
ENG2 with MATH2	0.45†	.03
ENG2 with CON2	0.40	.39
MATH2 with CON2	0.53†	.05
TSRQ3 with ENG3	0.24	.38
TSRQ3 with MATH3	0.11†	.01
ENG3 with MATH3	0.39†	.04
TSRI-CON1 with TSRI-CON2	0.10	.10
TSRI-CON1 with TSRI-CON3	0.10	.10
TSRI-CON2 with TSRI-CON3	0.14	.14

Note. Estimates with a dagger are not significant at $p = .05$. TSRQ = teacher–student relationship quality; ENG = teacher perception of child academic engagement; MATH = Woodcock–Johnson III Broad Math age standard score; CON = conduct engagement; TSRI-CON = Teacher Student Relationship Inventory Conflict subscale (teacher perception of conflict).

Table 4

Parameter Estimates of Covariance in the Model Presented in Figure 3

Parameter	Unstandardized estimate	Standardized estimate
Covariance of exogenous variables		
TSRQ1 with ENG1	0.57	.70
TSRQ1 with READ1	2.54	.19
TSRQ1 with CON1	0.62	.95
ENG1 with READ1	5.74	.29
ENG1 with CON1	0.56	.58
READ1 with CON1	2.77	.18
Covariance of correlated residuals		
TSRQ2 with ENG2	0.37	.41
TSRQ2 with READ2	0.18†	.01
TSRQ2 with CON2	0.48	.61
ENG2 with READ2	0.65†	.04
ENG2 with CON2	0.41	.39
READ2 with CON2	0.08†	.01
TSRQ3 with ENG3	0.24	.39
TSRQ3 with READ3	0.17†	.01
ENG3 with READ3	0.65	.05
TSRI-CON1 with TSRI-CON2	0.10	.10
TSRI-CON1 with TSRI-CON3	0.10	.10
TSRI-CON2 with TSRI-CON3	0.14	.14

Note. Estimates with a dagger are not significant at $p = .05$. TSRQ = teacher–student relationship quality; ENG = teacher perception of child academic engagement; READ = Woodcock–Johnson III Broad Reading age standard score; CON = conduct engagement; TSRI-CON = Teacher Student Relationship Inventory Conflict subscale (teacher perception of conflict).