Do student self-efficacy and teacher-student interaction quality contribute to emotional and social engagement in fifth grade math?

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Abstract

This study examined (a) the contribution of math self-efficacy to students' perception of their emotional and social engagement in fifth grade math classes, and (b) the extent to which high quality teacher-student interactions compensated for students' low math self-efficacy in contributing to engagement. Teachers (*n* = 73) were observed three times during the year during math to measure the quality of teacher-student interactions (emotional, organizational, and instructional support). Fifth graders (*n* = 387) reported on their math self-efficacy at the beginning of the school year and then were surveyed about their feelings of engagement in math class three times during the year immediately after the lessons during which teachers were observed. Results of multi-level models indicated that students initially lower in math self-efficacy reported lower emotional and social engagement during math class than students with higher self-efficacy. However, in classrooms with high levels of teacher emotional support, students reported similar levels of both emotional and social engagement, regardless of their self-efficacy. No comparable findings emerged for organizational and instructional support. The discussion considers the significance of students' own feelings about math in relation to their engagement, as well as the ways in which teacher and classroom supports can compensate for students lack of agency. The work has implications for school psychologists and teachers eager to boost students' engagement in math class.

Keywords: teacher-student interactions, social engagement, emotional engagement

Do student self-efficacy and teacher-student interaction quality contribute to emotional and social engagement in fifth grade math?

Student success in math is essential for a strong workforce because math provides the foundation for many science, technology, and engineering disciplines. Success in math hinges on students' engagement in math instruction (Hughes & Kwok, 2007; Marks, 2000). Recent recommendations from the National Council for Teachers of Mathematics (2014) highlight the importance of student engagement. According to NCTM Principals to Actions (2014), ideal math learning is not a passive process involving practicing procedures, memorizing formulas, and using standard algorithms. Instead, students develop understanding of mathematical procedures and concepts by making sense of mathematical tasks, engaging in reasoning, problem solving and discourse with their teachers and other students, and exploring mathematical problems in order to find a solution. High levels of student engagement are foundational to NCTM instructional approaches, an issue that is concerning given evidence showing that students vary widely in their engagement in learning (Fredricks, Blumenfeld, & Paris, 2004). Educators and school psychologists need improved understanding of the factors that contribute to engagement. Student engagement stems from both internal processes (i.e., intrapsychic experiences) as well as external supports (i.e., classroom experiences) that are present or absent in students' lives. Understanding the contribution of internal and external experiences on students' engagement in math is an essential step toward improving math achievement.

Research examining the factors contributing to student engagement in math is especially important during the late elementary school years. Learning math is a cumulative task and students who fall behind may find it difficult to catch up (Bodovski & Farkas, 2007). Further, math can be particularly challenging with periods in which students feel frustration and confusion as a natural part of the learning process (Licht & Dweck, 1984). In the presence of challenge, there are critical and important "emotional ingredients" required so that students maintain their involvement in learning and persist in the presence of adversity (Finn & Zimmer, 2012, p. 101). Self-efficacy is one such emotional ingredient. Students who experience high self-efficacy in math are more likely to persist at difficult tasks compared to those with low self-efficacy (Bandura, 1977). Understanding students' self-efficacy to learn math, the implications of these feelings for engagement, and the extent to which teachers can compensate for low self-efficacy sheds light on the student and classroom inputs essential for math learning.

Engagement in Learning

Student engagement is regarded as a multi-faceted construct with psychological and behavioral components that are critical for learning (Fredericks, Blumenfeld, & Paris, 2004). As described by Reschly and Christenson (2012, p. 3), "student engagement is the glue, or mediator, that links important contexts—home, school, peers, and community—to students and, in turn, to outcomes of interest." Contemporary math classrooms represent an interesting context in which to study engagement given recent NCTM guidelines that emphasize teaching strategies designed to deepen students' engagement in learning. The NCTM themes encourage risk-taking, "productive struggle," and discourse about mathematical ideas (NCTM, 2014, p. 3) – themes that direct research interest toward emotional and social engagement in learning.

Emotional engagement refers to the emotions (i.e., enjoyment, interest, and pleasure) experienced when pursuing a particular subject or school-related task (Mahatmya, Lohman, Matjasko, & Farb, 2012). Students who are emotionally engaged enjoy the feeling of solving problems and find the material interesting. Emotional engagement relates to achievement indirectly (Finn & Zimmer, 2012); that is, emotional engagement relates to student participation in the classroom, which in turn, relates to achievement (Voelkl, 1997). Further, emotional engagement shows continuity over time; students showing higher emotional engagement during early school grades (first through third grade) have been shown to demonstrate improved academic performance in eighth grade (Ladd & Dinella, 2009).

Social engagement refers to the social interactions students have as part of academic instruction (Patrick et al., 2007; Rimm-Kaufman et al., 2015). Students demonstrate social engagement through their active participation in positive exchanges with peers that are connected to the instructional content of the lesson. For example, a student may demonstrate social engagement by working in a group to help one another solve a particular problem in class or by sharing instructional materials (e.g., math manipulatives) with other students. Patrick et al. (2007) showed that social engagement (i.e., task-related interaction) in fifth grade math class related to higher math grades, even after controlling for achievement in the previous year.

Factors Influencing Student Engagement

Many factors influence students' levels of engagement in the classroom. We use the person-environment fit theory (Mitchell, 1969) as our conceptual basis to identify factors that contribute to emotional and social engagement. The person-environment fit theory posits that academic constructs (e.g., engagement, achievement) reflect the interaction between attributes of the student and his or her environment (Eccles, Lord, & Midgley, 1991). Applied to the math classroom, a student is more likely to succeed when the student's individual resources fit well with the demands of the classroom environment. Students become susceptible to academic decline without this fit in place. Consider the application of the person-environment fit theory to an academically demanding fifth grade classroom. If a student enters into the classroom environment with strong internal resources (e.g., self-efficacy), the student may be well equipped to face the challenges presented, resulting in more engagement in learning. Without these internal resources, the student may be less likely to perceive math as engaging. In the absence of internal resources, the student may rely on resources outside of themselves to compensate and boost their engagement. Students' sense of self-efficacy in math and supportive teacher-student interactions are internal and external factors that may promote engagement.

Self-efficacy. Self-efficacy refers to an individual's perception of his or her capacity to learn or perform a task in a given domain (Schunk & Pajares, 2005). By late elementary school, students have a well-developed sense of self-efficacy that is subject-specific and stems from their home, school, and peer experiences (Linnenbrink & Pintrich, 2003; Schunk & Pajares, 2005). Students with high self-efficacy tend to participate eagerly, persist in the face of challenge, and expend greater effort to reach a goal, whereas students with low self-efficacy tend to dwell on past mistakes and lessen their efforts in the face of difficult tasks (Bandura, 1977). Students' perceptions of their own self-efficacy in learning play a critical role in student motivation and engagement (Linnenbrink & Pintrich, 2003; Zimmerman, Bandura, & Martinez-Pons, 1992). High academic self-efficacy contributes to academic achievement (Appleton, Christenson, & Furlong, 2008), academic effort (Sakiz, Pape, & Hoy, 2012), social competence, and positive relationships with peers (Kuperminc, Blatt, & Leadbeater, 1997).

Self-efficacy in math has been shown to contribute to academic resilience among upper-elementary students from low socioeconomic backgrounds (Borman & Overman, 2004) and math achievement in a sample of sixth graders (Pajares & Graham, 1999). However, very few studies have examined the role of self-efficacy in predicting emotional and social engagement in math. One exception is work by Patrick et al. (2007) that showed a strong relation between academic efficacy (students' view of their ability to complete math successfully), social efficacy with peers (students' judgment of their ability to relate well with peers), and social engagement among fifth graders. Both academic and social efficacy with peers related to math achievement, an association that was partially mediated by social engagement.

Teacher-student interaction quality. The quality of teacher-student interactions is an example of an influence external to the child that has been shown to contribute to engagement (Rimm-Kaufman et al., 2009). Teacher-student interaction quality is highly variable across the U.S., with some classrooms offering more support for learning than others (Ruzek, Hafen, Hamre, & Pianta, 2014). Teacher-student interaction quality is multi-dimensional, in that teachers can provide support that is emotional, organizational, or instructional in nature (Pianta & Hamre, 2009). Teachers provide emotional support by being sensitive, responsive, warm, and aware of student interests and needs. Teachers facilitate organizational support by creating non-chaotic classroom environments characterized by clear expectations and productive learning. Teachers offer instructional support by giving clear feedback to students, creating opportunities for conceptual thinking, and modeling new vocabulary.

There is growing evidence implicating the importance of emotional support on engagement. Higher levels of emotional support related to improved student English Language Arts grades, an association mediated by students' rating of engagement (interest, enjoyment, effort) in a sample of fifth and sixth graders (Reyes, Brackett, Rivers, White, & Salovey, 2012).

Middle school students who viewed their math teachers as emotionally supportive showed greater emotional engagement (i.e., academic enjoyment in learning), which in turn, related to greater academic effort (Sakiz, Pape, & Hoy, 2012). Fifth grade math students who viewed their teachers as emotionally supportive showed greater social engagement, an association that was mediated by students' personal motivational beliefs (i.e., perception of their academic efficacy, social efficacy, and mastery goals in math) (Patrick et al., 2007).

Some research on teacher-student interactions differentiates among emotional, organizational, and instructional supports for student engagement. Students who viewed their classroom environments as more caring and well structured (i.e., higher in emotional and organizational support) were more likely to report being engaged in school, which led to higher test scores and attendance (Klem & Connell, 2004). Students' perception of teacher social support, support for autonomy, and promotion of academic discussion (corresponding to higher emotional, organizational and instructional support) in seventh grade related to various aspects of school engagement (participation, identification, use of self-regulation strategies) and higher academic achievement in eighth grade (Wang & Holcombe, 2010). High quality, meaningful learning experiences in which students report experiencing challenging questions, in-depth learning, and opportunities to apply the subject to problems outside of school (i.e., higher instructional support) predicted math engagement in the late elementary and middle school years (Marks, 2000).

Despite research linking teacher-student interactions and engagement, there are a few key shortcomings of existing work. The majority of engagement research cuts across content domains and few studies focus on the math domain, specifically. Students' experiences differ depending on the academic subject. Students who perceive themselves as engaged in math may not feel equivalently engaged in Science or English (Green, Martin, & Marsh, 2007; Reeve, 2012). In fact, comparisons across content domains reveal unexpected results. For instance, Marks (2000) showed that students found math class more engaging than social studies; a result that was evident despite the fact that fifth graders perceived more support for learning from their teachers, parents, and peers in social studies than math.

Another shortcoming stems from data sources. Many studies measuring engagement rely on teacher-reports or observer reports (e.g., Borman & Overman, 2004; NICHD-ECCRN, 2005). Although teachers and observers can be useful informants, using this type of measurement for engagement ignores the possibility that fifth grade students may appear engaged even when they are disinterested (Rimm-Kaufman et al., 2015). Using student-reported measures of engagement can address this problem.

The temporal configuration of data collection represents another shortcoming. Most existing work gathers data on teacher-student interactions and/or student engagement at a single point in the year (e.g., Borman & Overman, 2004; Mercer et al., 2011; NICHD-ECCRN, 2005; Wang & Holcombe, 2010). Measurement at a single time point fails to account for the day-to-day variability that exists over the school year.

Teacher-Student Interaction Quality as a Potential Moderator

The majority of research examining teacher-student interaction quality indicates the value of high quality, supportive interactions (Pianta & Hamre, 2009). However, the presence of positive teacher-student interactions may be more important for some students than others (e.g., Malecki & Demaray, 2006), depending on student attributes and prior experiences. To guide the direction of our hypotheses, we rely on the academic risk perspective (Hamre & Pianta, 2005; Roorda et al., 2011) that suggests that relational assets in the environment have greater influence on students' outcomes when students are at risk for school problems. Existing work supports this position. Malecki and Demaray (2006) found that perceived teacher support had a stronger relation to academic achievement for students with lower socio-economic status compared to those with higher levels. Hamre and Pianta (2005) showed that higher levels of instructional and emotional support were stronger predictors of achievement gains for first grade students classified as at-risk (based on demographic characteristics and social, behavioral, academic, and attentional problems) compared to students without such risks.

Applied to the math classroom, we expect a student with greater risk (e.g., low self-efficacy) is more likely to benefit from classroom relational resources (i.e., high quality teacher-student interactions) than a student with less risk (e.g., high self-efficacy). Based on past work, we expect high self-efficacy students to show high levels of emotional and social engagement in learning. This association indicates a good fit between the capacity of the individual and the demands of the environment. In the absence of self-efficacy, however, students may show lower emotional and social engagement owing to the lack of person-environment fit. Students with low self-efficacy may need to rely on external supports in the classroom (emotional, organizational or instructional support) to compensate for their lack of agency.

Current Study

The present study extends existing engagement research by using observational measures of teacher-student interaction and student-report measures of student engagement collected at multiple points across the school year to cast a new light on the individual and combined contributions of student self-efficacy and teacher-student interactions on engagement in math. We addressed two research questions. First, to what extent does math self-efficacy relate to students' perception of their emotional and social engagement in fifth grade math classes? Based on theory and research (e.g., Schunk & Pajares, 2005; Skinner & Belmont, 1993), we hypothesized that higher self-efficacy in math would relate to greater emotional and social engagement because students' intra-psychic resources would be well matched to the challenges of the math classroom. Second, does this relation between self-efficacy and engagement persist across various levels of teacher-student interaction? That is, might high quality teacher-student interactions compensate for students' low math self-efficacy in contributing to engagement? We hypothesized that students low in self-efficacy would only perform well if there were resources present in the environment (i.e., high quality teacher-student interactions) that met students' needs and compensate for students' low self-efficacy. In contrast, we expected that students with high self-efficacy would perform equivalently well, regardless of the teacher-student interaction quality.

Method

Participants

Participants enrolled in the present study based upon their participation in the Responsive Classroom Efficacy Study, a randomized controlled trial examining the impact of a social and emotional learning intervention (Rimm-Kaufman et al., 2014). All schools were from a single school district located in a suburban area in a mid-Atlantic state. Schools were invited to participate in a more intensive data collection in the third year of the study, resulting in 20 schools (12 intervention, 8 wait-list control) and 63 fifth grade teachers. Students were selected using a stratified random sampling approach. Five students were selected from each classroom from a larger pool of consented children, bounded by two considerations: we aimed to have equivalent gender proportions within each class and selected children who were demographically representative of the school (based on ethnicity, free/reduced price lunch [FRPL], and English Language Learner [ELL] status). Approximately five children per classroom were selected in this manner (mode = 5), resulting in a total sample size of 387 children (53% female). In the sample, 143 children were Caucasian, 118 were Hispanic American, 65 were Asian American, 23 were African American, 19 were multi-racial, and 19 had missing data. Parents received a gift card for their child's participation.

Students in the final sample had an average age of 10.5 years (*SD* = .37) at the beginning of the school year. School records indicated that 22% of the sample was eligible for FRPL, defined as a household income of $40,793 for a family of four (roughly 180% below the federal poverty guideline in 2010-2011). In addition, 37% of students were either: 1) ELL; 2) previously received ELL services and were being monitored; or 3) previously received ELL services and were recently monitored within the past 24 months. The sample consisted of 63 teachers, who were 87 percent female and had 12.5 years of experience on average (Range = 1 - 38). All teachers held bachelor degrees, 68% held masters degrees, and all reported having a full state certification. Forty-eight teachers were Caucasian, five were Hispanic, two were multi-racial, one was Native American, and one was African American. These 63 teachers taught math in 73 distinct classrooms of students. Eight teachers taught more than one classroom of students, where six teachers taught two classes and two teachers taught three classes. Because the research questions pertained to teacher-student interactions (which vary as a function of having different teachers or students in the classroom), multi-level models were used with nesting occurring at the classroom level. Teachers received financial compensation for participating.

Measures

Engagement in math. Student-report measures were used to measure two types of engagement: emotional and social engagement.

Emotional engagement in math. The emotional engagement measure consisted of five items assessing students' enjoyment of, and interest in, math class on a particular day (sample alpha = .91). This measure was based upon similar measures created by Kong, Wong, and Lam (2003) and Skinner and Belmont (1993), and included items such as, "Math class was fun today." Students rated the items on a scale ranging from one (*no, not at all true*) to four (*yes, very true*). Refer to Table 1 for a full item list.

Social engagement in math. The social engagement measure consisted of four items measuring the degree to which students discussed math content to one another in math class for a particular day (sample alpha = .74). This measure was adopted from Patrick et al. (2007) and included items such as, "Today I helped other kids with math when they didn't know what to do." Items were on a scale ranging from one (*no, not at all true*) to four (*yes, very true*). Refer to Table 1 for a full item list.

The research team piloted the engagement questionnaire in a sample of 33 fifth graders in three schools prior to its implementation in this study. This resulted in an alpha for the complete measure of .90 and inter-item correlations larger than .50. In the current sample (N = 387), the engagement questionnaire was administered three times over the course of the academic year. Note that the aforementioned alphas were aggregated across time points to create a single estimate. A confirmatory factor analysis incorporating all three administration periods with the two factors of social engagement and emotional engagement in math yielded good model fit, described later in the Results section.

Teacher-student interaction quality. The Classroom Assessment Scoring System (CLASS; Pianta et al., 2008), a high-inference, classroom observational assessment tool, was used to measure the quality of teacher-student interactions. The CLASS includes ten measured dimensions that correspond to three interaction domains: emotional support, classroom organization, and instructional support. Each dimension is rated on a seven-point scale ranging from one (*low)* to seven (*high*). Emotional support is comprised of teacher sensitivity, regard for student perspectives, positive climate, and negative climate (sample alpha = .83). Teacher sensitivity refers to the teacher providing comfort and reassurance toward both the children's academic and social needs. Regard for students' perspectives describes situations in which the teachers' choice of activities to facilitate in the classroom is related to students' interests. Positive climate refers to classroom interactions between the teacher and students that show respect, enthusiasm, and enjoyment. Negative climate refers to sarcasm, anger, or general harshness in the teachers' interactions toward the students (and is a reverse-scored item).

Classroom organization is comprised of instructional learning formats, productivity, and behavior management (sample alpha = .82). Instructional learning formats refers to teachers' use of activities and materials to help facilitate learning. Productivity includes the teachers' use of instructional time to enable learning opportunities. Behavior management refers to proactive methods used to prevent behavioral problems.

Instructional support is comprised of concept development, quality of feedback, and language modeling (sample alpha = .72). Concept development indicates the teachers' use of strategies to promote higher order thinking. Quality of feedback refers to the specific feedback given by teachers' in response to student work and questions. Language modeling includes the facilitation and encouragement of advanced language in the classroom.

Coders used a protocol-based training process that included four-phases: preparation, training, reliability, and calibration. Preparation consisted of reading manuals and conducting practice observations. Training consisted of a two-day interactive training session conducted in small groups, followed by joint observations with an expert coder. To assess reliability, ten 15-minute segments were assessed and compared to a gold standard, prepared by the instrument's authors. Coders' responses exceeded the minimum amount of reliability required, which consisted of being within one scale point of the gold standard on at least 80% of the responses (mean = 90%). Finally, calibration consisted of additional sessions of independent coding that occurred between once or twice a month in a small group setting. During these meetings, all coders watched and scored a 15-minute observation selected at random to calculate inter-rater reliability (mean ICC = .92).

Math self-efficacy. Students' math self-efficacy was assessed with the Academic Efficacy subscale of the Patterns of Adaptive Learning Scale (Midgley et al., 2000). This subscale was modified to apply to a math context and piloted in a sample of 39 children (pilot alpha = .89). Students rated five items such as, "I know I can learn the skills taught in math this year," and "I can learn math even if the work is hard" on a scale ranging from one (*almost never*) to four (*all the time*). These items were then averaged to create a composite value of math self-efficacy, where higher values indicated higher self-efficacy (sample alpha = .80).

Covariates. Although not the primary focus of this study, several variables that often relate to engagement were included as potential covariates. Initial achievement was included because of associations between achievement and engagement (Dotterer & Lowe, 2011). English language learner status was included due to its link with lower levels of engagement during whole-class instruction (Brooks & Thurston, 2010). Free and reduced price lunch eligibility was included as a proxy for socio-economic status, because elementary school students living in impoverished environments tend to be lower in self-regulatory abilities and engagement in learning (Evans & Rosenbaum, 2008). Gender was included because of work showing that boys are less engaged than girls in fifth grade math (Marks, 2000). Teacher experience was included because of work showing that teacher years of experience is related to teacher self-efficacy and job satisfaction, which may indirectly relate to student engagement (Klassen & Chiu, 2010). Finally, even though preliminary results indicated that exposure to the *RC* approach did not relate to student engagement in math in this sample (Rimm-Kaufman, et al. 2015), intervention status was included as a covariate given that this study does come from a larger, randomized control trial.

*Initial achievement***.** Students' initial math achievement was measured using scores from a state standardized test, the Standard of Learning (SOL), administered in May of the students' fourth year (Virginia Department of Education, 2008). The test contained 50 multiple-choice items designed to assess understanding in four skill categories: (a) number and number sense, (b) computation and estimation, (c) measurement and geometry, and (d) probability, statistics, patterns, functions, and algebra (Virginia Department of Education, 2008). Scores were scaled to range from 200 to 600, where a scaled score of 400 represents pass/proficiency and a 500 represents pass/advanced. A Plain English version of this test was used if the students were not proficient in English. Questions were presented in a way that emphasized numbers instead of words. Scoring used the same approach as the regular math test.

English Language Learner status (ELL). Students were coded as ELL if they previously received ELL services and were being monitored or if they previously received ELL services and were monitored recently (i.e., within the past 24 months).

Intervention status (Responsive Classroom [RC]). Schools were randomized to either a wait-list control (coded as 0) or *RC* intervention (coded as 1) condition two years prior to data collection, as described in (Rimm-Kaufman et al., 2014).

Procedure

District data, including FRPL eligibility, ELL status, and initial math achievement measured by the fourth grade state test were recorded in the spring while the students were enrolled in fourth grade. All other measured variables, including classroom observations and child self-report data, were gathered over the course of the students' fifth grade year.

Teachers distributed questionnaires to all students to measure math self-efficacy in the fall of the school year. Research assistants conducted classroom observations in math classes at three time points during the school year, corresponding to three windows (window 1: late September to late November; window 2: late November to mid-February; and window 3: late February to late April). Observations were conducted on days deemed "typical" by the teacher. The full length of each math lesson (M = 63 minutes) was recorded for later coding of teacher-student interactions using the Classroom Assessment Scoring System. In total, two fifteen-minute segments of each lesson were used for coding. The research assistant distributed student engagement questionnaires to the students immediately after each of the three classroom observations.

Data Analysis

Preliminary analyses. The first analytic step involved reduction of the engagement data to create two variables: social engagement and emotional engagement in math. Categorical confirmatory factor analyses (CFA) with tests of longitudinal measurement invariance across the three time points were conducted in MPlus version 7 (Muthén & Muthén, 1998-2012) using full information maximum likelihood estimation to handle missing data. Invariance was examined using change in model fit indices as recommended by Little (2013). Given the focus of the research questions and because these measures showed no evidence of systematic change over time, factor scores for the three time points were averaged to create a mean score on each measure for each student. We selected this approach to provide a more reliable estimate of the student's daily classroom engagement.

The next step was to conduct missing data analyses on all variables to be included in the models. On average, five percent of the participants were missing on each variable. Data were assumed to be missing at random given the exhaustive nature of the covariates and lack of systematic trends found in the missing data analyses. To handle missingness in the multi-level models, 10 imputed datasets were created using MPlus (Muthén & Muthén, 2008-2012), using an unrestricted two-level imputation procedure to account for the nested structure of the data. Despite the low rates of missing data, we considered using more imputations as recommended by Bodner (2008). Both strategies were tested and yielded identical results. Therefore, subsequent analyses were based on the decision to use 10 imputed datasets to increase computational efficiency.

Primary analyses. Three-level multi-level regression models were used to test the main effects of self-efficacy and each CLASS domain as well as the cross-level interaction between math self-efficacy and the three CLASS domains on the two student engagement outcomes. All multi-level analyses were conducted using R version 3.0.1 (R Core Team, 2014). Models were estimated using the lme4 package (Bates, Maechler, Bolker, & Walker, 2014), and pooled estimates for the fixed effects were created using the mice package (van Buuren & Groothuis-Oudshoorn, 2011). The models were estimated using restricted maximum likelihood to calculate the ICCs, while all other models used traditional maximum likelihood given the focus on model comparison and interpreting fixed effects (Hox, 2010). Simple slopes analyses probing the cross-level interactions were conducted following the procedure outlined in Bauer and Curran (2005), with the imputed data estimates being pooled according to Rubin (2004). After building the final models, model assumptions such as normality of residuals and linearity, as well as outlier diagnostics and variance inflation factors among predictors, were examined and met.

Multi-level model building. The two research questions involved: (a) the contribution of self-efficacy to engagement, and (b) the extent to which teacher-student interaction quality moderated the relation between math self-efficacy and student engagement. Student engagement in math was measured via two constructs (i.e., emotional and social engagement), while teacher-student interaction was measured via three CLASS domains (emotional support [ES], classroom organization [CO], and instructional support [IS]). Two models were constructed, one for each engagement outcome. The final models for both outcomes incorporated all three CLASS domains as main effects, as well as cross-level interaction between all three CLASS domains with the math self-efficacy variable. Multi-level models were built using a bottom-up approach (Hox, 2010). First, an unconditional model was estimated to partition the variance between the three levels (schools, classrooms, students). Next, the models including only covariate terms were estimated. Then, models including covariate terms and all main effects were estimated. Lastly, the final models were created with all predictors and the cross-level interactions of interest (i.e., CLASS domain X math self-efficacy). Note that because some teachers had multiple classrooms, a four-level multi-level model was considered and tested. Analyses of the four-level model revealed comparable results to the three-level model. For simplicity, we report only the results from the three-level model.

A generalization of the structure for the final version of these two models can be seen in the equation below, where $engagement_{ijk}$ represents the engagement score for student i (n = 387) in classroom j (n = 73) in school k (n = 20). For brevity, all level-1 and level-2 covariates were modeled as fixed effects and are represented by the ellipsis in both levels.

Level 1:

$$Engagement_{ijk} = \beta_{0jk} + \beta_{1jk}(Math\ SE_{ijk}) + \ldots + e_{ijk}$$

Level 2:

$$\beta_{0jk} = \gamma_{00k} + \gamma_{01k}(ES_{jk}) + \gamma_{02k}(CO_{jk}) + \gamma_{03k}(IS_{jk}) + \ldots + r_{0jk}$$

$$\beta_{1jk} = \gamma_{10k} + \gamma_{11k}(ES_{jk}) + \gamma_{12k}(CO_{jk}) + \gamma_{13k}(IS_{jk}) + \ldots + r_{1jk}$$

Level 3:

$$\gamma_{00k} = \eta_{000} + \eta_{001}(RC\ Intervention_{k}) + \mu_{00k}$$

Centering procedure. Centering decisions were determined to optimize testing both main effects (self-efficacy, teacher-student interaction quality) and a cross-level interaction (self-efficacy X teacher-student interaction quality) as dictated by our original research questions. As such, the level-1 predictor, math self-efficacy, was group-mean centered. This centering approach is often the preferred centering method when examining cross-level interactions because it removes the potential confound of between-cluster variation in the level-1 predictor and creates a “pure estimate” of the interaction effect (Enders & Tofighi, 2007). All other level-1 and level-2 variables in the model were grand-mean centered to increase interpretability of the intercept estimate. In addition to this centering procedure, all fixed-effect estimates were standardized to ease the interpretability of the models.

Results

Confirmatory Factor Analysis

Longitudinal measurement invariance was examined for the engagement factors. More specifically, we tested the assumption of strong measurement invariance in the factor model. This type of measurement invariance indicates that the loadings and threshold estimates for each item are constrained to be equivalent across time. This assumption must be met in order to compare a construct across time, because otherwise changes might simply be due to an artifact in the measurement model (Widaman, Ferrer, & Conger, 2010). Because there was no theoretical reason to believe there would be substantial variation in the measurement model over the course of the academic year, both loadings and thresholds across time for both factors were fixed in one simultaneous step. We followed the recommendations of ΔCFI < .01 when testing for longitudinal measurement invariance found in Little (2013). The baseline model showed good model fit despite a significant global chi-square test, $\chi^2(282) = 360.25$, $p < .01$, RMSEA = .027 (90% CI: [.018, .035]), CFI = .99. The constrained model showed no substantial loss of model fit, ΔRMSEA = .00, ΔCFI < .01. Factor scores were then calculated for each factor at every time point. Because these scores showed no statistically significant evidence of change over time and had high correlations between time points (r_{mean} = .79, all r's > .70), they were averaged to create the two dependent variables of emotional engagement and social engagement[1]. Standardized factor loadings for the items averaged across all three time points are presented in Table 1.

Descriptive Statistics

On average, students reported high levels of math self-efficacy (i.e. M = 3.30 on a 4-point scale). However, student scores were found to be variable (Range = 1.40 – 4.00; SD = 0.57), indicating full use of the scale. Zero-order correlations showed a positive relationship between math self-efficacy and both the emotional (r = .26, p < .01) and social (r = .38, p < .01) engagement outcomes. All three CLASS domains showed very small correlations with the two engagement outcomes (all $|r|$ < .09, p > .09). The CLASS domains were correlated with each other (r's ranged from .62 to .67) indicating similarity among these three facets of teacher-student interaction quality. This alerted us to examine variance inflation factors for multicollinearity, which were within reasonable levels for all models (all VIF < 2). Emotional and social engagement correlated positively with one another (r = .52, p < .01) indicating that these constructs are related, but still have substantial unique variance. Table 2 displays descriptive statistics for each independent variable and the correlation of each variable with the two engagement outcomes.

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[1] A growth curve model for both emotional and social engagement showed that time corresponded to a .01 to .02 SD change in both outcomes, suggesting stability in the mean trajectory. Additionally, adding a random slope only modestly improved model fit (or did not at all, depending on whether AIC or BIC was considered as the information criterion, with BIC using a more severe penalty against more complex models). Similar results appeared for the three CLASS dimensions: only classroom organization yielded a small, positive, statistically significant change over time, with no evidence for statistically significant variance in slopes.

Multi-level Models

The first step of multi-level model building involved creating an unconditional model to partition the variance in the two outcomes between the classroom level and the school level. Intraclass correlation coefficients (ICCs) for the engagement outcomes revealed more variability at the classroom level than at the school level. The classroom-level ICC for the emotional engagement outcome showed 11% of the variability was due to the classroom, whereas the social engagement outcome showed 17% of the variability was due to the classroom. The school-level ICCs for both emotional and social engagement were smaller, with only 2% and 5% of the variance in each outcome occurring at the school level, respectively.

In addition to the baseline model, a covariate model, a main effects model, and a cross-level interaction model were estimated in a hierarchical fashion. A pseudo-R^2 was created by calculating the proportion reduction in deviance comparing a given model to the baseline model for the purposes of model comparison. For emotional engagement, there was a 15% reduction in deviance for the covariate model, a 28% reduction in deviance for the main effects model, and a 29% reduction in deviance for the full model. For social engagement, there was a 16% reduction in deviance for the covariate model, a 27% reduction in deviance for the main effects model, and a 29% reduction in deviance for the full model. These values, along with parameter estimates and standard errors, can be seen in Table 3 for emotional engagement and Table 4 for social engagement.

Regarding the parameter estimates, the results for the emotional engagement model will be presented first, followed by the results for the social engagement model.

*Emotional engagement***.** Consistent with the study hypotheses, students with higher levels of math self-efficacy relative to their class showed higher levels of emotional engagement (β = .16, 95% CI: [.09, .23], $p < .01$). This main effect was also qualified by a negative interaction with emotional support ($\beta = -.14$, 95% CI: [−.25, −.04], $p < .01$), such that the association between self-efficacy and emotional engagement was attenuated in classrooms with higher levels of emotional support. No other significant cross-level interactions occurred between math self-efficacy and the other two CLASS domains.

The significant cross-level interaction in the emotional support interaction model was inspected further, treating the emotional support variable as the moderator and testing simple slopes for significance at values of -1 *SD*, 0, and + 1 *SD*. Results indicated that for both students in classrooms with low (β = .30, 95% CI: [.17, .44], $p < .01$) and average (β = .16, 95% CI: [.09, .24], $p < .01$) levels of emotional support, there was a positive relation between math self-efficacy and emotional engagement with math. That is, students who were higher in math self-efficacy reported higher emotional engagement, even in classrooms with lower to average levels of emotional support. Students in classrooms with high levels of emotional support, however, showed no such effect (β = .02, 95% CI: [−.11, .14], $p = .39$), indicating that students in classrooms with higher levels of emotional support reported similar levels of emotional engagement, regardless of self-efficacy in math (see the upper panel of Figure 2 for a visual representation of these results). Although this figure may seem to suggest that students with high levels of self-efficacy were less emotionally engaged in classrooms with higher levels of emotional support when compared to classrooms with lower levels of emotional support, this relationship was not statistically significant ($p = .19$).

Although not an original focus of this study, the emergence of the main effect of ELL status on emotional engagement led us to investigate the possibility of a three-way interaction between ELL, self-efficacy, and teacher-student interactions. The two-way interaction between emotional support and self-efficacy remained statistically significant, but the additional two-way three-way interactions were not ($p > .10$) and the models are not reported for brevity. Additionally, intervention status did not relate to emotional engagement; model results with and without intervention status were comparable.

Social engagement. Results for the social engagement model resembled results from the emotional engagement model. Students with higher levels of math self-efficacy relative to their class showed higher levels of social engagement ($\beta = .24$, 95% CI: [.13, .35], $p < .01$), consistent with the study hypotheses. However, this main effect was qualified by a negative interaction with emotional support ($\beta = -.26$, 95% CI: [−.41, −.11], $p < .01$), such that the association between math self-efficacy and social engagement was attenuated in classrooms with higher levels of emotional support. No other significant cross-level interactions occurred between math self-efficacy and the other two CLASS domains.

The significant cross-level interaction in the emotional support interaction model was inspected further by treating the emotional support variable as the moderator and testing simple slopes for significance at values of -1 SD, 0, and +1 SD. Results indicated that both students in classrooms with low ($\beta = .50$, 95% CI: [.30, .70], $p < .01$) and average ($\beta = .24$, 95% CI: [.13, .35], $p < .01$) levels of emotional support showed a positive relation between math self-efficacy and social engagement with math. Students high in math self-efficacy reported being more socially engaged with math, even in classrooms with lower to average levels of emotional support. Students in classrooms with high levels of emotional support, however, showed no such effect (β = -.02, 95% CI: [−.20, .17], p = .57), indicating that students reported similar levels of social engagement in classrooms with higher levels of emotional support regardless of their self-efficacy in math (see the lower panel of Figure 2 for a visual representation of these results). Although this figure may seem to suggest that students with high levels of self-efficacy are less socially engaged in classrooms with higher levels of emotional support when compared to classrooms with lower levels of emotional support, this relationship was not statistically significant (p = .21).

Although not an original focus of this study, the emergence of the main effect of gender on social engagement as well as research supporting gender effects important in math learning (e.g., Marks, 2000) led us to investigate the possibility of a three-way interaction between gender, self-efficacy, and teacher-student interactions. The two-way interaction between emotional support and self-efficacy remained statistically significant, but the additional two-way and three-way interactions were not (p > .10) and the models are not reported for brevity. Additionally, intervention status did not relate to social engagement; model results with and without intervention status were comparable.

Discussion

The purpose of the present study was twofold: (a) to examine the contribution of math self-efficacy to students' perception of their emotional and social engagement in fifth grade math classes, and (b) to examine whether high quality teacher-student interactions compensate for students' low math self-efficacy in contributing to engagement. There are two findings of note, with results of comparable direction and magnitude for both emotional and social engagement in math. First, students with higher levels of math self-efficacy (relative to other students in their class) reported experiencing greater levels of emotional and social engagement in math class. This finding is consistent with other work describing student self-efficacy as a critical element in students' motivation (Linnenbrink & Pintrich, 2003; Martin, Anderson, Bobis, Way, & Vellar, 2012). Second, in classrooms with high levels of emotional support (e.g., sensitive, responsive interactions among teachers and students), students reported similar levels of both emotional and social engagement, regardless of their initial self-efficacy. High levels of emotional support, but not organizational or instructional support, compensated for students' feelings of low self-efficacy in contributing to student engagement. These findings reflect the person-environment fit theory and are consistent with the academic risk perspective. Students perform best when their intra-psychic experiences fit well with the demands and challenges in their environment. Although the design of the current study does not warrant causal inference, students at greater risk for school problems (based on low-self efficacy) appeared to benefit more from high quality emotional support than their counterparts without such risk—a finding consistent with other school-based research (Crosnoe & Cooper, 2010; Hamre & Pianta, 2005).

This study takes a distinct perspective by focusing on emotional and social engagement in fifth grade classrooms—aspects of engagement that are less well studied than behavioral engagement (Finn & Zimmer, 2012). Four unique contributions stand out. First, we focus on engagement in math exclusively in contrast to most research that considers engagement in school across school subjects. Second, we focus on students' own perception of their emotional and social engagement in math learning as opposed to relying on teacher or observer report. Third, we differentiate students based on their initial self-efficacy in math learning; in doing so, we call attention to the reality that students' intra-psychic experiences can cause them to hold back and not engage fully in the instruction offered to them. Fourth, we gathered data from students on their engagement on three different days during the year, allowing us to create a more stable representation of students' overall classroom experience. Taken together, this study contributes to an important area of need by considering both student self-beliefs and classroom experiences that threaten (or bolster) student engagement (Finn & Zimmer, 2012).

Self-Efficacy and Engagement

The first finding highlighted the strong relation between student self-efficacy and emotional engagement in math class. Emotional engagement refers to the students' enjoyment and interest in math, feelings that are critically important to both motivation and success. Singh, Granville, and Dika (2002) found that motivation toward attending school and attitudes toward math and science were important predictors of both math and science achievement in a sample of middle school students. Additional research has found that interest related positively to students' use of regulatory strategies (e.g. seeking/learning information and behavior management) when learning math (Cleary & Chen, 2009). Thus, existing work suggests that sustained interest and enjoyment in math has important consequences for future success. However, maintaining high levels of interest and enjoyment daily in math may not be tenable, especially when students are learning new and difficult material. The findings here suggest the important role that self-efficacy plays in boosting emotional engagement in math, situating self-efficacy as an important student attribute to maintain motivation in learning despite the challenges present.

Social engagement refers to positive exchanges between peers that connect to the instructional content of the lesson. The current results suggest that when a student feels more effective in math, he/she appears to be more comfortable working as part of a group and helping others. Social engagement is a less well-studied but critically important aspect of engagement. Viewed from a developmental perspective, schools have the potential to be socially-rich resources in students' lives yet relatively little of the school day involves teachers' facilitation of peer exchanges about academic content (NICHD-ECCRN, 2005). Future research on social engagement is necessary given the relation between peer groups, student enjoyment of learning, and academic achievement (Ryan, 2001) and given national math standards for teachers that proscribe peer interaction and mathematical discourse (National Council for Teachers of Mathematics, 2014).

The results show that self-efficacy early in the fifth grade year relates to greater emotional and social engagement throughout the school year. However, feelings of self-efficacy and emotional and social engagement may be cyclical in nature. That is, higher levels of engagement might also produce stronger feelings of efficacy. Students derive feelings of efficacy (or lack of self-efficacy) from the feelings that they experience when they perform tasks (e.g., calm and curious versus agitated) and the observations of successful task performance that they make about students like them (Schunk, 1985, 1987). Thus, it is quite plausible that positive feelings about completing math (emotional engagement) fuel stronger feelings of self-efficacy in the future. It is also feasible that that students working with peers like them who also are succeeding at tasks contribute to stronger feelings of self-efficacy. These possibilities warrant future inquiry.

Moderating Role of Teacher-Student Interaction Quality

The second finding showed that the positive relation between self-efficacy and engagement was present only in classrooms with lower to average levels of emotional support. Students in classrooms with higher emotional support showed similar levels of emotional and social engagement, regardless of students' perceptions of their self-efficacy. The person-environment fit theory states that students are more susceptible to academic decline when there is a lack of alignment between their individual needs and the demands of their learning environment. Additionally, the academic risk perspective posits that the quality of teacher-student interactions may have greater influence on student engagement when the students' attributes place them at greater risk for school problems. This finding fits with both theories and highlights the importance of having a student in a classroom that adequately addresses his or her emotional needs. It is possible that high self-efficacy serves as a buffer in that the presence of this internal, intra-psychic resource compensates for being in a classroom that lacks teacher warmth, teacher responsiveness and positive social climate. As a result, students high in self-efficacy report being more emotionally and socially engaged regardless of teacher supportiveness. Students with lower levels of self-efficacy, however, lack this buffer. As a result, their engagement levels are more reflective of the immediate classroom conditions, meaning that students show lower levels of engagement in classrooms with lower levels of teacher support and higher levels of engagement in the presence of higher levels of teacher support.

Although the present findings suggest that students with high self-efficacy seem to be more engaged regardless of the classroom environment, this finding does not mean that positive teacher-student interactions are not important for them as well. One plausible reason that we did not see associations between self-efficacy and engagement among students in classrooms with high levels of emotional support pertains to sampling. The sample of children selected had an average math self-efficacy of 3.30 on a scale from 1 to 4, indicating that this sample of students was very high in math self-efficacy. This raises a question for future research. If, on average, the sampled students reported lower levels of self-efficacy, would we have detected a greater influence of self-efficacy on engagement regardless of emotional support?

Although emotional support moderated the relation between self-efficacy and engagement, organizational and instructional supports did not. These findings show differentiation among the types of supports available to students with low self-efficacy. The presence of moderation for emotional support but not organizational and instructional support is surprising given that the subject area is math. Math tends to focus on the development of technical skills compared to other content areas (social studies, language arts) that lend themselves to conversations about relationships and feeling states (Pianta et al., 2008). One possibility is that emotional support may be especially important for help-seeking. Given comparable classroom conditions, students who are low in self-efficacy may be less likely to seek help than their high self-efficacy peers because of their concerns that peers and teachers will question their competence (Linnenbrink & Pintrich, 2003). Teachers who are sensitive, aware of student needs and individual differences, positive, and approachable may be more accessible to students and may counteract the tendency of students with low self-efficacy to withdraw from available supports.

Although the moderation finding is somewhat surprising for the math domain, it is not the only research linking emotionally supportive interactions to engagement. Several other studies in upper elementary and middle school demonstrate the importance of emotionally supportive relationships for predicting student engagement and learning (Klem & Connell, 2004; Reyes et al., 2012; Sakiz et al., 2012). However, results for classroom organization are mixed; some studies link classroom organization to engagement for students more at risk for school problems (Ponitz, Rimm-Kaufman, Brock & Nathanson, 2009), whereas others show the importance of classroom organization regardless of the students' risk profile (Rimm-Kaufman et al., 2009). Among the three components—emotional, organizational, and instructional support—work on instructional support has been the least conclusive (Pianta, Belsky, Vandergrift, Houts & Morrison, 2008), which is one possible explanation for why instructional support findings did not support moderation here.

Limitations

This study has several limitations. First, teacher-student interaction quality was measured using an observationally-based tool, resulting in a classroom-level variable. Although using an observational measure can help circumvent potential measurement issues found in self-report data (e.g., Fan et al., 2006), doing so ignores the fact that children in the same classroom may have different relationships and interactions with their teacher. Measuring teacher-student interaction as a child-level variable could provide more detail regarding unique teacher-student relationships. Second, this study is descriptive and does not permit causal inferences. Comparable work that intervenes to improve emotional support is necessary to establish cause and effect relationships. Third, both measures of math self-efficacy and engagement in math involved student self-report. The high average value for self-efficacy may reflect issues of social desirability. Thus, interpretation of the positive relationship between self-efficacy and engagement requires caution because it may reflect systematic effects of a single reporter.

Finally, we acknowledge some limitations in operationalizing social engagement in that asking a student if they discussed math content with their peers may reflect aspects of the teachers' instruction (i.e., did the teacher provide time to work with peers) instead of the actual engagement of the student. This concern was partially mitigated because many of the teachers used standards-based math practices involving opportunities to work with peers.

Future Directions

The present study calls attention to the importance of examining how constructs such as self-efficacy, teacher-student interactions, and engagement not only relate to the math domain (e.g., Patrick et al., 2007), but also to math sub-domains in later educational experiences. As math focus shifts from basic numbers and operations to more specific subject matter, such as algebra and geometry, it seems important to examine the consequences of students feeling efficacious in one math subject but not others. Having this knowledge could improve student placement with some teachers versus others, and also could target points in students' school experience when they need extra support.

Future research could pursue the ideas outlined in this paper in a longitudinal framework to better understand the potential bi-directional relations between the students and teachers in the math classroom. For example, Hughes and Chen (2011) found that peer liking and teacher-student relationship quality exhibited bidirectional effects on one another in a three-year longitudinal study, such that students who reported higher levels of peer relationships at an earlier time point typically had teachers report higher levels of teacher-student relationship quality at a later time point. In the context of this study, such a longitudinal framework would allow the examination of how students with low self-efficacy respond to different classroom environments in subsequent years. For example, students with low self-efficacy coming from a supportive classroom might be more resilient in later classroom experiences compared to students with low self-efficacy who consistently reside in classroom environments poorly matched to their psychological needs. Future work measuring self-efficacy longitudinally may have value given that self-efficacy is a malleable construct that could have bi-directional relations with different types of student engagement in learning.

Implications for Educational Practitioners

The person-environment fit theory guides the implications of this work. Practitioners can focus on *person* or *environment* characteristics to improve engagement. Focusing on person characteristics involves enhancing self-efficacy in students with the idea that self-efficacy may offer resiliency and enable high levels of engagement even in the presence of unsupportive teachers. One approach to promote self-efficacy in math is to help students interpret their feelings when they experience a challenge. When students feel challenged in math, a school psychologist or teacher can help the student realize that this feeling stems from the actual challenge of the work while also conveying his/her realistic belief that the student is capable of meeting his/her high expectations. Research has shown that setting these high standards and promoting the belief that the students can achieve those standards results in increased levels of identification with the particular skill in question (i.e., association of self-identity with a given domain; Cohen, Steele, & Ross, 1999). Yet another approach to enhancing self-efficacy in math is by promoting a growth mindset (i.e., belief that ability can be developed with effort) rather than a fixed mindset (i.e., belief that ability is a stable trait that someone either has or does not have). Helping students see the connection between their effort and performance contributes to a growth mindset. This approach shows promise given existing work linking growth mindsets to motivation and achievement (Blackwell, Trzesniewski, & Dweck, 2007). Enhancing student self-efficacy could be fruitful to buffer students as they face challenges in math.

Practitioners can take a different approach to promoting student engagement by intervening to improve teachers' emotional support in the math classroom. Several interventions look promising to improve teacher-student interaction quality. My Teaching Partner-Secondary, a web-based coaching program for secondary teachers, produced an increase in student achievement gains, an effect mediated by improved quality of teacher-student interactions (Allen, Pianta, Gregory, Mikami, & Lun, 2011). Social and emotional learning interventions such as *Responsive Classroom* approach, 4Rs, and RULER also show promise in their ability to boost emotional support in teachers (Abry, Rimm-Kaufman, Larsen, & Brewer, 2013; Brown, Jones, LaRusso & Aber, 2010; Rivers, Brackett, Reyes, Elbertson & Salovey, 2012). Taken together, both student self-efficacy and emotionally supportive teacher-student interactions are malleable characteristics of individuals and classroom environments. Efforts to boost either person or environment features may be promising avenues to improve emotional and social engagement.

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Table 1

Confirmatory Factor Analysis for Student-Reported Engagement

Items	Average Standardized Loading
Emotional Engagement	
Math class was fun today	.88
Today I felt bored in math class	-.74
I enjoyed thinking about math today	.89
Learning math was interesting to me today	.83
I liked the feeling of solving problems in math today	.77
Social Engagement	
Today I talked about math to other kids in class	.63
Today I helped other kids with math when they didn't know what to do	.77
Today I shared ideas and materials with other kids in math class	.70
Students in my math class helped each other learn today	.65

Note: Model fit was good for the two-factor model: RMSEA = .027 (90% CI: [.019, .034]), CFI = .99. Additionally, comparing the two factor model seen above to a one factor model resulted in a decrease in model fit, RMSEA = .072 [.067, .077], CFI = .90.

Table 2
Descriptive Statistics and Correlations of Each Predictor with Engagement Outcomes

Variables	*M*	*SD*	M*in*	*Max*	*N*	Correlation with Social Engagement	Correlation with Emotional Engagement
Gender	.53	-	-	-	386	.10*	.03
ELL	.37	-	-	-	332	-.06	.16**
Free/Reduced Lunch	.22	-	-	-	386	.01	.14**
Initial Achievement	506.38	70.68	284.00	600.00	332	.14**	.01
Teacher Experience (years)	12.43	8.65	1.00	38.00	374	-.12*	-.02
Intervention Status	.55	-	-	-	387	.09	.02
Self-Efficacy	3.30	.57	1.40	4.00	379	.37***	.26***
Emotional Support	5.17	.60	3.62	6.17	357	.06	.06
Instructional Support	3.36	.66	1.83	5.17	357	-.04	.07
Classroom Organization	6.03	.41	4.39	6.67	357	.05	.09
Social Engagement	-.01	.48	-1.25	1.02	384	-	.52***
Emotional Engagement	-.04	.68	-1.92	1.22	384	.52***	-

Note. Child Gender (0 = male, 1 = female); ELL (0 = no, 1 = English Language Learner status); Free/Reduced lunch (0 = no, 1 = yes); Teacher Degree (0 = no Masters, 1 = Masters); Intervention Status (0 = control, 1 = intervention).
* $p < .05$, ** $p < .01$, *** $p < .001$

Table 3
Model results for the four multi-level models with emotional engagement in math as the outcome.

Estimate	Model 1 (Null)	Model 2 (Covariate)	Model 3 (Main Effects)	Model 4 (Full)
Intercept	-.05 (.05)	-.08 (.05)	-.08 (.05)	-.08 (.05)
Gender	-	.02 (.04)	.03 (.04)	.02 (.04)
ELL	-	.08 (.04) *	.10 (.04) *	.11 (.04) *
Free/Reduced Lunch	-	.07 (.04)	.08 (.04)	.08 (.04)
Initial Achievement	-	.07 (.04)	.04 (.05)	.04 (.05)
Teacher Experience (years)	-	.02 (.05)	.03 (.05)	.03 (.05)
Intervention Status	-	.00 (.05)	-.03 (.05)	-.03 (.05)
Self-Efficacy	-	-	.15 (.04) ***	.16 (.04) ***
Emotional Support	-	-	.03 (.06)	.03 (.06)
Instructional Support	-	-	.00 (.07)	.00 (.07)
Classroom Organization	-	-	.06 (.07)	.06 (.07)
Emotional Support x Self-Efficacy	-	-	-	-.14 (.05) **
Instructional Support x Self-Efficacy	-	-	-	.06 (.05)
Classroom Organization x Self-Efficacy	-	-	-	.01 (.07)
ΔR^2	-	.15	.28	.29

Note. All estimates are standardized and reported with their standard errors in the parentheses. ΔR^2 was calculated as the reduction in deviance compared to the null model.
* $p < .05$, ** $p < .01$, *** $p < .001$

Table 4
Model results for the four multi-level models with social engagement in math as the outcome.

Estimate	Model 1 (Null)	Model 2 (Covariate)	Model 3 (Main Effects)	Model 4 (Full)
Intercept	-.01 (.08)	-.06 (.09)	-.05 (.09)	-.05 (.09)
Gender	-	.15 (.05) ***	.15 (.05) **	.14 (.05) **
ELL	-	-.09 (.06)	-.08 (.06)	-.07 (.06)
Free/Reduced Lunch	-	.01 (.06)	.03 (.06)	.02 (.06)
Initial Achievement	-	.16 (.06) **	.11 (.07)	.11 (.07)
Teacher Experience (years)	-	-.06 (.08)	-.08 (.08)	-.11 (.08)
Intervention Status	-	.06 (.10)	.04 (.10)	-.04 (.09)
Self-Efficacy	-	-	.21 (.05) ***	.24 (.06) ***
Emotional Support	-	-	.08 (.11)	.09 (.11)
Instructional Support	-	-	-.14 (.12)	-.15 (.11)
Classroom Organization	-	-	.06 (.12)	.05 (.12)
Emotional Support x Self-Efficacy	-	-	-	-.26 (.08) ***
Instructional Support x Self-Efficacy	-	-	-	.05 (.08)
Classroom Organization x Self-Efficacy	-	-	-	.06 (.10)
ΔR^2	-	.16	.27	.29

Note. All estimates are standardized and reported with their standard errors in the parentheses. ΔR^2 was calculated as the reduction in deviance compared to the null model.
* $p < .05$, ** $p < .01$, *** $p < .001$

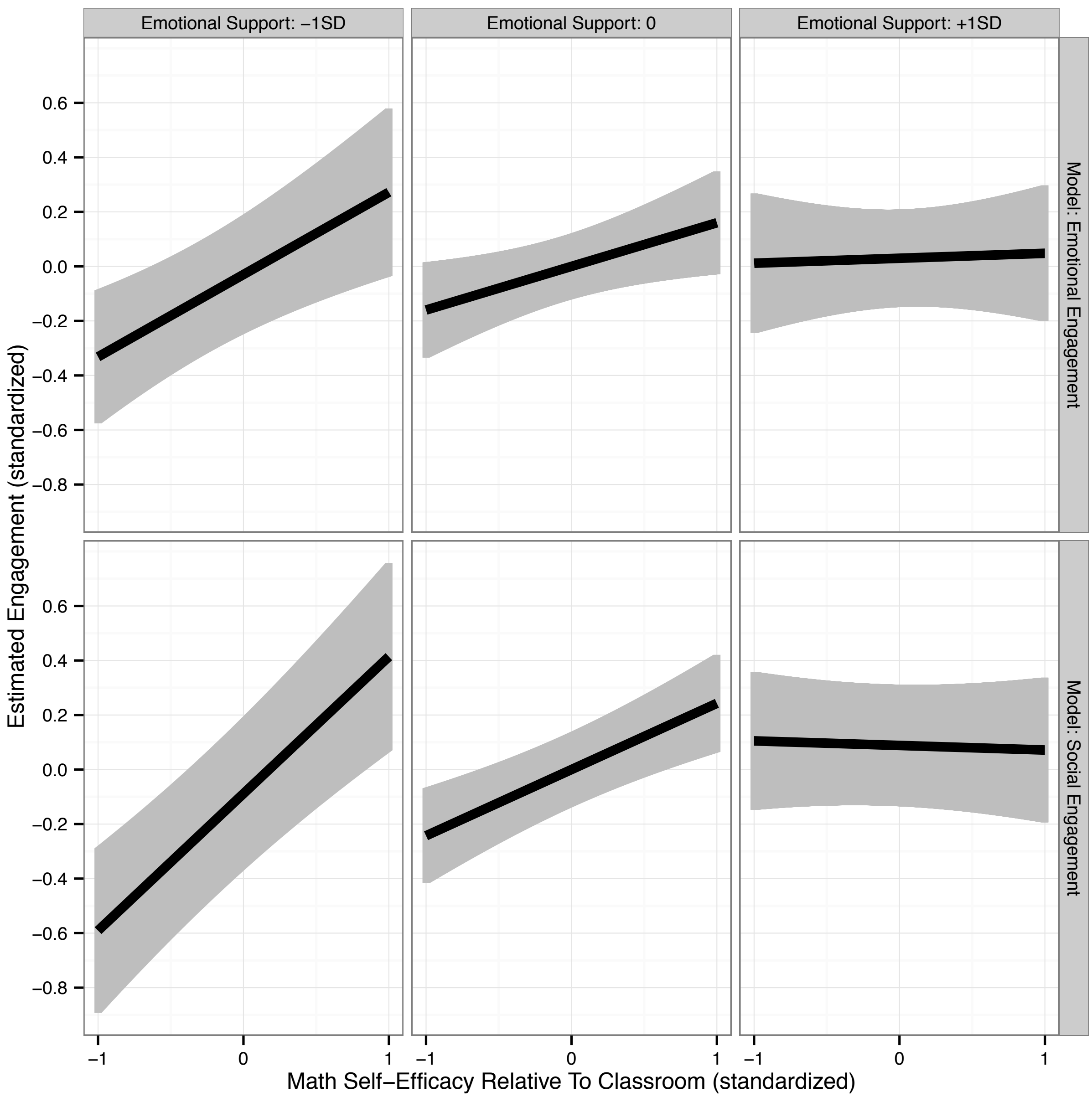

Figure 2. Plots of simple slopes to visualize the interaction between math self-efficacy and classroom emotional support with both student emotional engagement (on the top) and student social engagement (on bottom) in math as the outcome variables. Here, emotional support is treated as the moderator. The gray intervals are standard errors, estimated via a multilevel non-parametric bootstrap procedure.