A Multi-method Approach for Describing the Contributions of Student Engagement on Fifth
Grade Students' Social Competence and Achievement in Mathematics

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Abstract

Multiple perspectives of measuring engagement (i.e., student-, teacher-, and observer-report) were used to describe the contributions of engagement during mathematics instruction on fifth graders' ($N=387$) social skills and achievement. Students completed questionnaires on their mathematics engagement. Teachers completed questionnaires on students' engagement and social skills. Researchers observed student engagement during math lessons. Students' scores on a standardized test were used to assess mathematics achievement. All three approaches to measuring engagement were significantly associated with students' social skills in math class. Teacher- and observer-reported engagement were significantly associated with students' mathematics achievement, but student-reported engagement was not significantly associated with achievement. Moderation analyses revealed that associations between math engagement and outcomes were no different for boys than girls. Findings are useful when considering ways to identify engagement and promote social interactions and achievement during mathematics instruction.

Keywords: Engagement, Mathematics, Social competence, Achievement, Gender, Elementary School

During fifth grade, students are typically culminating their elementary school experiences and preparing for the transition to middle school. Fifth grade teachers face challenges in their efforts to engage children in mathematics learning during this critical juncture. The purpose of the study is to improve our understanding of engagement in upper elementary school mathematics classes and help educators make decisions about how to assess student engagement in efforts to promote mathematics achievement and social skills. In this study, we use three approaches to measuring engagement (i.e., observed, student-reported, and teacher-reported) and build upon existing research (Rimm-Kaufman, Baroody, Larsen, Curby, & Abry, 2015) to consider how these approaches to measuring engagement relate to student outcomes.

Defining and Measuring Engagement

To effectively guide students' development of academic and social skills, teachers need to make daily decisions about what instruction and supports they are offering and what adjustments need to be made. Day to day teachers need to rely on indicators that they can see. One indicator of school success is students' engagement in learning (Connell, 1990; Connell & Wellborn, 1991; Skinner, Kindermann, Connell, & Wellborn, 2009).

Engagement is a complex construct (Fredricks, 2011; Reschly & Christenson, 2012; Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006). While there is a need to understand engagement and help teachers to engage students in content areas, such as mathematics, conceptualizing and reporting engagement can be challenging. In order for student engagement to be a meaningful indicator of school success, schools need tools to measure engagement in specific classroom contexts that predict important outcomes such as achievement and social skills. Accomplishing this task requires understanding the construct of engagement (i.e., what is

being measured) and examining the relative contribution of different measurement approaches in the classroom setting.

Engagement is conceptualized as a multi-dimensional construct (Fredricks, 2011; Reschly & Christenson, 2012; Skinner, Kindermann, Connell, & Wellborn, 2009); however the number of dimensions varies by model. Most scholars agree that engagement consist of some type of participatory component (Reschly & Christenson, 2012). This refers to students' involvement and participation in tasks or activities (Fredricks, 2011; Fredricks, Blumenfeld, & Paris, 2004; Reschly & Christenson, 2012). Measures of engagement also differ by method and informant (e.g., questionnaire, observation; Fredricks et al., 2011). In this paper, we used three approaches to measuring engagement in fifth grade math classrooms: observation, student-report, and teacher-report. These three measures provide the perspectives of different informants on fifth grade students' mathematics engagement and capture the participatory aspect of engagement which involves thinking and focusing on math-related tasks.

Role of Engagement and Outcomes

Theoretical framework. The Self-Systems framework posits four main components: context, self, action, and outcomes (Connell, 1990; Connell & Wellborn, 1991; Skinner, Kindermann, & Furrer, 2009). *Context* refers to the opportunities and provisions afforded by the child's setting (e.g., the classroom). *Self* refers to the internal cognitive and emotional processes that occur within the child such as perceived competences and autonomy. *Action* stems from the context and self-processes and is displayed through engagement or disaffection. Lastly, *outcomes* refer to factors that are predicted by engagement such as academic achievement and social competence. For this study we focus on the latter half of the model, specifically the action (engagement) and outcome (achievement and social competence) components.

The most prevalent research on engagement focuses on students' engagement across academic domains or content areas (Fredricks et al., 2011; Reschly & Christenson, 2012). In this study, we specifically examine engagement in mathematics class. Beginning in early elementary school, children are able to distinguish between domains in terms of task value, task enjoyment, and task-related feelings of competence (Mantzicopoulos, French, & Maller, 2004; Marsh, Ellis, & Craven, 2002; Wigfield, Tonks, & Klauda, 2009). This means students can be more engaged in one area (e.g., mathematics) while being less engaged in another (e.g., social studies; Mark, 2000). In this study, we focus specifically on examining mathematics engagement.

Engagement, social skills, and achievement. According to the Self-systems framework, engagement within a high quality context produces two important school outcomes: social competence and academic achievement (Connell, 1990; Connell & Wellborn, 1991; Skinner et al., 2009). Research suggests that both of these outcomes are important to school success.

Social skills. Students who are less engaged are more likely to display off-task behavior that disrupts class and learning. Social skills have been extensively studied in preschool and early elementary grades and are associated with indicators of school success (Domitrovich, Cortes, & Greenberg, 2007; McClelland, Acock, & Morrison, 2006; McClelland, Morrison, & Holmes, 2000). Furthermore, elementary and middle school curricula, programs, and interventions which focus on fostering positive interactions and prosocial behaviors are associated with positive student benefits (Brackett, Rivers, Reyes, & Salovey, 2012; Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011; Greenberg et al., 2003; Payton et al., 2008).

Upper elementary school teachers report that certain social skills (e.g., cooperation, self-control) are critical to school success and maintaining an effective learning environment (Lane, Givner, & Pierson 2004; Lane, Pierson, & Givner, 2003; Meier, DiPerna, & Oster, 2006).

Engagement is likely to promote more positive peer interactions that foster learning (Kindermann 1993, 2007). Student cooperation, self-regulation, and positive peer interactions are especially important in mathematics classrooms in light of recent standards-based math instruction which emphasizes enhancing students' understanding of critical concepts through small group activities and discussions (Fuson, Kalchman, & Bransford, 2005; National Council of Teachers of Mathematics [NCTM], 2000). These activities require peer interactions, discussions, and resolution of differing view points; all classroom experiences that rely on students' appropriate social skills.

Math achievement. Student engagement has been linked to students' general academic achievement in elementary and middle school (Bodovski & Farkas; 2007; Finn & Zimmer, 2012; Hughes, Luo, Kwok, & Loyd, 2008; Marks, 2000) and specifically to students' mathematics achievement in elementary school (DiPerna et al., 2005; Hughes et al., 2008). Despite the growth of research on student engagement, little research focuses exclusively on mathematical engagement during math activities (Fredericks, Blumenfeld, & Paris, 2004). Studies (e.g., DiPerna et al., 2005; Hughes et al., 2008) have assessed mathematical achievement as an outcome, but the engagement measure has not been math specific. It is likely that math specific engagement will also be significantly associated with mathematics performance, since general engagement is related to mathematics. However, this assumption needs empirical support. Engagement is recognized as an important component in mathematical learning as demonstrated by NCTM (2000) and the National Research Council [NRC] (2005) who press for greater understanding of the classroom conditions that foster engagement in mathematics.

Student gender. Several factors contribute to the associations between engagement, achievement and social skills. One potential moderator is student gender. Gender differences

have been reported in engagement, mathematics achievement, and social interactions.

Throughout elementary, middle, and high school, girls are more likely to be rated by themselves and teachers higher on engagement (Hughes et al., 2008; Lam et al., 2012; Roorda, Koomen, Spilt, & Oort, 2011). However, engagement in boys is a stronger predictor of academic outcomes compared to engagement in girls (Van de gaer, Pustjens, Van Damme, & De Munter, 2009).

Elementary school girls, on average, have closer and lower conflict relationships with teachers compared to boys (Hughes et al., 2008), while boys, on average, have higher mathematics performance than girls (Robinson & Lubienski, 2011).

Current Study

Our previous work has examined the contributions of teacher-student interaction quality and student gender on students' engagement in math classrooms (Rimm-Kaufman et al., 2015). The current study builds on this work by linking student engagement with student outcomes in math classrooms. Specifically, this study contributes to the field by considering the relative utility of three approaches to measuring engagement. Examining the relative contribution of each measure of engagement to students' social competence and math achievement in upper elementary math classrooms can help address practical questions including: How useful are teachers' reports of students' mathematical engagement in predicting students' social and math performance at the end of the year? Is it a better use of teachers' time and school resources to ask students directly about their engagement or bring in an outside observer at various points in the year to give a sense of what's working or not working? Are the associations between signs of engagement and social and math outcomes similar for boys and girls?

Specifically, we address two research questions: (a) To what extent does students' engagement in mathematics relate to students' social skills and mathematics achievement? (b)

Does student gender moderate the association between student mathematics engagement and outcomes (i.e., social skills in math class and mathematics achievement)?

Common covariates (i.e., working memory, age, family income) were measured and included in models. Each of these covariates is likely to contribute to engagement and/or outcomes. Working memory is related to higher-order cognitive tasks (e.g., reasoning; Daneman & Carpenter, 1980). Poor working memory is associated with increases in adults' ratings of children's inattentive behavior (one aspect of engagement) and decreases in children's performance on math tasks via increased math anxiety (Ashcraft & Moore, 2009; Engle, 2002; LeFevre, DeStefano, Coleman, & Shanahan, 2005; Lui & Tannock, 2007). Age is associated with self-regulation, an important aspect of social skills, as well as mathematics performance and engagement (Bronson, 2001; Mark, 2000; Robinson & Lubienski, 2011). Low family income is an indicator of the challenges and stresses of living in an impoverished environment which contributes to students' ability to self-regulate, engage, and perform well in school (Eccles & Wigfield, 2002; Evans & English, 2002; Evans & Rosenbaum, 2008; Huang, 2000; Mark 2005).

Method

Participants

Sixty-three fifth grade math teachers from 20 schools in a Mid-Atlantic state consented to participate in the current study. Teachers were mostly females ($n = 57$) and Caucasian ($n = 48$), with an average of 12.49 years of teaching experience (range = 1-38 years). Mailings were sent to parents/guardians of fifth grade students in participating classrooms before the beginning of the school year. Parents/guardians of 479 students signed consent forms and received gift cards following approved IRB protocols. Of the students with parental consent, researchers selected approximately five students per classroom ($n = 387$; mean age = 10.47 years, $SD = .38$, 183

boys). Selection of students was random within two constraints a) the resulting sample was representative of the school demographics (41% = Caucasian, 21% = Free/reduced priced lunch [FRPL]) and b) the sample consisted of roughly equal numbers of boys and girls.

Procedures

Parents completed a questionnaire on their child's demography and family background and research assistants assessed children's working memory in the fall. Research assistants observed the frequency of student engagement during a math lesson and rated students' engagement. Observations were scheduled in windows: fall (September-November), winter (November-February), and spring (February-April). After each observation, students completed a questionnaire reporting on their engagement in math class that day. In the spring, math teachers completed questionnaires on students' engagement in math class and students' social competence. Researchers procured students' 5th grade mathematics achievement scores on state tests from district databases (see Rimm-Kaufman et al., 2015 for additional information).

Measures

Parent questionnaire. Items asked about parents' highest educational attainment, language spoken at home, child's race/ethnicity, child's age, and child's gender.

Working memory. Working memory was assessed using the Auditory Working Memory (AWM) subtest of the Woodcock Johnson III (WJIII) Test of Cognitive Abilities (Woodcock, McGrew, & Mather, 2001). The subtest consists of 21 items administered via audio recording and requires students to listen and recall sets of words. AWM has good internal consistency reliability with a median alpha of .88 in a sample of 5-19 year old children (Mather & Woodcock, 2001).

Observed engagement. Engagement in math class was observed using the Student Observed Engagement Measure, a time sampling and global rating system (Ponitz, Rimm-Kaufman, Grimm, & Curby, 2009) that built upon prior observational systems designed to measure engagement (NICHD-ECCRN, 2005; Rimm-Kaufman, Curby, Grimm, Nathanson, & Brock, 2009). Research assistants observed each student for two non-consecutive four-minute intervals during a math lesson. At the end of each minute, the observer rated the student as engaged or disengaged/disaffected. This resulted in four engagement ratings within each four-minute interval. Engagement ratings were based on attention, focus, and on-task behaviors. At the end of each interval, global ratings on participation, self-reliance, and disruptive behavior were given on a scale from one to seven ($1 = low$; $7 = high$). Disruptive behavior was reversed coded.

Intensive reliability training was conducted before observers began classroom data collection. Reliability was lower than desired before beginning classroom observations of students (ICC of .65 disengagement and 75% within one scale point for the global ratings based on eight segments). During monthly calibration sessions (additional eight segments), reliability improved (ICC of .95 for disengagement and 90% within one scale point for the global ratings).

Student-reported engagement. Students reported on their engagement in math class using a 6-item questionnaire with a scale from 1 (*no, not at all true*) to 4 (*yes, very true*). This questionnaire assessed behavior showing cognitive engagement in learning (e.g., “I paid attention in math class today”) as well as disaffected learning behavior (e.g., “In math class today, I thought about other things instead of math”, (reverse coded). Measures from other research teams were adapted to assess students’ cognitive engagement in math class (Meece, 2009; Rowley, Kurtz-Costes, Meyer, & Kizzie, 2009; Skinner & Belmont, 1993). An average

was taken for each student resulting in an engagement score ranging from 1-4. Internal consistency-reliability was adequate in the current sample ($\alpha = .78$). This estimate is consistent with or higher than internal consistency-reliability estimates for engagement items used in self-report measures during elementary school (Fredricks et al., 2011).

Teacher-reported engagement. Students' engagement in math class was measured using an 8-item questionnaire. The questionnaire contained items pertaining to engaged behavior (e.g., "This student works as hard as he/she can during math class") and disaffected behavior (e.g., "This student's attention seems to wander during math class" [reverse coded]). This engagement measure was developed originally by Connell and Wellborn (1991), but the items used herein were adapted for a mathematics context. Teachers rated each engagement item on a four-point scale (1 = *strongly disagree*; 4 = *strongly agree*). Items in this measure have been used in other studies of students' engagement (Skinner & Belmont, 1993; Wu, Hughes, & Kwok, 2010). An average was taken for each student resulting in an engagement score ranging from 1-4. Internal consistency-reliability was excellent in the current sample ($\alpha = .92$).

Social skills. Students' social skills were measured through the Social Skills Improvement System (SSIS; Gresham & Elliott, 2008). Teachers completed 20 items from three of the subscales: cooperation (e.g., Follows your directions), communication (e.g., Says "please"), and engagement (Makes friends easily). Items were rated on a 4-point scale (1 = *Never*, 4 = *Very Often*). Scores were averaged together to create a social skills score which was used in analyses ($\alpha = .94$).

Mathematics achievement. Students' fifth grade mathematics achievement was measured using scores from the fifth grade Standards of Learning (SOL) assessment, a 50-item multiple choice state standardized test administered in May ($\alpha = .88$; Virginia Department of

Education [VDOE], 2008). Items assess students' 1) number and number sense, 2) computation and estimation, 3) measurement and geometry, and 4) probability, statistics, patterns, functions and algebra (VDOE, 2010). Raw scores were computed by summing the number of correct items. These scores were then converted to a scaled score (refer to VDOE 2008 for more information). Scale scores range from 200-600, with students being considered proficient with a score of 400 or above.

Plan of Analyses

We created aggregated scores for observer-reported engagement by performing a confirmatory factor analysis using the time-sampled observed engagement frequency (engaged vs. disengaged) and the three global ratings. We then computed a composite of these factor scores across time. We created a composite for student-reported engagement by computing the average engagement scores across time points (for more information on the creation of engagement scores see Rimm-Kaufman et al., 2015). Descriptive statistics and correlations were computed for variables of interest (Table 1 and 2). Means are reported for the whole sample as well as by gender to provide context for later analyses.

Preliminary descriptive analyses. Girls on average had higher means on all approaches to measuring engagement, a finding reported elsewhere (Rimm-Kaufman et al., 2015). Table 1 expands beyond previous work (Rimm-Kaufman et al.) and provides descriptive statistics showing gender differences for each approach to measurement. Engagement measures were significantly correlated with each other, but the magnitude of these correlations was small, as reported elsewhere (Rimm-Kaufman et al.).

Contributions of engagement. To address the first research question, we simultaneously regressed math achievement and social competence scores on student engagement. Three models

were conducted (one model for each measurement approach for engagement—student, teacher, and observer). We accounted for nesting at the classroom level by adjusting the standard errors preventing them from being artificially low (Mplus command: TYPE=COMPLEX). All analyses controlled for student gender (1 = girl, 0 = boy), FRPL (1 = eligible, 0 = not eligible), English proficiency level, and working memory (See Table 2 for correlations among variables). Full Information Maximum Likelihood (FIML) was used to account for missing data (Muthén & Muthén, 1998-2010).

Gender as a moderator. To address the second research question, we created three interaction terms between gender and each measurement approach of engagement (Engagement X Gender). These terms were added to the models described above.

Results

Contributions of engagement. All approaches to measuring students' mathematics engagement were significantly related to teacher-reported ratings of students' social competence (student-reported: $b = .20$, $\beta = .22$, $p < .01$; teacher-reported: $b = .38$, $\beta = .56$, $p < .01$; observer-reported: $b = .22$, $\beta = .29$, $p < .01$). Teacher- and observer-reported students' mathematics engagement were significantly related to students' mathematics achievement ($b = 27.31$, $\beta = .29$, $p < .01$; $b = 22.61$, $\beta = .22$, $p < .01$). Student-reported mathematics engagement was not significantly related to students' mathematics achievement ($b = 12.38$, $\beta = .10$, $p = .08$; Table 3).

Gender as a moderator. Although there were gender differences in mean levels of student mathematics engagement (Table 1), gender was not a significant moderator in any of the models with social competence as the outcome (student-reported: $b = -.04$, $\beta = -.03$, $p = .71$; teacher-reported: $b = -.06$, $\beta = -.06$, $p = .35$; observer-reported: $b = -.08$, $\beta = -.07$, $p = .31$). Gender also did not moderate the association between students' mathematical engagement and

mathematical achievement in any of the models (student-reported: $b = 8.42$, $\beta = .09$, $p = .13$; teacher-reported: $b = 7.24$, $\beta = .06$, $p = .50$; observer-reported: $b = 5.65$, $\beta = .04$, $p = .60$).

Post Hoc Analyses. Descriptive statistics were calculated for individual engagement items on the student and teacher report measures for boys and girls in order to better understand which item or items might account for gender differences reported by teachers and students. Girls, on average, were rated higher than boys on all items for both teacher and student reports. Teachers on average rated girls .21 points higher on items (.04 - .34) and students on average rated girls .13 points higher on items (.04 - .28) compared to boys. The item on which there was the largest difference between girls and boys for teacher and student reports had to do with attention (“This student’s attention seems to wander during math class”, (reverse coded); “I only paid attention in math when it was interesting”; respectively).

Discussion

We used three approaches to measuring engagement in fifth grade mathematics classrooms. Teacher and observer reports of student mathematics engagement were significant predictors of state mathematics achievement and teacher-reported student social competence in math class. Student-reported engagement significantly predicted teacher-reported student social competence in math class, but not state mathematics achievement. Students’ gender did not moderate the association between student mathematics engagement and achievement or social competence.

Contribution of Engagement

Engagement in mathematics was associated with students’ mathematical achievement on two of the three approaches to assessing engagement. These associations were present when adults reported on students’ mathematical engagement (i.e., teachers or observers), but were not

present when students reported their engagement. This finding is consistent with studies that have reported associations between non-content specific teacher-reported engagement and mathematical achievement (DiPerna et al., 2005; Hughes et al., 2008).

All three measures of engagement were associated with teachers' reports of students' social skills with teacher-reported student engagement having the strongest association. This is likely due to shared source and methods variance (i.e., the same informant and similar method of data collection). The associations among informants' reports of student engagement and students' social skills supports the Self-Systems framework which theorizes that engaged behavior contributes to higher social competence. The ability to assess factors that contribute to social competence is meaningful as more classrooms adopt standards-based math practices that utilize peer and small group work (Fuson et al., 2005; NCTM, 2000).

Student reported engagement related to social skills, but was not associated with mathematics achievement. It may be that student-reported engagement captures a different aspect of engagement compared to adult reports of students' engagement. For example, in a study by Gresham, Elliott, Cook, Vance, and Kettler (2010) small cross-informant (parents, teachers, students) correlations were reported on ratings of social skills and problem behaviors using the SSIS in a sample of students (mean age=11.9 years). While the informants in our study did not include parents, but instead researchers, there are several parallels. First, adult-adult informant convergence was higher than adult-child convergence. Specifically, in our study teacher-observer ratings of engagement showed the most convergence and most similar patterns of association. Some of the unshared variance may, in part, be explained by familiarity with the student. Observers did not have previous knowledge of the students and based ratings on what they saw during the session. Teachers, however, interacted with students on a daily basis. Teachers'

ratings were probably based upon observations of specific behaviors and interactions as well as teachers' perceptions of what the teacher thought the student was capable of doing. Second, correlations in the study by Gresham et al. (2010) were highest for subscales that are more likely to be observable or noticeable (i.e., externalizing, hyperactivity). Engagement has both internal and external components as well. Adults are likely basing their assessments on what they see or what students choose to share (e.g., external displays of focus/attention—"This student's attention seems to wander during math class (reversed)."). Fifth grade students on the other hand, may base their ratings on internal psychological states or emotional-social considerations (e.g., feelings of belonging, interactions with friends in class that day—"Today I only paid attention in math when it was interesting.").

These differences in informant ratings may be more apparent when examining the association between concepts that are more distinct. Overall, there are more similarities between engagement and social skills (e.g., internal and external components) than engagement and mathematics. Studies that have reported on associations among elementary students' engagement and mathematics achievement have relied on teacher reports (DiPerna et al., 2005; Hughes et al., 2008). Differences in how teachers and students conceptualize engagement may differ in ways that are meaningful when predicting mathematics achievement. Aspects of engagement, such as focus and attention, may better predict mathematics performance compared to aspects, such as a sense of belonging. In practical terms, the association between student-reported engagement and social competence, but not mathematical performance suggests that student-reported engagement is a useful metric if schools are focusing on promoting social competence. Schools may want to consider using teacher- or observer-reported engagement when the outcome of interest is mathematical performance on a standardized test.

Gender as a Moderator

We did not find moderation effects of student gender on the association between students' mathematical engagement and outcomes of mathematics achievement and social skills in math class. Thus, despite girls outperforming boys in math engagement (particularly on items related to attention), associations between math engagement and achievement/social skill outcomes were comparable for boys and girls. A recent meta-analysis of gender differences and similarities suggest that there is more variability within genders than between genders (Hyde, 2014) suggesting we should not assume gender differences are as large as people might think. In the present study, the measures of engagement show differences in mean levels between boy and girl samples, but the link between engagement and outcomes is comparable regardless of gender. This finding has practical applications. A teacher might note a boy's low engagement and be dismissive of its consequences (e.g., say, "it's just a boy thing"). Yet, the low levels of engagement should be recognized and noted as much as if a girl was showing comparable low engagement because such engagement indicators are equivalently consequential for social and academic outcomes for both genders.

Furthermore, research on students' mathematics achievement suggests that the end of elementary school is a critical turning point in mathematics performance for students. The percent of students who fall below grade-level proficiency increases in the middle school years (National Center for Educational Statistics [NCES], 2012). We see an enigma requiring further study; boys' math performance increases relative to girls' math performance during the elementary school years, however girls' engagement levels remain higher than boys' engagement levels during this same time period (Hughes et al., 2008; Robinson & Lubienski, 2011; Roorda et al., 2011). Factors such as student-teacher relationship quality and expectations of adults are

theorized to contribute to students' self-appraisal, engaged behaviors, and achievement in school settings (Connell, 1990; Connell & Wellborn, 1991; Eccles & Wigfield, 2002; Meece, Wigfield, & Eccles, 1990; Skinner et al., 2009). Examination of these additional factors may help explain the inverse pattern seen in mean levels of mathematics engagement and mathematics achievement between girls and boys.

Limitations

In this study, we used three approaches when measuring fifth graders' mathematics engagement to capture the perspectives of different informants (i.e., teachers, students, and researchers). The timing and method of collection differs among the measurement approaches which is consistent with how these measures are typically used (Fredricks et al., 2011). This in part, made it difficult to directly compare the measures in relation to outcomes. Nevertheless, it is valuable in that it allows for comparisons among the measures that are authentic and related to outcomes in ways that the measures are often used (e.g., examining how observations throughout the school year relate to end-of-the year achievement).

We present one linear model according to a theoretical framework. Thus, the associations we tested were directional (i.e., student engagement contributing to student outcomes). We acknowledge that these associations are likely to be complex and may involve bi-directional associations or feedback loops (Skinner & Belmont, 1993). Due to the temporal order in which we collected data, it would be illogical to test models in which a variable that was collected later in the school year predicted a variable collected earlier in the year. Furthermore, our models are correlational in nature and causal inferences are not warranted. We ground our findings in theory and prior research. Overall consistency across measurement approaches in student mathematics engagement and previous research support our findings as robust, but we cannot say that

engagement, especially by itself, predicts higher social skills and mathematics achievement.

Additionally, although we discuss group differences between girls and boys, we caution against using these findings to stereotype girls and boys.

Contributions and Future Directions

This study contributes to the current literature on engagement in several ways. First, we used a multi-faceted approach to measure math engagement to examine each approach in relation to students' outcomes. The study findings suggest that engagement may be another point where researchers and educators can intervene, especially for students who are performing below grade level in mathematics. Teachers' day-to-day experiences in classrooms often involve reflections upon their students' engagement. Providing validation to teachers that points out that their observations of students' engagement relates to achievement and social competence outcomes may support teachers' efforts in sizing up their day-to-day experiences in the classroom and adjusting course to keep students engaged.

Second, all three approaches to measuring engagement contributed to teachers' reports of student social competence. Successfully navigating social networks becomes increasingly important as students transition into middle school. Examining what factors contribute to mathematics engagement (e.g., peer engagement, parent and teacher expectations) and in what ways students express mathematics engagement (e.g., internal vs. external displays) will be useful when developing ways to promote engagement in math classes.

Finally, engagement appears to be an equivalently important indicator of outcomes for both girls and boys. More research is needed to further examine factors and develop strategies that can be adapted to engage all students in mathematics. Creating regular formative

assessments of engagement may give teachers tools for identifying individual students who seem less engaged in order to provide a timely and well-tailored intervention.

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Table 1

Descriptive Statistics for Measures

Measures	<i>n</i>	<i>M</i>	<i>SD</i>	Range
Observed Engagement	383	.01	.62	-2.50 - 0.99
Girls	200	.13*	.54	-1.95 - 0.99
Boys	182	-.13*	.67	-2.50 - 0.99
Student-Reported Engagement	384	3.42	.43	1.50 - 4.00
Girls	201	3.48*	.40	1.89 - 4.00
Boys	182	3.35*	.46	1.50 - 4.00
Teacher-Reported Engagement	359	3.05	.64	1.00 - 4.00
Girls	194	3.14*	.61	1.38 - 4.00
Boys	165	2.94*	.66	1.00 - 4.00
Social Competence	361	3.54	.45	1.40 - 4.00
Girls	194	3.64*	.36	2.30 - 4.00
Boys	167	3.43*	.51	1.40 - 4.00
Mathematics Achievement	326	543.81	61.16	351 - 600
Girls	177	536.63*	62.99	351 - 600
Boys	148	552.22*	58.16	399 - 600

*Note:** indicates means are significantly different at $p < .01$. To test gender differences,

regressions were conducted with gender as a dichotomous predictor while accounting for

clustering. Observed engagement descriptive statistics are based on the factor score.

Table 2

Correlations among Variables

	Student Age	Working Memory	FRPL Status	English Proficiency	Student Gender
Observer-reported engagement	-.06 (311)	.16** (366)	.02 (382)	-.10 (328)	.21** (382)
Student-reported engagement	-.09 (312)	.05 (367)	.03 (383)	-.05 (329)	.15** (383)
Teacher-reported engagement	-.07 (303)	.20** (354)	.02 (359)	-.13* (311)	.16** (359)
Social competence	-.03 (304)	.24** (357)	-.04 (361)	-.23** (313)	.24** (361)
Mathematics achievement	.07 (272)	.31** (319)	-.08 (325)	-.25** (326)	-.13* (325)

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

Note. Correlations among observer- and teacher-reported interest and child characteristics of age, FRPL, and gender are reported in Rimm-Kaufman et al. (2015).

Table 3

Model Results for each Math Engagement Approach

	Observer-reported		Student-reported		Teacher-reported	
Student Engagement ON						
Student age	-0.02	(.06)	-0.11 *	(.05)	-0.09	(.05)
Working memory	0.15*	(.06)	0.01	(.07)	0.18**	(.06)
FRPL status	0.07	(.06)	0.02	(.06)	0.04	(.06)
ELL proficiency	-0.10	(.07)	-0.09	(.07)	-0.04	(.07)
Student gender	0.16**	(.05)	0.19**	(.05)	0.13*	(.06)
Social Competence ON						
Student age	-0.05	(.05)	-0.03	(.06)	-.004	(.05)
Working memory	0.09	(.06)	0.14*	(.06)	0.04	(.05)
FRPL status	0.004	(.06)	0.02	(.06)	-0.003	(.04)
ELL proficiency	-0.17*	(.08)	-0.18*	(.08)	-0.16**	(.06)
Student gender	0.18**	(.05)	0.19**	(.05)	0.15**	(.04)
Engagement	0.29**	(.05)	0.22**	(.06)	0.56**	(.04)
Mathematics Achievement ON						
Student age	0.07	(.06)	0.08	(.07)	0.10	(.06)
Working memory	0.20**	(.06)	0.23**	(.06)	0.17*	(.06)
FRPL status	-0.03	(.06)	-0.01	(.06)	-0.03	(.06)
English proficiency	-0.13	(.08)	-0.15	(.08)	-0.15	(.08)
Student gender	-0.15**	(.05)	-0.14**	(.04)	-0.16**	(.05)
Engagement	0.22**	(.06)	0.10	(.05)	0.29**	(.05)

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

Note. Models were run separately for observer-, student-, and teacher-reported student engagement. Standardized coefficients are reported in the table. Standard errors are in parentheses.