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Perceptions of Relatedness with Classroom Peers Promote Adolescents' Behavioral Engagement and Achievement in Secondary School

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Abstract

Secondary school is a vulnerable time where stagnation or declines in classroom behavioral engagement occur for many students, and peer relationships take on a heightened significance. We examined the implications of adolescents' perceptions of relatedness with classroom peers for their academic learning. Participants were 1084 adolescents (53% female) in 65 middle and high school classrooms. Multilevel cross-lagged path analyses found that adolescents' perceived relatedness with classroom peers subsequently predicted their increased self-reported behavioral engagement in that classroom from fall to winter and again from winter to spring. Higher engagement in spring predicted higher end of year objective achievement test scores after statistical control of prior year test scores. Implications are discussed for increasing classroom peer relatedness to enhance adolescents' achievement.

Keywords

Secondary school; Adolescents; Peer relatedness; Engagement; Achievement

Author Contributions A.Y.M. conceived of the study, participated in its design and coordination, and drafted the manuscript; E.A.R. participated in the design and coordination of the study, helped to draft the manuscript, and conducted the data analysis; C.A.H. participated in the design and coordination of the study and conducted the data analysis; A.G. participated in the design and coordination of the study; J.P.A. participated in the design and coordination of the study. All authors read and approved the final manuscript.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no competing interests.

Ethical Approval Study procedures were approved by the Institutional Research Ethics Board at the University of Virginia, and by the school districts where the data were collected. All procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments.

Informed Consent Informed consent was obtained from all individual participants included in the study. For the participants who were minors, they provided informed assent while their parents provided informed consent.

Introduction

Humans are fundamentally social, possessing a strong need to belong which is likely evolutionarily ingrained (Cacioppo and Patrick 2008). Feelings of relatedness with peers—defined as perceptions that peers respect the adolescent, care about the adolescent's needs, and include the adolescent as a valued member of the group (Goodenow 1993) are suggested to bolster adolescents' adjustment (Wentzel et al. 2010), including their academic learning in the school environment (Song et al. 2015). Relatedness with peers may take on a particularly heightened significance for adolescents. It is developmentally appropriate for adolescents to rely more and more on their peer group (and to be attuned to their peer group) as opposed to their family of origin as they progress through middle and high school (Dishion and Tipsord 2011). This suggests that secondary school students may be the age group most affected by their relatedness with classroom peers (Rodkin and Ryan 2012).

Specific to the academic context, peer relatedness may facilitate adolescents' comfort in taking learning risks without fear of derision (Hamm and Faircloth 2005), such as asking peers for help with material (Ryan and Shim 2012). Lacking perceptions of belonging with peers, by contrast, may predispose adolescents to be distracted by task-irrelevant or anxious thoughts (Ryan and Patrick 2001). Given the normative stagnation or decline in students' engagement in secondary school (Wang et al. 2015) which has downstream effects for academic learning (Lee 2014), relatedness with classroom peers may be an important way to promote adolescents' engagement and subsequent achievement.

Specificity of Relatedness with Classroom Peers

In theory, the effects of peer relatedness on academic learning should be the most robust for relatedness with *classroom peers* as affecting learning *in the particular subject matter of that classroom*, as opposed to relatedness with peers across neighborhood and school contexts as affecting achievement overall. Ryan and Patrick (2001) argue for the importance of the specific distinction between adolescents' emotional bonds with the peers in their classroom compared to their bonds with friends outside of class, or in a clique or a crowd—suggesting that classroom peers have unique effects in creating the social context and learning environment of that classroom. Studies documenting benefits of classroom peer relatedness on learning have occurred among elementary school students. For instance, children with negative peer experiences within their elementary school classroom may become disengaged from academic instruction (Iyer et al. 2010), withdraw from class participation (Ladd et al. 2008), and show reduced academic self-concept (Flook et al. 2005)—factors which result in poorer grades and achievement test scores. However, among middle and high school students, perceptions of relatedness have been most commonly considered across an adolescent's entire peer group (in school generally, or both inside and outside of school), as opposed to in a specific classroom (see Ryan and Patrick 2001, who suggest this is an oversight).

The current study examines adolescents' relatedness with classmates in an identified course for three reasons. As noted above, relatedness with peers in a specific class potentially has the strongest effect on academic learning in that particular course subject matter, because

these peers are assumed to create a context of safety to take learning risks in that classroom environment. It is not assumed that such a context of safety will generalize to other environments where these specific peers are not present. Second, although adolescents may be friends with some of their classmates in a particular course, they rarely choose the classmates in their course, and typically there are classmates with whom the adolescent is not friends and would not have elected to affiliate with under other circumstances. This distinction is important given findings that similarity in grade point averages and truancy is explained by peer selection (who the adolescent chooses to befriend) in addition to friends' behaviors reciprocally influencing one another over time (Rambaran et al. 2017). How adolescents may be influenced by classroom peers whom they did not select (and with whom they are forced to interact on a daily basis regardless of whether they want to) is important for the study of adolescent development. Finally, teachers can potentially shape relatedness among the students in their classroom (Mikami et al. 2010), while it may be unrealistic for teachers to influence the peer relatedness of adolescents in the lunchroom or outside of school. As such, if classroom peer relatedness is found to influence engagement and achievement, there may be more direct intervention implications for educators who wish to bolster adolescents' learning.

The Influence of Peer Relatedness on Adolescents' Academic Learning

Some existing empirical work suggests that classroom peer relatedness may relate to academic learning among adolescents, but such work tends to be limited by cross-sectional designs. Wentzel et al. (2010) found that 6th–8th grade students' perceptions of belonging, acceptance, and respect from peers in an identified classroom were associated with their self-reported interest in the academic subject matter in that classroom at a single time point. Achievement was not assessed. These associations held after accounting for other types of positive experiences with peers and teachers. In addition, Wentzel et al. (2016) found that 5th and 6th grade Mexican American students' self-perceptions of peer belonging and acceptance in an identified classroom correlated with teacher ratings of students' academic effort and socially responsible classroom behavior at the same time point. However, only the association between peer relatedness and socially responsible classroom behavior, and not the association between peer relatedness and academic effort, remained after statistical control of other positive experiences with peers, parents, and teachers. The authors speculate that peer relatedness may set the stage for a respectful and well-functioning classroom, upon which academic effort is influenced by parents and teachers (Wentzel et al. 2016). It is also possible that the nature of the sample (Mexican American early adolescents) enhanced the influence of adults relative to peers on academic behaviors.

In addition, a study involving Canadian 6th and 7th graders found that teacher- and self-reported engagement mediated associations between self-reported peer victimization (presumed to indicate less peer relatedness) and teacher-reported achievement, at a single time point (Hoglund 2007). Engagement, victimization, and achievement were assessed across school as a whole and not specific to an identified class (Hoglund 2007). Finally, Liem and Martin (2011) found that among Australian adolescents in grades 7–12, students' self-reports of how easily they made friends (not specific to the school setting) correlated with their objective achievement test scores, mediated by self-reported engagement in school

as a whole. Collectively, these four cross-sectional studies suggest promising effects of peer relatedness on academic learning via engagement, but they are limited by reliance on cross-sectional designs that prevent determination of the directionality of effects. These studies also inconsistently pinpoint relatedness with *classroom peers* and rarely include objective measures of achievement.

There is also intriguing longitudinal work to suggest the positive effects of peer relatedness on adolescents' learning. Hamm and Faircloth (2005) found that 6th graders sense of belonging in the spring in an identified classroom was predicted by students' self-perceptions of relatedness with peers in that classroom in the previous fall, after statistical control of fall sense of belonging. However, academic outcomes were not measured. Ryan and Patrick (2001) reported that students' perceptions of the teacher as promoting interaction and mutual respect among classroom peers in a specified math class in the spring of 7th grade predicted increases in their self-reported motivation and engagement about math in the transition between 7th and 8th grade. Although prior math grades were controlled for in the model, the effects of motivation/engagement on subsequent achievement were not tested. It is also unknown to what extent perceptions of the teacher promoting positive peer interactions translated into actual feelings of peer relatedness. Relatedly, previous analyses in the current study sample found that teachers' emotionally supportive practices predicted students' increased mastery motivation and engagement over a school year in an identified classroom, and one mediator of this effect was students' perceptions of classroom peer relatedness (Ruzek et al. 2016). However, whether motivation and engagement resulted in higher achievement, or the extent to which reciprocal associations existed between peer relatedness and engagement, were untested. These longitudinal studies are promising but they omit one or more key parts of the hypothesized links between classroom peer relatedness and academic achievement.

We are only aware of one study that examined the links between peer relatedness (which was measured at school generally), engagement, and objective measures of achievement, in a longitudinal design among secondary school students. Song et al. (2015) found that Korean 7th grade students' perceptions of peer acceptance and respect (at school generally) incrementally predicted students' increasing mastery goals for learning from Year 1 to Year 2, and mastery goals predicted higher achievement test scores from Year 2 to Year 3. Although peer relatedness was not as strongly associated with academic achievement compared to support from parents, the authors speculate that they may have found stronger effects if they had measured peer relatedness and achievement specific to an identified classroom. Also, the Korean cultural context may have reduced the importance of peer relatedness, as compared to western cultures in which it is more normative for adolescents to separate from parents (Song et al. 2015).

Finally, although it may seem less relevant at first glance, among college students (late adolescents/emerging adults), even short-term experimentally-manipulated experiences of social exclusion in the lab have yielded detrimental effects on academic behaviors with implications for achievement. Brief social exclusion resulted in greater procrastination instead of studying for an upcoming test (Twenge et al. 2002), lower persistence on cognitive puzzles (Buelow et al. 2015), and hampered performance on standardized aptitude

test questions (Baumeister et al. 2002), suggesting behavioral effects on engagement and cognitive skills in college samples. Conversely, an intervention to foster self-perceptions of relatedness with university peers led to an increase in 1st year college students' obtained college GPA (Walton and Cohen 2011). These studies are relevant because peer relatedness is rarely able to be randomly assigned. Collectively, these lab-based results suggest that peer social exclusion (interpreted to be the opposite of peer relatedness) as well as increased peer relatedness may have causal effects on academic engagement and achievement.

We note that these studies have focused on adolescents' self-perceptions of peer relatedness, as opposed to peers' feelings of relatedness to the adolescent. Self-perceptions of relatedness likely do not perfectly align with peers' feelings assessed via sociometric measures; for instance, McElhaney et al. (2008) report a correlation of $r = 0.25$ between these two constructs in an adolescent sample. Notably, this correlation is lower than what has been found among elementary school children (Harter 1985), which may reflect adolescents' growing abilities for self-reflection and identity exploration, leading to heightened importance of self-perceptions in the adolescent developmental period (Goodenow 1993). Self-perceptions of peer relatedness have been found in other work to predict peer-reported and observed social behaviors of aggression/hostility, withdrawal, and advice-seeking from friends across a 1-year period, after statistical control of peer sociometric acceptance (McElhaney et al. 2008). Although to our knowledge no study has directly tested the incremental predictive power of self-perceptions of relatedness compared to peers' report of relatedness on participants' academic learning, there is promising support for the unique importance of self-perceptions of relatedness, particularly in the adolescent developmental period.

Current Study

Secondary school is a vulnerable time where stagnation or declines in behavioral engagement occur for the majority of students in their classes (Wang et al. 2015); declines in engagement, in turn, may result in meaningful reductions in academic achievement (Lee 2014); and adolescents are strongly attuned to and motivated by peers, perhaps more than any other age group (Rodkin and Ryan 2012). Consequently, relatedness with *classroom peers* has direct potential to promote adolescents' academic learning in that course subject matter. The current study aimed to test this hypotheses using a longitudinal design and incorporating objective measures of academic achievement, which represent advances over existing work.

We examined prospective associations between middle and high school students' perceptions of relatedness with their classroom peers and their behavioral engagement in that classroom, assessed at three time points (fall, winter, spring) across a school year. We also examined how classroom peer relatedness and engagement predicted relative changes in objective academic achievement test scores in that course subject from the year prior to the study year to the end of the study year. Our first hypothesis was that after statistical control of prior academic achievement in the course subject matter, perceptions of relatedness with classroom peers would predict increases in adolescents' engagement in that classroom, between fall and winter, and between winter and spring. We expected that the associations

between students' earlier peer relatedness and subsequent engagement would remain after statistical control of the reciprocal influences of their engagement on peer relatedness. Second, we hypothesized that students' higher engagement and peer relatedness in that classroom in spring would predict increases in achievement scores in that course subject matter at the end of the study year, after statistical control of achievement in the same course subject the prior year. Finally, we tested the robustness of the model by exploring the applicability of findings across course content and across high vs. low average entering achievement levels of students in that classroom.

Method

Participants

Participants were 1084 students nested in 65 public middle and high school classrooms in 10 schools located in suburban and rural areas of Virginia, United States. Students were diverse across gender (53% female) and ethnicity (62% White; 30% Black; 4% Hispanic/Latino; 4% other, largely Asian or multiracial). The grade level breakdown of students was: 23% in grade 6, 23% in grade 7, 18% in grade 8, 16% in grade 9, 9% in grade 10, 10% in grade 11, and 1% in grade 12. Grades 6–8 represented middle school and grades 9–12 represented high school. Approximately 39% of participating students qualified for free/reduced lunch, an indicator of low income status.

Classroom teachers had 9 years of experience on average, and were predominantly female (68%). The ethnic breakdown of teachers was 83% White, 11% Black, and 6% other (largely Asian or multiracial). Study classrooms were divided into language arts/social studies (55%) and math/science (45%) course content. All students met as a group in that classroom for approximately 50–60 min per school day, and the same group of students remained in that classroom with the same teacher and subject matter for the entire school year.

Procedure

The data collection took place across one school year. In the spring before the academic year began the study was presented to all teachers in the school, after which teachers who elected to participate provided informed consent. Teachers identified a single class for the study with the requirements that they were the primary instructor, and that an end-of-course standardized achievement test was administered to assess student learning in the course content (as part of the statewide assessment requirements). Then, at the start of the academic year, students in that teacher's identified class, along with their parents, were invited to participate. Parents provided informed consent and the students provided assent. A majority of eligible students (78%) consented, yielding an average of 16.68 participating students per classroom ($SD = 4.46$).

Thereafter, consented students were asked to complete questionnaires about their experiences in the identified classroom. Students filled out these questionnaires during class time in the identified classroom at three time points during the school year: fall (October), winter (January), and spring (April). At the end of the academic year, statewide standardized achievement tests were administered to all students, and scores of consented students in the

subject matter of the identified class were obtained from the school registrar. In addition, each student's achievement test scores were obtained from the registrar in the most closely matched subject area from the year prior to the study year.

The current data draws from a larger study testing the effect of My Teaching Partner-Secondary, a teacher professional development intervention, on teacher practices and student achievement over the course of two academic years (Allen et al. 2011). Teachers were randomly assigned to receive the intervention or to be in a control group receiving business-as-usual professional development. Teacher assignment to intervention or control condition was not associated with the outcome measures in the current sample (although we statistically controlled for intervention condition anyway in data analysis). Participating in the intervention yielded effects on student achievement in a follow-up study year but no effects on achievement were found in the first year of the study, suggesting that the intervention requires more than one year of participation to translate into changes in student achievement. For this reason, we included only the first year of the larger study in the current analyses.

Measures

Classroom peer relatedness—Students self-reported on their perceptions of relatedness with their classroom peers in the identified course. Students were instructed to answer the questions while specifically thinking about their interactions with their peers in the identified classroom during class time (which was the setting in which they were completing the questionnaire), and not peers at school outside of that classroom or in other non-school contexts.

Students answered four items concerning the proportion of classroom peers in the identified course that: "you get along with?"; "you do not get along with?" (reverse scored); "respect you and listen to what you have to say?"; and "put you down, tease you, or pick on you?" (reverse scored). Each item was answered on a 5-point Likert scale [5 = *all (100%)*; 4 = *most (75%)*; 3 = *about half (50%)*; 2 = *few (25%)*; 1 = *none (0%)*]. Higher scores on this measure indicated greater perceptions of relatedness with classroom peers.

These items are conceptually similar to those used in other studies to measure self-reported peer relatedness and feelings of belonging (e.g., "My classmates make me feel good about my ideas; Wentzel et al. 2010; "Students get along well in my school"; Song et al. 2015; "My teacher does not allow students to make fun of other students' ideas in class; Ryan and Patrick 2001; "In this class it's hard for me to make friends"; Hamm and Faircloth 2005), and crucially, found to be associated with adolescents' academic engagement, motivation, and achievement in these other studies. The current measure was also found in a previous study to be sensitive to an intervention to increase middle school students' relatedness with classroom peers (Mikami et al. 2005). Internal consistency in Mikami et al. (2005) was 0.72, and in the current sample it was 0.67, 0.71, and 0.72 in the fall, winter, and spring data collection time points of the academic year, respectively.

Classroom behavioral engagement—Students self-reported their engagement, again specific to the content in the identified class (which was the setting in which they were

completing the questionnaire). They completed five items taken from a commonly used scale of behavioral engagement and disaffection, with strong psychometric properties (Wellborn 1991). Sample items included "I try hard to do well in this class", "When I'm in this class, I participate in class discussions," and "When I'm in this class, I think about other things" (reverse scored). Each item was answered on a 5-point Likert scale (1 = *not at all true*; 5 = *very true*). Higher scores indicated greater engagement in that classroom. Internal consistency in the current sample was .68, .74, and .76 in the fall, winter, and spring data collection time points of the academic year, respectively.

Academic achievement in identified class subject—The state of Virginia requires all schools to administer end of year achievement tests, called Standards of Learning, in order to measure learning in certain subjects throughout secondary school. Schools across the state administer the same test, student scores are normed, and the results inform the calculation of each school's adequate yearly progress. For each consented participant, we obtained that student's score on the end of year Standards of Learning exam associated with the course content of the identified class in the study. In addition, we also obtained that student's score on the prior year's Standards of Learning exam in the subject most similar to the identified class in the current year (e.g., English language, mathematics, science, or history/social studies). The district registrar provided this information to the research team. These state-wide, standardized exams have strong psychometric properties, such as good test-retest reliability and concurrent validity with other accepted tests of student achievement (Virginia Department of Education 2015). Internal consistency (alpha) for subject tests ranges from 0.86–0.92 (Virginia Department of Education 2015).

Data Analytic Plan

We aimed to assess changes across the school year in adolescents' perceptions of classroom peer relatedness and adolescents' behavioral engagement in the classroom, the reciprocal relations between these two constructs, and each construct's association with relative gains in academic achievement. To do so we estimated parameters for a longitudinal cross-lagged panel model. Because students were nested in classrooms and 48% of the variance in end of year student achievement (ICC = 0.48) was attributable to the classroom level, this necessitated multilevel modelling. Classrooms were nested in schools; however the school level ICC was 0.018, suggesting minimal outcome variance in student achievement between schools. Accordingly, we estimated two level path models (students nested in classrooms) for this analysis using Mplus 7.2 (Muthén and Muthén 2014). Student level variables were group mean centered as the focus of this investigation was on within-classroom (student-level) estimates of the longitudinal process.

Missing outcome data (19% of the sample) were determined to be missing at random as outcome missingness was explainable by the other included variables in the model. Likewise, missing data on the key student-reported scales were accounted for by demographic variables included in the model. Accordingly, we employed full information maximum likelihood estimation, which uses all cases to provide parameter estimates and standard errors that are robust to non-normal data and non-independence in the observations.

Figure 1 displays the model structure. We estimated autoregressive paths between a variable at the initial time point to that *same* variable as measured at the subsequent time point (i.e., paths from fall to winter and from winter to spring in peer relatedness, and in behavioral engagement). We simultaneously estimated cross-lagged regression paths between one of the variables at the initial time point and the other variable at the subsequent time point (i.e., paths from fall engagement to winter peer relatedness, fall peer relatedness to winter engagement, winter peer relatedness to spring engagement, and winter engagement to spring peer relatedness). Spring measures of peer relatedness and behavioral engagement were indicated as predictors of end of year standardized achievement. These paths were estimated at the student level.

At the student level, we statistically controlled for the effects of student demographic variables (gender, free and reduced price lunch, and ethnicity) and student achievement test scores from the prior year on the fall measures of peer relatedness and behavioral engagement, and on the end of year standardized test scores. At the classroom level, we controlled for the average achievement from the prior year's standardized test scores of students in the classroom, whether the identified course contained language arts/social studies content vs. math/science content, whether it was a high school classroom vs. a middle school classroom, and whether the teacher had been assigned to the intervention group vs. the control group. We initially included a larger number of covariates, however because all other potential covariates were non-significant at the $p < .10$ level, and we had no directional hypotheses regarding them, we dropped them from final models (Little 2013).

Finally, we examined the robustness of our cross-lag findings by estimating whether the results were sensitive to classroom context, specifically across course content (language arts/social studies vs. math/science) or across average student achievement in that classroom from the prior year's test scores (split at the median). We selected these two variables as potential moderators because we thought they carried the most theoretical and practical relevance for educators of secondary school students. That is, secondary school teachers often work in teams with other teachers of the same course content, and they adjust their teaching methods when instructing classrooms at different achievement levels (e.g., honors, regular, remedial; Wing 2006). We estimated these as multi-group path models by first estimating a configural model (i.e., paths freely estimated across groups), and then formally testing for differences by constraining the cross-lagged paths to be equivalent across groups. Constrained models were rejected (i.e., the presence of moderation was supported) if the Satorra-Bentler $\chi 2$ difference test was significant at the $p < 0.05$ level, indicating that constraining the paths worsened model fit relative to a model with paths allowed to freely vary across groups (Muthén and Muthén 2014).

The majority ($n = 961$) of the 1084 students in the analysis were study participants in one study classroom (i.e., one identified course); however, the remainder took part in the study in two different classrooms (i.e., two identified courses, each with a different subject matter and teacher). We considered each student's report of peer relatedness and engagement in that classroom, and their associated achievement test scores in that class subject, to be specific to the identified classroom that they were in at the time when they completed the measures. Removing duplicate

Results

Descriptive Statistics

Table 1 displays the means and standard deviations (SDs) of all study variables along with their zero-order correlations. Student reports of classroom peer relatedness were generally high across time points and were correlated at $r = 0.44$ or above. Student reports of behavioral engagement were strongly correlated across time points (all at or above $r = 0.51$), but a noticeable dip in engagement levels was observed in the winter when average engagement was a full point lower than it was in either the fall or spring. Finally, peer relatedness and engagement were positively correlated within and across time points.

Effects of Prior Year Achievement

Results from the cross-lagged model are displayed in Fig. 1. For simplicity of presentation we do not show all regression paths and instead focus on students' reports of classroom peer relatedness and behavioral engagement and their academic achievement. However, as shown in Table 2, males reported lower levels of peer relatedness and engagement in the fall than females and Black students reported more peer relatedness than non-Black peers. Results suggested that prior year (initial) achievement test scores in the subject most related to the current year's course positively predicted adolescents' fall engagement (but not their reports of peer relatedness). As all student level variables were group-mean centered, the standardized coefficients displayed in Fig. 1 can be interpreted as the effect of the predictor on the outcome for a student one unit higher on the predictor than the average student in the classroom. For example, a 1 SD increase in prior achievement score, relative to the average achievement score in the classroom, is associated with a 0.011 SD increase in a student's fall behavioral engagement.

Reciprocal Influences between Peer Relatedness and Behavioral Engagement

As was seen in the zero-order correlations, Fig. 1 shows that the autoregressive paths from fall to winter and from winter to spring time points were consistently positive and significant across both peer relatedness and engagement. That is, not surprisingly, students who reported more peer relatedness at an earlier time point tended to also report peer relatedness at the next time point (i.e., from fall to winter and from winter to spring); similar patterns were observed for students' behavioral engagement across all three time points.

The cross-lagged pathways quantify the degree to which the constructs are interrelated across time. As can also be seen in Fig. 1, higher peer relatedness at an earlier time point predicted subsequent higher engagement at the next time point, even after accounting for prior levels of engagement; that is, both the paths from fall peer relatedness to winter engagement and from winter peer relatedness to spring engagement were significant. In summary, a student's perceptions of more relatedness with peers in the identified classroom, relative to the average perception of peer relatedness in that classroom, consistently contributed to predicting that student's relative increases in engagement in that classroom across the school year. The coefficients indicate that a 1 SD increase in peer relatedness, relative to the average score in the classroom on this variable, is associated with a 0.08 SD

increase in a student's behavioral engagement from fall to winter and a 0.09 SD increase in their engagement from winter to spring.

The only cross-lagged pathway in the opposite direction that was significant ran from winter engagement to spring peer relatedness (see Fig. 1) such that a 1 SD increase in engagement in winter, relative to the classroom average of engagement, is associated with a 0.08 SD increase in a student's perceptions of peer relatedness from winter to spring. This suggests that the associations between relatedness with classroom peers and behavioral engagement in that classroom may in part be bidirectional, but this may predominantly occur between winter and spring time points and not earlier.

Impact on End of Year Achievement

The effects of students' prior year achievement on end of year achievement were controlled for at the student level and classroom level, as both were highly significant predictors of end of year achievement (see Table 2). As such, these models assess whether school year changes in students' classroom peer relatedness and behavioral engagement in an identified class are associated with relative changes in academic achievement in that course subject matter from the previous year. The other classroom-level controls included in the model (whether a teacher received the professional development intervention vs. was in the control group, whether the classroom was in a high school vs. middle school, and whether the course content was language arts/social studies vs. math/science) were not associated with relative changes in students' academic achievement. At the student level, only a student's participation in the free/reduced price lunch program was associated with relative declines in achievement (Table 2).

As seen in Fig. 1, spring behavioral engagement was the strongest predictor of relative gains in academic achievement. Specifically, a 1 SD increase in spring behavioral engagement, relative to the classroom mean of behavioral engagement, is associated with a 0.09 SD increase in a student's spring achievement scores from the previous year's achievement scores. Spring peer relatedness was not directly associated with relative changes in academic achievement, after accounting for engagement and the other variables in the model.

Sensitivity Analyses—Moderation by Classroom Factors

We examined the robustness of our findings by estimating whether the results differed based on course content (language arts/social studies vs. math/science) and the average prior year achievement among students in the classroom (above vs. below the sample median). Results from separate multiple group models indicated that the cross-lag relations and associations with academic achievement were consistent across these different classroom types.

Discussion

Concerning stagnation or declines in classroom behavioral engagement occur for the majority of secondary school students (Wang et al. 2015), which may result in hampered academic achievement in the longer term (Lee 2014). Meanwhile, it is developmentally appropriate for adolescents to be highly motivated by and attuned to their peer group (Rodkin and Ryan 2012). This study found that adolescents' perceptions of greater

relatedness with their classroom peers predicted progressive increases in their behavioral engagement in that classroom, over the fall, winter, and spring of an academic year. At the same time, higher behavioral engagement in winter predicted increasing perceptions of peer relatedness in spring. Crucially, higher spring behavioral engagement was associated with relative gains in students' standardized achievement scores in the identified class subject. The same was not true of peer relatedness, but the results suggest that perceptions of relatedness with classmates may indirectly influence adolescents' academic achievement through their effect on increasing spring behavioral engagement. Findings held after statistical control of demographic features as well as prior year student achievement in the most closely matched academic subject. The model appeared equally applicable across course subject matter and the average entering achievement level of students in that classroom, supporting the potential robustness of findings.

Implications of Peer Relatedness for Adolescents' Academic Learning

Study results underscore the connectedness between adolescents' social and academic worlds in the classroom. We speculate that students' perceptions of peer relatedness promote their adaptive help-seeking from classroom peers about academic material (requests for peer help that further learning and problem solving; Ryan and Shim 2012). Adaptive help-seeking requires adolescents to feel safe and supported by their classroom peers, such that they will put themselves in the vulnerable position of declaring they need help. Adolescents who engage in adaptive help-seeking must also take academic risks by tackling a challenging problem instead of giving up or seeking the easy way out. Crucially, adaptive help-seeking is suggested to decline in secondary school (Ryan and Shim 2012), but may be facilitated by stronger peer relatedness. Furthermore, it is also possible that even if students are willing to ask peers for help, social marginalization may objectively limit students' opportunities to receive actual help from peers. Collectively, these findings suggest a process through which students lacking relatedness with classroom peers may fail to ask for, and fail to receive, help from peers, therefore depriving them of the known benefits of peer-assisted learning (McMaster et al. 2006).

We additionally speculate that lacking relatedness with classmates impedes cognitive attention (as found in controlled, lab-based studies where brief social exclusion experiences led to reductions in working memory and task persistence; Baumeister et al. 2002). Said another way, when students feel socially marginalized, this may prove distracting such that it is harder to focus on the material, persist in efforts to understand it, and process it on the level required for retention. Collectively, these behaviors manifest as reduced behavioral engagement when occurring in a classroom environment, ultimately hampering academic learning.

The effect sizes suggested that a 1 SD increase in an adolescent's perceptions of relatedness with classroom peers, relative to the classroom mean, was associated with that adolescent gaining 0.08 to 0.09 of a SD in behavioral engagement over the next assessment period (e.g., fall to winter, or winter to spring). Although a 0.08 to 0.09 SD increase in engagement may seem modest, it is important to remember that the assessment periods occurred approximately 3 months apart from one another. Over the course of several years of

secondary school, we speculate that these effects could compound, leading an adolescent on a highly positive, reinforcing trajectory toward increasing engagement. Our finding that some degree of earlier engagement also predicts subsequent increases in peer relatedness further suggests the possibility of a compounding, virtuous cycle.

The real-world educational implications of this finding are significant considering the concerning normative stagnation and decrease in behavioral engagement during secondary school (Wang et al. 2015). Further, the downstream effects of perceptions of relatedness with classroom peers, via their positive effects on increased behavioral engagement, were suggested to result in better objectively assessed standardized achievement test scores: an outcome measure with importance for adolescents imminently facing the prospect of whether they may continue on to post-secondary education enrollment and attainment.

Our results held after statistical control of content area and a host of classroom and student demographic variables, as well as prior levels of achievement. In addition, we formally tested for moderation, finding that relations were robust across the course subject matter as well as average student prior academic achievement in that classroom. We find it notable that despite a wide range of content areas for which different curricular instruction methods may be required, the common factor of peer relatedness in that classroom appears to bolster learning of the subject matter. We speculate this may have occurred because social connection is a universal need (Cacioppo and Patrick 2008), no matter what the specific course content. Results also suggest that peer relatedness benefits learning regardless of the average entering achievement level of the class. One implication is that even in remedial track classes where the peer group culture may appear uninterested in the subject matter (e.g., see Hamm et al. 2014), perceptions of social belonging and relatedness with classroom peers nonetheless promote engagement with the course material (or conversely, it may be that lack of these factors make a student's experience in that classroom aversive and therefore distract from engagement further).

Overall, we found consistent pathways between peer relatedness at an earlier time point predicting changes in students' behavioral engagement, beginning as early as the fall of the academic year. By contrast, we found less evidence for the reciprocal process, that behavioral engagement predicted subsequent changes in peer relatedness. To the extent this reverse pathway occurred in our sample, it happened only between the winter and spring time point and not earlier. It may be that the effects of engagement on peer relatedness come on line later or take time to develop. Perhaps perceptions of peer relatedness in the classroom are helpful to initially engender motivation and cognitive attention in the course, which manifests as behavioral engagement (Ryan 2000). Once engagement is higher this provides a platform for students to feel included by their peers; that is, students who are more engaged in the subject are more likely to contribute to group projects and comment on other students' ideas in class discussion. These behaviors may provide more opportunities for peer relatedness, contributing to a virtuous cycle.

The bidirectional associations found between engagement and peer relatedness across the winter to spring time point reinforce findings from elementary classrooms of reciprocity between these two constructs (e.g., Chen et al. 1997). Nonetheless, we speculate that

engagement may be relatively more likely to evoke peer relatedness among elementary school students relative to among secondary school students. Elementary school children tend to socially accept classmates with higher academic achievement, leading to consistent and strong positive correlations between achievement and sociometric preference in this age group (Ladd et al. 1999). This finding may be less robust in secondary school students, reducing the path from engagement to peer relatedness among adolescents. By contrast, because adolescents may be in a developmental age group where peers are more influential (Dishion and Tipsord 2011) and peer relationships take on higher significance (Juvonen 2007), this may amplify the path from peer relatedness to behavioral engagement among secondary school students relative to elementary school children.

Finally, we wish to highlight that we assessed peer relatedness specific to one identified classroom (not in general across school or in out of school contexts). We posit that perceptions of peer relatedness occurring in that classroom are most associated with academic engagement and ultimately, learning, in that classroom. In addition, we think it is important that students have limited ability to choose the peers in their classroom, as opposed to their friends in the lunchroom or after school, which separates the effects of peer selection from peer influence.

Lack of Direct Associations between Peer Relatedness and Achievement

Unlike our finding that prior academic achievement predicted initial behavioral engagement, in this study prior achievement did not predict initial classroom peer relatedness. Perhaps other unmeasured variables also influenced initial peer relatedness in the current study, such as pre-existing interactions with those peers or expectations about classmates. Alternatively, this finding may mean that teachers shape students' peer relatedness via their own behavior and instructional practices; peer relatedness is not fixed at school year entry (Ruzek et al. 2016). A growing literature posits that the teacher is an invisible hand affecting students' relationships with one another in that classroom (Farmer et al. 2011).

Additionally, we found that spring peer relatedness had no direct effects on end of year achievement. Rather, effects of peer relatedness on academic achievement appeared to occur indirectly via increased behavioral engagement. This was consistent with Song et al. (2015) who found indirect pathways between earlier peer relatedness and subsequent achievement, via mastery goals. This supports the theoretical model that social belonging increases academic risk-taking, help seeking from peers, motivation, and cognitive attention to course material (i.e., engagement), which has the eventual effect on achievement. One implication of this finding, however, is that it may be harder for educators to notice the effects of peer relatedness on achievement because they occur indirectly, which means that teachers may be less likely to attempt to change classroom social dynamics.

Study Strengths and Limitations

Strengths of this study include the longitudinal design with classroom peer relatedness and engagement assessed at multiple time points, and the inclusion of achievement test scores both before the study year and at the end of the study year. This design, combined with the use of cross-lagged path modelling, permitted exploration of how processes between

classroom peer relatedness and engagement may unfold over time. The use of standardized achievement test scores may also be a strength, given that many prior studies have used teacher-assigned grades or teacher-completed rating scales as the achievement outcome. Standardized achievement test scores may reduce potential teacher biases. For instance, a teacher's expectations of a student (which could be influenced by student demographic factors), or a student's defiant behavior, are more likely to affect teacher-given grades relative to standardized test scores (Jussim and Eccles 1992). On the other hand, grades possibly represent a more real-world academic outcome reflecting the culmination of a student's motivation and effort over time, and are less likely to be influenced by test anxiety. This may be why a meta-analysis found overall stronger effects for parental support on adolescents' grades relative to on standardized test scores (Jeynes 2007).

This study possesses several limitations. First, we only measured students' self-perceptions of their peer relatedness. This procedure is consistent with many other researchers studying this construct (e.g., Ryan and Patrick 2001; Song et al. 2015; Wentzel et al. 2010), and self-perceptions of peer relatedness (above and beyond peers' perceptions) are arguably incrementally important for students' eventual academic behaviors in the classroom (e.g., McElhaney et al. 2008). However, self-perceptions of relatedness may or may not correspond with peers' actual sociometric liking or disliking, a construct found to relate to achievement in its own right in a study of early adolescents across the transition to middle school (Kingery et al. 2011). Students also self-reported on their engagement, and incorporating other informants such as teacher report or observations would have been useful. The pathways between peer relatedness and engagement may be inflated in this sample owing to the shared method variance in the assessment of these constructs. Notably, however, engagement was both predicted by, and a predictor of, academic achievement test scores in the expected directions.

Another issue is that classroom peer relatedness is only one of many ways that peers are known to influence adolescents' academic engagement and achievement. As just a few examples, the selection of friends and the influence of friends' own achievement orientations, the quality of friendships, academic support from friends, and exposure to victimization, are all important (Rodkin and Ryan 2012). Furthermore, relatedness with parents, teachers, and peers may interact together to influence adolescent academic learning (Song et al. 2015; Wentzel et al. 2010); these processes were not measured in the current study. Finally, it is important to keep in mind that the participation rate in this study was 78%, and we do not know the extent to which findings would differ for students who did not elect to participate.

Implications for Policy and Practice

As other researchers have speculated, the need for social belonging with peers may be highly powerful among adolescents (Juvonen 2007). Developmentally, middle and high school students are increasingly relying on peers' reactions to determine (and to shape) their own evolving identities (Dishion and Tipsord 2011). Educators are most likely to be able to influence adolescents' peer relatedness occurring in their classroom as opposed to in the lunchroom or outside of school contexts (Hamm et al. 2014). Therefore, secondary school

may be an opportune time for educators to target classroom peer relatedness to promote students' academic engagement and ultimately, achievement.

Unfortunately, the structure of secondary school (changing classes, greater emphasis on course content as opposed to interpersonal interactions, increasing school size) may limit opportunities for peer relatedness precisely during the developmental period in which relatedness is most needed (Juvonen 2007). Indeed, students report declining perceptions of peer support following the transition to high school (De Wit et al. 2011). It is notable that middle school teachers report lower self-efficacy for managing their students' peer relationships relative to elementary school teachers (Ryan et al. 2015). Potentially, the emphasis on content instruction in the training of middle and high school teachers (Villegas-Reimers 2003) may leave teachers without the tools to attend to students' peer experiences in their classroom, as well as foster beliefs among teachers that curriculum is the predominant way to improve achievement in this age group.

Nonetheless, there are several promising ways in which secondary school teachers may be able to encourage peer relatedness (Kindermann 2011), for instance by not allowing students to put down others' ideas (Ryan and Patrick 2001). Additionally, teachers may stress mastery goals as opposed to performance goals (Ryan and Patrick 2001), or use cooperative learning strategies (Mikami et al. 2005), as these are suggested to create a less competitive and more supportive peer group environment in studies of adolescents. Secondary school teachers who are coached to use emotionally supportive practices when engaging with students may also improve peer relatedness among students, perhaps because students model the teacher's positive and supportive behaviors when interacting with one another (Mikami et al. 2011). Potentially, even training secondary school teachers to be more aware of and attuned to classroom peer dynamics may have positive effects on increasing students' peer relatedness (Hamm et al. 2011).

Conclusions

Adolescents in secondary school commonly experience stagnation or declines in classroom behavioral engagement, with direct implications for their academic achievement and educational attainment in the longer term. The current findings underscore the importance of classroom peers for academic learning in the adolescent developmental period. Adolescents' perceptions of relatedness with classroom peer relatedness contributed to their better behavioral engagement in that classroom over the course of a school year, and were not simply a product of good engagement. Higher engagement in spring predicted in turn predicted higher end of year objective achievement test scores after accounting for prior year test scores. In conclusion, increasing perceptions of relatedness between classroom peers may be a promising and underutilized pathway to promoting adolescents' academic learning.

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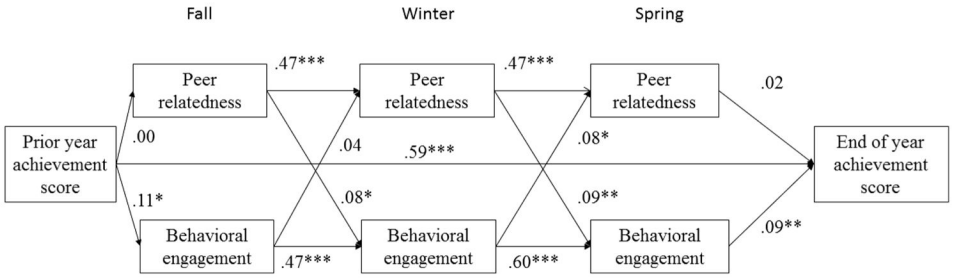

Fig. 1.

Cross-lagged path model of effects of behavioral engagement and peer relatedness on academic achievement. Standardized (beta) coefficients are presented. In addition to prior year achievement score, we controlled for the effects of demographic variables on fall measures of peer relatedness and engagement and the effect of free and reduced lunch on end of year achievement score (see Table 2). At the classroom level, we controlled for the average prior achievement score of students in that classroom, whether a middle or high school classroom, and whether the teacher was in the intervention or control group on end of year achievement test score (see Table 2). $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

Table 1

Descriptive statistics and correlations between study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Gender	1													
2. Ethnicity	−0.02	1												
3. Free/reduced lunch	−0.02	0.4***	1											
4. Fall peer relatedness	−0.08	0.06	−0.04	1										
5. Winter peer relatedness	−0.09*	0.02	−0.07	0.49***	1									
6. Spring peer relatedness	−0.1***	0.01	−0.05	0.44***	0.53***	1								
7. Fall engagement	−0.07*	−0.06*	−0.05	0.11***	0.14***	0.18***	1							
8. Winter engagement	−0.07	−0.07	−0.02	0.18***	0.3***	0.22***	0.51***	1						
9. Spring engagement	−0.04	−0.01	−0.02	0.19***	0.28***	0.32***	0.51***	0.64***	1					
10. Prior year achievement	−0.01	−0.30***	−0.26***	0.01	0.13**	0.08	0.08*	0.07	−0.02	1				
11. End of year achievement	0.03	−0.31***	−0.24***	0.07*	0.13***	0.13**	0.08	0.07	0.02	0.65***	1			
12. Intervention status	0.29	−0.14	0.05	0.04	−0.05	−0.03	−0.001	0.01	−0.06	0.04	−0.1	1		
13. School level	−0.17	0.19	−0.04	0.69***	0.35	−0.29	−0.40	−0.15	−0.13	−0.13	0.05	−0.14	1	
14. Course content	0.06	−0.24	0.26	−0.21	0.39	0.32	−0.13	−0.3	0.24	0.03	−0.06	0.05	−0.03	1
Mean (standard deviation)	47%	30%	39%	4.11 (.67)	4.02 (.71)	4.07 (.77)	3.97 (.66)	2.66 (.76)	3.89 (.79)	4.58 (.80)	4.56 (.75)	52%	35%	55%

Note: Gender: 1 = male, 0 = female; Ethnicity: 1 = Black, 0 = non-Black; Free/reduced lunch: 1 = present, 0 = absent; Intervention status: 1 = intervention group, 0 = control group; School level: 1 = high school, 0 = middle school; Course content: 1 = language arts/social studies, 0 = math/science

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$ observations did not change results. As such, analyses retained the full sample of 1084.

Table 2

Effects of control variables on peer relatedness, engagement, and achievement

	Std. Est.	SE	*p*-value
Within Classroom (Student) Level			
Behavioral Engagement Fall ON			
Prior Year Achievement	0.08	0.03	0.012*
Male	−0.10	0.03	0.00**
Black	−0.04	0.03	0.25
Peer Relatedness Fall ON			
Male	−0.08	0.04	0.05*
Black	0.07	0.03	0.02*
Achievement Spring ON			
Prior Year Achievement	0.59	0.03	0.00***
Free & Reduced Price Lunch	−0.11	0.02	0.00***
Between Classroom Level			
Achievement Spring ON			
Prior Year Achievement	0.67	0.09	0.00***
High School (vs. Middle School)	0.14	0.08	0.09
Langauge Arts/Social Studies (vs. Math/Science)	−0.03	0.80	0.80
Teacher in Intervention	−0.09	0.09	0.35
Student Level Achievement Spring R^2	0.40		
Classroom Level Achievement Spring R^2	0.48		

Note: Standardized regression estimates are shown. The cross-lagged panel model only included control variables that either had a *p*-value less than .10 or variables that were related to missingness on student-reported or outcome variables. Within classroom (student) level regression coefficients were group-mean centered

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$