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Educational and Career Interests in Math: A Longitudinal Examination of the Links Between Classroom Environment, Motivational Beliefs, and Interests

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Drawing on the expectancy-value model, stage–environment fit theory, and self-determination theory, this study examined the longitudinal associations between classroom characteristics, expectancies-values, high school course enrollment, and career aspirations in the domain of math. Data were collected on 3,048 youth who reported on their classroom experiences in 7th grade, expectancies-values in 6th, 7th, and 10th grades, and career aspirations in 12th grade. Student grades for math courses were collected from school records at 6th, 7th, and 10th grades, and their math course enrollment was collected from 9th through 12th grades. Results indicated that students' math classroom experiences predicted their expectancies and values, which, in turn, predicted the number of high school math courses taken and career aspirations in math. Gender and math ability differences are also discussed.

Keywords: math achievement, classroom characteristics, expectancy-value, motivation, career interest

Classroom environment is a critical context for promoting the development of students' educational and career interests (Simpkins, Davis-Kean, & Eccles, 2006). As students progress from middle to high school, they have opportunities to tailor their educational experiences to align with their career interests. Evidence suggests that academic motivation and engagement influence youths' capacities to plan for future careers (Durik, Vida, & Eccles, 2006; Wang, Willett, & Eccles, 2011). Students can refine their intellectual capacities and skills in particular domains, such as math, by choosing to engage in particular academic activities. Research on achievement motivation provides some insights into why adolescents choose to participate in certain academic activities (Cleary & Chen, 2009; Eccles, 2009; H. Patrick, Ryan, & Kaplan, 2007; Wang & Holcombe, 2010). However, less attention has been devoted to how classroom characteristics interact with students' motivation to influence their subsequent educational and career interests. In this study, I use the expectancy-value model (Eccles, 2009), stage–environment fit theory (Eccles & Midgley, 1989), and self-determination theory (R. M. Ryan & Deci, 2002) to test the longitudinal relationships among students' perceptions of classroom environment, motivational beliefs, high school course selection, and career aspirations in math to gain a better understanding of what leads to different pathways in the pursuit of a math career.

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Expectancy-Value Model

According to the expectancy-value model (Eccles, 2009), achievement-related behaviors such as high school course selection and occupational aspiration are most directly influenced by individuals' expectations for success and the relative subjective task values they attach to various courses or occupations. People will select those achievement-related activities that they think they can master and that have the highest subjective task value for them. Extant research has indicated that the students who are most likely to take math courses and to aspire to math-related careers place higher value on and have greater confidence in their math abilities than those who are not (Eccles, 2007). Because individuals' educational and career interests and choices are influenced by the relative levels of expectations for success and subjective task values across the set of options being considered, the examination of the development of these motivational beliefs will increase our understanding of youths' choices and interests among various courses and occupations.

Moreover, Eccles and colleagues (1993) suggested that the socialization processes linked to various social contexts (e.g., classroom and family) influence both group and individual differences in motivational beliefs in different achievement-related activities. For instance, teachers create opportunities for students to engage in a variety of achievement-related activities through classroom climate (Eccles, 1994). These classroom experiences provide students with information about their competence, interest, and value for various types of activities (Schunk, Pintrich, & Meece, 2008). Over time, this information cumulates to inform the development of ability self-concept beliefs and subjective task values for the variety of activity types to which the students are exposed (Schunk & Ertmer, 2000). In turn, these motivational beliefs influence the students' subsequent engagement in different educational activities as well as future educational and occupational aspirations (Simpkins et al., 2006).

Many scholars agree that youths' course selection and occupational aspirations in high school have long-term implications on their college and postcollege choices (Simpkins & Davis-Kean, 2005), yet little longitudinal research has focused on the classroom and motivational precursors to those math achievement-related behaviors that can compel students to hone their math skills. It is important to study the contextual and psychological factors that predict students' choices to engage in math activities and to determine whether proclivities toward math result from early classroom experiences (Durik et al., 2006). By pinpointing the proximal predictors of math choices and interests and identifying when they begin to predict important choices, we will be better able to know how and when to direct instructional interventions toward specific aspects of math-related motivation.

The Link Between Perceived Classroom Characteristics and Motivational Beliefs

Student motivation and engagement are optimized in classroom settings that meet individuals' developmental needs for competence, autonomy, and relatedness (Eccles & Midgley, 1989; R. M. Ryan & Deci, 2002). Stage–environment fit and self-determination theorists suggest that students will place high value, have high expectations for success, and be optimally motivated to engage in the learning activities in classroom settings that provide opportunities for them to fulfill these developmental needs. Conversely, students will disengage from learning in classroom settings that do not provide such opportunities. Unfortunately, there is evidence suggesting that secondary school classrooms, in comparison to elementary school classrooms, provide fewer opportunities for student self-management, choice, cooperation, and collaboration and are characterized by a less favorable interpersonal relationship with teachers and peers (Eccles & Roeser, 2009). Eccles et al. (1993) argued that much of the decline in students' motivation and engagement reflects developmentally inappropriate changes in the nature of school or classroom settings.

In this study, I focus on five aspects of math classroom environment in seventh grade that most closely link to developmental needs (Turner & Patrick, 2004; Wang, 2009; Wang & Dishion, 2011). The degree to which students perceive that the classroom environment meets their personal needs influences the development of their motivational beliefs (Fast et al., 2010; H. Patrick et al., 2007). Seventh grade was selected because it is the first year of junior high school in the districts included in this study, and prior research has shown a marked decline in students' math-related motivational beliefs at exactly this point in their school years (Eccles et al., 1993). It is also the year just prior to student decisions about taking Algebra in the eighth grade.

Teacher Expectations for Individual Students

Differential teacher expectations for the achievement success of individual students are related to differential treatment and student achievement outcomes (Jussim & Harber, 2005; Turner & Patrick, 2004). Teachers are more emotionally supportive of their high-expectancy students, they teach them more challenging material, and they provide them with more positive feedback and opportunities to demonstrate mastery. The differential expectations and treatment of students by their teachers may impact the students' sense of competence and as a result affect their self-expectations and future achievement outcomes (Jussim & Eccles, 1992; National Research Council, 2004).

Promoting Cooperation/Collaboration

Teachers promote cooperation and collaboration by having students share ideas, work together in small-group activities, or engage in informal help seeking and help giving during individual seatwork (Wang & Holcombe, 2010). Cooperation and collaboration are critical components of student-centered instructional practices. When students are encouraged to interact and exchange ideas with each other during class, opportunities to justify their own position and gain exposure to other possibilities increase (Durik & Eccles, 2006). Students feel more confident about their ability to learn and complete activities successfully when cooperating with others, as opposed to working on their own, because of the greater array of resources on which to draw (H. Patrick et al., 2007; A. M. Ryan & Patrick, 2001). Moreover, class cooperation and interaction provide opportunities for students to practice social skills and regulation of their own behaviors and emotions and experience a sense of relatedness to their peers (H. Patrick et al., 2007). This is likely to be particularly true in early adolescence, when the salience of peers is quite high (Eccles, Templeton, Barber, & Stone, 2003).

Support of Autonomy

Classroom practices that support students' sense of autonomy are critical for fostering intrinsic motivation to learn (Ryan & Deci, 2002). Eccles and Roeser (Eccles et al., 1993; Roeser & Eccles, 1998) found that the lack of opportunities for student autonomy helped explain declines in students' interest and valuing of school during their transition to middle school. A sense of autonomy is supported in classrooms where students have choices, share in decision making, and are relatively free from external control (Connell & Wellborn, 1991). Autonomy support can promote positive academic self-concept and interest because it provides opportunities for students to practice their decision-making skills, regulate their behavior, and experience a sense of personal satisfaction and responsibility through influencing their learning environment (Wang & Holcombe, 2010). However, it is critical that teachers support student autonomy in a context of adequate structure and orderliness (Skinner & Belmont, 1993). This issue is complicated by the fact that the right balance between adult-guided structure and opportunities for student autonomy may vary depending on students' academic ability level. High achievers may respond well to opportunities for autonomy, while low achievers may do better with more adult-controlled structure (B. C. Patrick, Skinner, & Connell, 1993).

Teacher–Student Relationships

Studies have shown the positive effect of supportive teacher–student relationships on motivation and engagement in a variety of academic settings (R. M. Ryan & Deci, 2002; Wentzel, 1998; Wigfield, Byrnes, & Eccles, 2006). There is strong evidence of the importance of positive teacher–student relationships, as well as a sense of belonging or relatedness, to adolescents' successful development in school (Furrer & Skinner, 2003; Wang & Eccles, in press). Teachers who are trusting, caring, and respectful of students provide the kind of socioemotional support students need to approach, engage, and persist on academic learning tasks (Roeser & Eccles, 1998), to foster positive academic self-efficacy and values, and to develop emotional comfort at school (Crosnoe, Johnson, & Elder, 2004). Students who perceive their teachers as supportive are more likely to view themselves as academically competent and set higher educational goals for the future (Wigfield et al., 2006). Similarly, students who perceive their teacher as caring have higher levels of interest and enjoyment in their schoolwork (Midgley, Feldlaufer, & Eccles, 1989), more positive academic ability concept (A. M. Ryan & Patrick, 2001), and greater expectancies for success in the classroom (Goodenow, 1993).

Teaching for Meaning

Meaningful curricula and instruction provide opportunities for students to connect personal goals and interests to actual classroom experiences, which increase feelings of autonomy and competence (Gentry & Owen, 2004). Research indicates that students enjoy learning when tasks are meaningful and relevant to personal goals and interests (National Research Council, 2004). The meaningfulness of the academic work to the students' interests and goals influences sustained attention, high investment of cognitive and affective resources in learning, and strong identification with educational goals (Hidi & Harackiewicz, 2000). Some researchers suggest that meaningful instruction and content also lead to stronger beliefs in one's academic abilities (Meyer, Turner, & Spencer, 1997; Stipek, 2001). Unfortunately, there is a disconnect between increases in students' cognitive sophistication, life experiences, and identity needs and the nature of the curriculum as students move from the elementary into secondary school years (Lee & Smith, 2001). Middle school students report higher rates of boredom than elementary school students when doing schoolwork, especially passive work (e.g., listening to lectures) and math and science (Larson & Richards, 1991).

The Link Between Motivational Beliefs and Educational and Career Interests

According to the Eccles expectancy-value model of achievement-related choices, individuals' expectations for success and the values that they attach to various tasks should directly influence their educational and occupational interests and choices (Eccles, 2009), and in fact they do predict math and science course enrollment choices, mathematical achievement, and educational or career aspirations in math and science (Updegraff, Eccles, Barber, & O'Brien, 1996). Subjective task values (e.g., interest, feelings of the importance) strongly predict enrollment plans, choices, and classroom engagement (Atwater, Wiggins, & Gardner, 1995), whereas expectancies are stronger predictors of subsequent academic performance (Updegraff et al., 1996; Wang & Eccles, 2011). Similarly, the number of math and science courses taken is predicted by youths' task values more than by their math academic self-concepts when both are included in the regression along with prior performance (Joyce & Farenga, 2000; Updegraff et al., 1996). Thus, it is important to distinguish the predictive role of expectancies for success from subjective task values. What is relatively unknown in the extant literature is how classroom characteristics relate to each of these sets of motivational beliefs and whether motivational beliefs mediate the association between classroom environment and educational and career interests. Filling this gap is one of the major goals in this study.

Gender Differences

There is evidence that motivational beliefs and achievement behaviors are likely to be shaped through gender norms and roles (Jacobs & Simpkins, 2005). For instance, although boys' performance in math is similar to or lower than girls' performance, boys have higher ability self-concepts in math (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002). Girls are less likely than boys to aspire to careers in fields related to mathematics but are not less likely than boys to take high school math courses (Simpkins & Davis-Kean, 2005). However, researchers have mainly focused on the gender differences in terms of the mean number of courses taken or the mean level of motivational beliefs and achievement; few studies have systematically examined whether the relations between classroom characteristics, expectancies-values, and interests vary for boys and girls.

Recent studies suggest that gender differences in students' preferences for learning contexts likely interact with subject area to affect their beliefs and interests in those subjects (Eccles et al., 1993). In particular, Jussim and Harber (2005) suggested that girls show more evidence of the classic teacher expectance effect than boys in math. Jussim and Harber explained these findings in terms of the fact that high achievement in math is less expected for girls. Thus, they may need more external support in developing stable high expectancies of themselves, and their expectancies are more likely to be undermined by negative external feedback. Moreover, girls appear to respond more positively to math instruction if it is taught in a cooperative or individualized manner rather than a competitive manner and if it is taught from an applied/person-centered perspective rather than from a theoretical/abstract perspective (Geist & King, 2004; Halpern, 2004). These effects likely reflect the fit between the teaching practices, instructional focus, and girls' values, goals, motivational beliefs, and learning styles (Urdan & Midgley, 2003). If particular classroom practices are more prevalent in one subject area than another, then one would expect gender differences in motivation to study these subject areas. Clearly, it is important to map gender differences in the relations among classroom characteristics, motivational beliefs, and career interests. This understanding will permit researchers and educators to promote those contextual and psychological factors that enhance girls' motivational beliefs and future aspirations in fields related to math.

Academic Ability Differences

Research suggests that math achievement is positively associated with youths' values and ability self-concepts as well as with their enrollment in additional elective math courses (Fast et al., 2010; Jacobs et al., 2002). The effect of classroom characteristics on student engagement and academic performance may also vary as a function of students' academic abilities (Elliot, McGregor, & Gable, 1999; Pintrich, 2000). For instance, high-performing students are more likely to benefit from autonomous learning environment than low-performing students because provision of autonomy can reinforce high-performing students' sense of competence and academic confidence but increase low-performing students' anxiety and sense of helplessness (B. C. Patrick et al., 1993). Few studies have examined the moderation effect of students' academic ability when examining associations between classroom environment, motivational beliefs, and course choice. Including math achievement as a moderator would allow us to determine whether students choose to participate in math at levels commensurate with their demonstrated math abilities.

The Current Study

This study aims to investigate classroom and motivational predictors of students' choices to enroll in high school courses and occupational aspirations that involve math skills. More specifically, drawing on the expectancy-value model, stage–environment fit theory, and self-determination theory, I investigate how students' perceptions of math classroom characteristics in seventh grade predict changes in youths' self- and task-related beliefs in seventh and 10th grades, which in turn predict 12th graders' course enrollment and occupational aspirations in math. Through this examination, I seek to identify the mechanisms by which students' perceptions of classroom characteristics exert influences on their educational and career interests through students' expectancies and subjective task values. Furthermore, I include measures of math performance in sixth, seventh, and 10th grades to control for the influence of performance feedback on youth beliefs and interests. Finally, I examine the moderation effect of gender and academic ability on perceptions of classroom environment, motivational beliefs, and subsequent math-related interests and choices. My conceptual model is presented in Figure 1. Using longitudinal data on a sample of urban adolescents, I address three specific research questions:

1. Do student perceptions of classroom characteristics predict changes in expectancies and subjective task values and educational and career interests in math (i.e., course enrollment and career aspirations)?

2. Are the relationships between student perceptions of classroom characteristics and educational and career interests in math mediated by expectancies and subjective task values?

3. Are there gender differences in student perceptions of classroom environment, motivational beliefs, course enrollment, and career aspirations in math? Does the strength of the associations between perceived classroom environment, motivational beliefs, and educational and career interests in math differ by gender or prior math achievement levels?

The associations of constructs and hypotheses in the model were both theory driven and research driven. First, I hypothesized that direct relationships would emerge between perceived classroom characteristics and both expectancies and subjective task values and between expectancies and subjective task values and educational and career interests. Second, I expected that expectancies and subjective task values would mediate the relationships between perceived classroom characteristics and subsequent educational and career interests. Third, I anticipated that perceived classroom characteristics linked to teacher expectations and cooperative learning would be more predictive of changes in girls' than boys' expectancies and subjective task values. Finally, I hypothesized that the positive association between autonomy support and high expectancies for success would be stronger for high-performing students than for low-performing students.

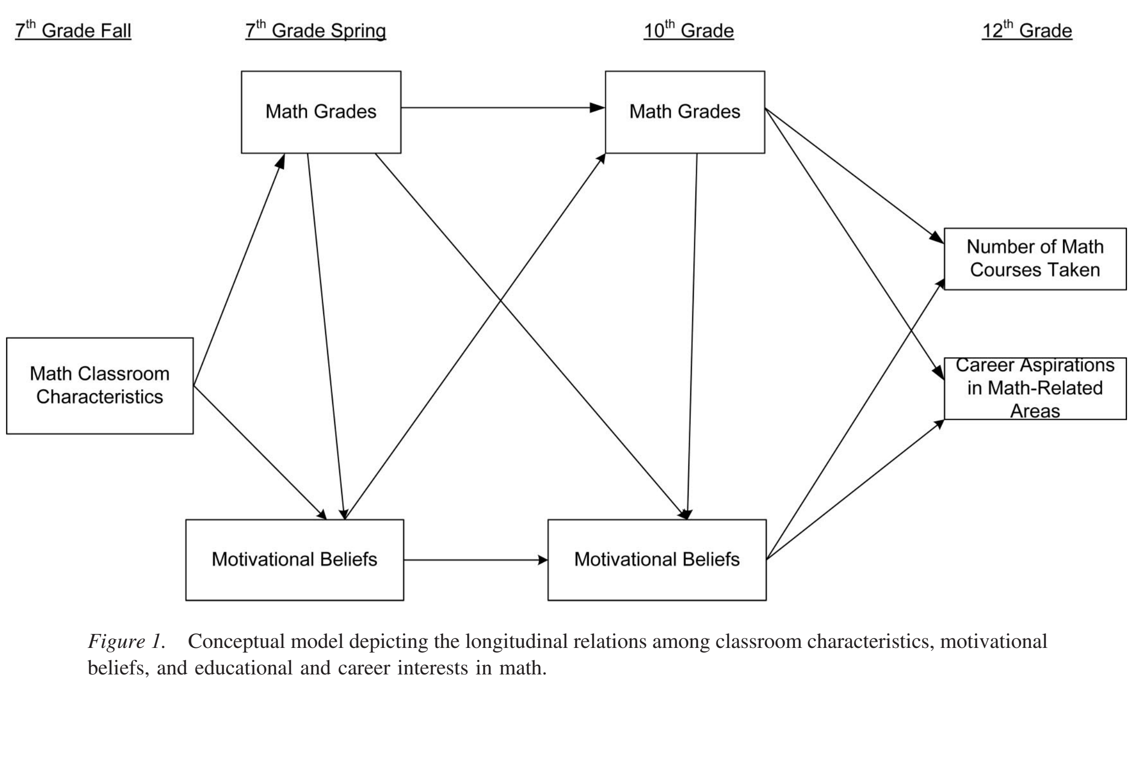

Figure 1. Conceptual model depicting the longitudinal relations among classroom characteristics, motivational beliefs, and educational and career interests in math.

Method

Sample

Data from the Michigan Study of Adolescent Life Transitions (MSALT), a large-scale longitudinal study, were used to investigate the impact of changes in classroom and family environments on adolescents' achievement-related beliefs, motives, values, and behaviors. The initial sample included 3,048 sixth-grade students, along with their teachers and parents, who were drawn from 124 math classes in 12 public schools located in working and middle-class communities in southeastern Michigan. MSALT includes data on these adolescents from sixth grade through 2 years post–high school. Data used in this study were from five waves: sixth grade (N = 3,048); seventh grade, Fall semester (N = 2,953); seventh grade, Spring semester (N = 2,950); 10th grade (N = 2,751); and 12th grade (N = 2,534) grade. Seventy-nine percent of the subsample in this study had complete data from sixth through 12th grades. The missing data rates in this study are comparable with other longitudinal studies (3% missing data at seventh grade, 6% missing data at 10th grade, and 12% missing data at 12th grade). The most common source of attrition was moving out of the school districts. To examine whether sample attrition influenced results, I compared individuals with complete data or missing data at one wave with individuals with missing data at two or more waves on all indicators included in the analyses. None of the 35 comparisons were statistically significant. At seventh grade, students' mean age was 12.4 years, 97% were White, 54% were girls, and the majority of the families (96%) had two parents living in the home. Forty percent of mothers and 42% of fathers had earned a degree from a four-year college. Family annual household income ranged from under \$10,000 to over \$80,000 (*Mdn* = \$55,000–\$65,000). It is important to note that the study was done in southeastern Michigan, where many of the families worked for the auto industry. Due to unionization, non–college graduates could earn quite high incomes. Thus, the sample is largely middle class in terms of income but evenly divided between blue-collar and white-collar employment status.

Procedure

Students and their parents were recruited through the schools. Letters describing the study and permission slips were given to families by teachers. Eighty-five percent of the families across the schools agreed to participate. Student data were collected at school during the school year. In the sixth and seventh grades, field staff administered questionnaires to the participating students during the period in which they normally received mathematics instruction. The questionnaires were administered over two consecutive days. In the 10th and 12th grades, questionnaires were filled out during a 90-min session in the school auditorium or the cafeteria. During this time, research staff members were available to answer questions. To maintain as large a sample as possible, questionnaires and postpaid return envelopes were sent to students who participated during previous waves of data collection but were absent on the day of the data collection. Students received small monetary incentives for their participation. Student grades, test scores, and specific courses taken were gathered from their school record data from sixth grade to 12th grade. Data were also collected from the parents through surveys mailed directly to the home and then returned in prepaid-postage envelopes. The only information from parents used in this study was parent education level, occupational status, and family annual income, which was used to determine socioeconomic status.

Measures

School math grades. School grades in math were collected from school record data every semester in sixth, seventh, 10th, and 12th grades. A mean of both semesters was used for each grade level. We used marks from Grades 6, 7, and 10 in this study.

Number of math courses. The number of high school math courses each student took was collected from the school record data. Math courses included General/Remedial Math, Pre-Algebra/Introduction to Algebra, Applied Algebra I and II, Algebra I and II, Honors Algebra II, Applied Geometry, Conceptual Geometry, Geometry, Introduction to Trigonometry, Trigonometry, Probability and Statistics, Pre-Calculus, Honors Pre-Calculus, Calculus, and AP Calculus. The outcome of course enrollment was calculated by summing the number of math courses students took between 11th and 12th grades. Previous research has indicated that this variable is a valid indicator of the level of math training as well as the quantity of math training (Updegraff et al., 1996). Those students taking more math courses were essentially the same students who were taking more advanced math courses at the end of their high school career because only two years of high school math were required for graduation.

Occupational aspirations in math-related areas. At Grade 12, students were asked to think about their future, consider a list of 45 different types of possible careers, and rate how likely they would be in each. For this study, we focused on the math-related jobs (e.g., engineer, math teacher, biologists, architect, business manager or administrator, stockbroker, accountant, CPA, medical doctor, and scientist). Responses were rated along a 7-point scale from 1 (*very unlikely*) to 7 (*very likely*). The variable of occupational aspirations was calculated by averaging the responses to the math-related job categories (α = .75).

Motivational beliefs. Students described their expectancies and values regarding math at sixth, seventh, and 10th grades. These scales have been used in prior studies and demonstrated excellent convergent and discriminant validity as well as strong psychometric properties (Anderman et al., 2001; Eccles et al., 1993; Jacobs et al., 2002). I created two latent variables to represent students' motivational beliefs:

1. *Expectancies.* I used five items to assess students' expectancies for success and self-concept of ability in math. Example items are "How good at math are you?", "How good would you be at learning something new in math?", and "How well do you expect to do in math this year?" Responses were rated along a 7-point scale, ranging from 1 (*not at all good*) to 7 (*very good*). This scale was reliable (α = .90–.94 between sixth and 10th grades).

2. *Subjective task values.* I combined two subscales to measure students' perceptions of math importance and interest in math. The subscale of math importance included three items, and example items are "In general, how useful is what you learn in math?" (1 = *not at all useful* to 7 = *very useful*) and "For me being good at math

is . . . ." (1 = *not at all important* to 7 = *very important*). The subscale of interest in math included three items, and example items are "Compared to most of your other activities, how much do you like math?" (1 = *not as much* to 7 = *a lot more*) and "In general, do you find working on math assignments. . . ." (1 = *very boring* to 7 = *very interesting*). These scales were reliable (α = .89–.95 between sixth and 10th grades).

Classroom characteristics. The 20-item Classroom Environment Measure was used to create five latent variables to tap students' perceptions of the classroom characteristics at seventh grade: (a) teacher expectations, (b) promotion of cooperation, (c) autonomy support, (d) teacher social support, and (e) teaching for meaning. The Classroom Environment Measure is a widely used and well-validated measure of students' perceptions of classroom climate (e.g., Mac Iver, 1988; Midgley et al., 1989). Previous research has indicated that the measure has strong psychometric properties, including internal consistency and criterion validity (Eccles, Lord, Roeser, Barber, & Jozefowicz, 1997). The Teacher Expectation subscale included three items (α = .83) and assessed teacher's expectations for the success and achievement of individual students (e.g., "The teacher expects me to do well in math this year"). The Promoting Collaboration subscale consisted of five items (α = .85) and assessed students' perceptions of the extent to which their teacher promoted collaboration and interaction (e.g., "We get to work with each other in small groups when we do math"). The Autonomy Support subscale included five items (α = .90) and assessed students' perceived opportunities to make decisions related to academic tasks and interact with one another during class (e.g., "The teacher asks us what we want to learn about in math"). The Teacher Social Support subscale consisted of four items (α = .87) and assessed students' perceived level of care and support from teachers (e.g., "The teacher cares how we feel"). The Teaching for Meaning subscale included three items (α = .90) and assessed the extent to which the curriculum and design of instruction were meaningful, relevant, and related to students' personal interests and goals (e.g., "We discuss problems and issues that are meaningful to us"). All items were rated on a 5-point scale, ranging from 1 (*not very often*) to 5 (*very often*).

Covariates. I controlled for a vector of important covariates related to adolescents' socioeconomic characteristics and prior academic achievement and interests, including gender (0 = girl, 1 = boy), ethnicity (0 = White, 1 = non-White), socioeconomic status (parent education and family annual income), math track level at Grade 7 (0 = remedial, 1 = basic, and 2 = advanced), student expectancies and subjective task values in sixth grade, course selection in ninth and 10th grades, and math achievement in sixth, seventh, and 10th grades. I standardized and added the parent's current occupational status and annual family income to create a composite measure of socioeconomic status, ranging from 1 (*low*) to 10 (*high*).

Analysis Plan

I used structural equation modeling (SEM) to test the hypothesized relations among the study constructs (see Figure 1). To address my Research Question 1, I began by fitting baseline models that assessed the direct effects within the model. In these analyses, I examined whether perceived classroom characteristics predicted the motivational beliefs that occurred therein and whether these motivational beliefs, in turn, predicted career aspirations and course enrollment. After establishing these direct relationships, I tested whether expectancies and subjective task values mediated the associations between perceived classroom characteristics and educational and career interests to address Research Question 2. I estimated indirect effects with delta method standard errors to confirm the mediation effects (Dearing & Hamilton, 2006; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). To address Research Question 3, I used a stepwise process for the multigroup comparisons in SEM recommended by Bollen (1989) and Kenny (2005) to examine whether the measurement and structural relations in the final model varied by gender or by students' prior math achievement levels. I included a series of increasingly restrictive constraints on the model parameters and examined whether doing so led to a significant decrease in the model fit by using chi-square difference tests and comparisons of comparative fit index (CFI) values (Chen, 2007). If the impositions led to a significant decrease in overall model fit, it would indicate that there were differences across the groups in the pattern of associations.

All analyses were conducted in Mplus 6.1. The current data set includes data from students nested within 124 classes and 12 schools. To account for the nested nature of the data, I fit a two-level model with random effects (individual and classroom) and included school as fixed effects. None of the school fixed effects were found to be statistically significant. In addition, I specified that the dependent variable—number of math courses—was treated as a count variable in the model and its estimation. I dealt with the missing data through full-information maximum-likelihood estimation, allowing me to include all available data and identifying the parameter values that have the highest probability of producing the sample data (Baraldi & Enders, 2010). The following tests for goodness of fit were used to assess both measurement and the structural models: the chi-square (χ^2) statistic, the CFI, the standardized root-mean-square residual (SRMR), and the root-mean-square error of approximation (RMSEA). SEM literature suggests model fit is excellent when the coefficient for CFI is greater than .95, and model fit is deemed adequate if the coefficient is greater than .90 (Byrne, 2001). For the SRMR and RMSEA, a coefficient less than .05 indicates an excellent fit, and a coefficient under .08 indicates an acceptable fit (Kline, 2005).

Results

I created latent variables for all constructs of perceived classroom characteristics and students' expectancies and subjective task values. Latent variable analysis is a more parsimonious representation of the processes under study, allowing me to better account for the individual contribution of each item and also to more precisely model measurement error (Bollen, 1989). Confirmatory factor analysis verified that the hypothesized constructs measured discrete, single latent variables. For all latent variables, individual loadings were generally comparable, and all were statistically significant at .001. For the assessment of the measurement model, all the variables were allowed to intercorrelate simultaneously. The measurement model was found to provide good fit, $\chi^2(230) = 879.46$, $p < .001$, CFI = .97, RMSEA = .02, SRMR = .01.

Interrelations, means, and standard deviations for all latent variables within my model are presented in Table 1. The expected relationships among the main constructs were obtained. For instance, the five aspects of students' perceptions of classroom environment were positively related to motivational beliefs. The motivational beliefs were positively related to course selection and career aspirations. With regard to gender differences, girls reported higher scores than boys for promotion of cooperation and teacher social support and lower scores than boys for teacher expectations, teaching for meaning, expectancies, and math career aspirations.

For ease of presentation, I display the standardized path coefficients for the final model with expectancies and subjective task values (values) separately in Figures 2 and 3; however, it is important to note that the two models were conducted in a single analysis as depicted in Figure 1. The final SEM model fit was good, $\chi^2(465) = 1{,}021.35$, $p < .001$, CFI = .95, RMSEA = .04, SRMR = .02. The model accounted for a large portion of the variance in the expectancies in seventh grade ($R^2 = .32$) and 10th grade ($R^2 = .40$), values in seventh grade ($R^2 = .35$) and 10th grade ($R^2 = .48$), course enrollment ($R^2 = .48$), and career aspirations ($R^2 = .56$).

The results are organized into three sections. First, I describe the direct paths within the model. In these analyses, I examined whether students' perceptions of classroom characteristics predicted the motivational beliefs and whether these beliefs, in turn, predicted the educational and career interests. Second, I present findings from mediation analyses. Finally, I discuss moderation analyses that explored possible differences in modeled relationships by adolescent gender and prior academic achievement levels.

Direct Effects Between Perceived Classroom Environment, Motivational Beliefs, and Educational and Career Interests

The separated SEM models are illustrated in Figures 2 and 3. Students' perceptions of teacher expectations, teacher social support, and teaching for meaning were positively associated with expectancies (βs = .26, .21, and .14, respectively) and subjective task values (βs = .21, .16, and .27, respectively) in seventh grade. Support of autonomy did not predict either students' expectancies or values. Students' expectancies in 10th grade positively predicted levels of math course enrollment and career aspirations in math-related areas in 12th grade (βs = .20 and .17, respectively). Similarly, students' values positively predicted levels of math course selection and math-related career aspirations in 12th grade (βs = .27 and .36, respectively). Math grades were positively associated with students' expectancies and values in seventh and 10th grades. The number of math courses taken and career aspirations related to math were also predicted by students' course grade at 10th grade (βs = .20 and .17, respectively).

In addition, three major differences emerged among these constructs based on post hoc analyses. First, the promotion of cooperative learning was significantly related to values but not to the students' math expectancies. Second, expectancies at seventh grade were a stronger predictor of changes in math grades from seventh to 10th grade than values at seventh grade. Finally, values were a stronger predictor of math course enrollment and math-related career aspirations than expectancies. Values were also a stronger predictor of both courses and aspirations than prior math grades.

Mediation Effects of Motivational Beliefs

Mediational analyses examined the extent to which the math expectancies and values mediated the relationships between perceived classroom characteristics and students' educational and career interests. Table 2 presents the standardized path coefficients for the total, direct, and indirect effects of perceived classroom characteristics on students' course selection and career aspirations. As shown in Figures 2 and 3, math expectancies and values fully or partially mediated the relationships between all perceived classroom characteristics and subsequent educational and career interests, except support for autonomy. Specifically, the associations of teacher expectations and teaching for meaning to course selection

Table 1
Means, Standard Deviations, and Intercorrelations Among Key Variables (N = 3,048)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Teacher expectations	—														
2. Promotion of cooperation	.08	—													
3. Autonomy support	.19	.18	—												
4. Teacher social support	.30	.15	.35	—											
5. Teaching for meaning	.21	.17	.19	.18	—										
6. Expectancies in seventh grade	.31	.11	.12	.26	.19	—									
7. Subjective task value in seventh grade	.27	.18	.09	.21	.34	.49	—								
8. Expectancies in 10th grade	.22	.08	.09	.19	.12	.52	.38	—							
9. Subjective task value in 10th grade	.16	.13	.08	.13	.20	.32	.49	.50	—						
10. Number of course enrollment	.25	.19	.10	.20	.22	.15	.17	.25	.30	—					
11. Career aspirations	.21	.15	$.05_a$	.17	.19	.18	.29	.21	.39	.15	—				
12. Math achievement in seventh grade	.26	.19	.08	.20	.23	.37	.36	.26	.16	.16	.12	—			
13. Math achievement in 10th grade	.17	.12	.06	.14	.16	.44	.28	.35	.26	.25	.22	.59	—		
14. Boy	.13	−.09	$.03_a$	−.08	.15	.11	$.02_a$	.09	$.01_a$	$-.02_a$	.18	$-.02_a$	$-.01_a$	—	
15. Socioeconomic status	$.05_a$	.08	.06	$.05_a$	$-.02_a$	$.02_a$	$.01_a$	$.02_a$	$.01_a$	.18	.15	.13	.15	$.02_a$	—
M	3.10	1.79	1.82	3.35	1.93	4.50	4.41	4.33	3.99	4.12	2.67	6.89	6.64	0.46	6.42
SD	1.14	0.66	0.64	0.76	0.71	1.32	1.42	1.48	1.39	3.12	2.28	1.12	1.22	0.52	0.78

Note. All coefficients are significant ($p < .05$), except those with subscript $_a$.

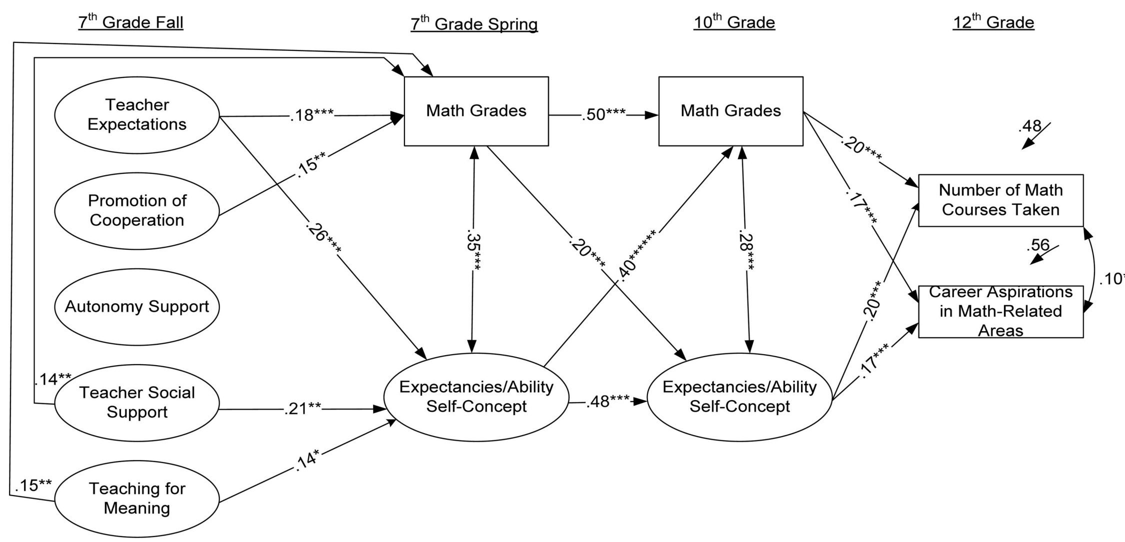

Figure 2. Conceptual model depicting the longitudinal relations among perceived classroom characteristics, academic self-concept, and educational and career interests in math. All coefficients shown are standardized and statistically significant at $p < .05$. Paths missing from exogenous variables to endogenous variables were examined but found not to be significant. Direct effects between perceived classroom environment variables and choice outcomes are shown in Table 3. Paths describing relations from controlling variables (i.e., gender, ethnicity, socioeconomic status) to mediating and outcome variables are available upon request.

and career aspirations were fully mediated by math expectancies and values. The associations of teacher social support to course enrollment and career aspirations were partially mediated by math expectancies and values. Finally, the associations of promotion of cooperation to course selection and career aspirations were partially mediated by math values.

Moderation Effects of Gender and Math Ability

I conducted two sets of moderation analyses to determine whether the measurement and structural relations in the final model varied by gender or math ability. For moderation analyses involving math ability, I tested differences across two ability

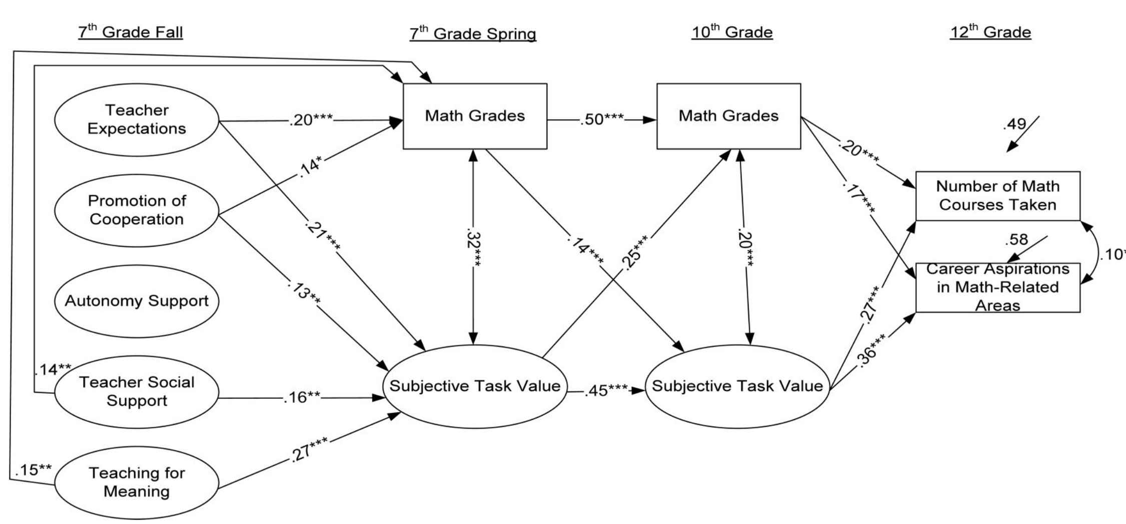

Figure 3. Conceptual model depicting the longitudinal relations among perceived classroom characteristics, subjective task value, and educational and career interests in math. All coefficients shown are standardized and statistically significant at $p < .05$. Paths missing from exogenous variables to endogenous variables were examined but found not to be significant. Direct effects between perceived classroom environment variables and choice outcomes are shown in Table 3. Paths describing relations from controlling variables (i.e., gender, ethnicity, socioeconomic status) to mediating and outcome variables are available upon request.

Table 2
Standardized Direct, Indirect, and Total Effects for the Hypothesized Path Models From Perceived Classroom Environment to Educational and Career Interests

Predictor and covariate	Course enrollment in 12th grade			Career aspirations in 12th grade		
	Direct	Indirect	Total	Direct	Indirect	Total
Predictor variable						
Teacher expectations	.12**	.18***	.30***	.10*	.15***	.25***
Promotion of collaboration	.05	.13***	.18***	.04	.13	.17***
Autonomy support	.02	.03	.05	.01	.02	.03
Teacher social support	.06	.14***	.20***	.05	.14***	.19***
Teaching for meaning	.10**	.15*	.25***	.10**	.16***	.26***
Covariate						
Math grade in sixth grade	.09*	—	—	.10*	—	—
Expectancies in sixth grade	.08*	—	—	.10*	—	—
Subjective task value in sixth grade	.08*	—	—	.14**	—	—

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

groups: high math grade and low math grade in seventh grade (I defined math score above average as high and below average as low). The measurement part of the model was first tested by constraining the factor loadings of the two models to be equal. The $\Delta\chi^2$ difference test showed that model fit decrease was not significant across gender, $\Delta\chi^2$ (23) = 32.40, p = .16, ΔCFI = .001, or academic ability, $\Delta\chi^2$ (23) = 28.52, p = .20, ΔCFI = .001. The constrained measurement model provided a good model fit overall for the two groups, respectively. After examining measurement equivalence, the paths of the two models were constrained to be equal sequentially.

Moderation analyses by gender in Table 3 indicated significant differences across groups in the relationships between perceived classroom characteristics and motivational beliefs. Further analyses revealed that the gender group differences were specific to the relationship between teacher expectations and expectancies, $\Delta\chi^2$ (7) = 17.08, $p < .05$, ΔCFI = .015, as well as support of collaboration and values, $\Delta\chi^2$ (7) = 19.13, $p < .01$, ΔCFI = .019. Teacher expectations were more strongly associated with expectancies for girls (β = .29, p = .001) than for boys (β = .15, p = .01). Similarly, for girls, increasing support of collaboration was associated with higher values (β = .19, p = .001); the same trend was found for boys though the coefficient was weaker (β = .09, p = .05).

For multigroup analyses involving math ability in Table 4, results indicated significant differences across groups in the relationship between support of autonomy and values, $\Delta\chi^2$ (7) = 15.381, $p < .05$, ΔCFI = .018. For high achievers, increasing autonomy support was associated with greater values (β = .12, p = .03); the coefficient was not significant for low achievers (β = .01, p = .17).

Discussion

In this study, I investigated the developmental relations between student perceptions of classroom characteristics, expectancies and subjective task values, and educational and career interests in math from seventh to 12th grades and in particular addressed gender and academic ability differences in these relations. As predicted, students' math classroom experiences at seventh grade predict math expectancies/ability self-concepts, subjective task values, and interests at seventh and 10th grades (controlling for prior math achievement, motivational beliefs, and family demographics). In turn, students who believed they were skilled or had an interest in

Table 3
Moderation Results: Effects of Gender on Modeled Relationships

Constrained path	χ^2 (*df*)	*p* (for $\Delta\chi^2$)	ΔCFI
1. Measurement model	1,183.36 (634)	*ns*	.001
2. Classroom characteristics → math grade in seventh grade	1,193.46 (642)	*ns*	.001
3. Classroom characteristics → motivational beliefs in seventh grade	**1,217.27 (651)**	**.01**	**.016**
Teacher expectations → expectancies/ability self-concepts	**1,234.35 (658)**	**.05**	**.015**
Support of collaboration → subjective task value	**1,236.40 (658)**	**.01**	**.019**
4. Math grade in seventh grade → math grade in 10th grade	1,231.56 (660)	*ns*	.001
5. Motivational beliefs in seventh grade → motivational beliefs in 10th grade	1,236.47 (665)	*ns*	.002
6. Math grade in seventh grade → motivational beliefs in 10th grade	1,240.85 (668)	*ns*	.001
7. Motivational beliefs in seventh grade → math grade in 10th grade	1,245.11 (671)	*ns*	.001
8. Math grade in 10th grade → educational and career interests	1,260.23 (680)	*ns*	.001
9. Motivational beliefs in 10th grade → educational and career interests	1,273.84 (692)	*ns*	.001

Note. Bolded pathways denote differences across gender groups. CFI = comparative fit index.

Table 4
Moderation Results: Effects of Math Ability on Modeled Relationships

Constrained path	χ^2 (*df*)	*p* (for $\Delta\chi^2$)	ΔCFI
1. Measurement model	1,046.37 (634)	*ns*	.001
2. Classroom characteristics → math grade in seventh grade	1,060.45 (642)	*ns*	.001
3. Classroom characteristics → motivational beliefs in seventh grade	**1,078.52 (651)**	**.05**	**.017**
Support of autonomy → expectancies/ability self-concepts	**1,093.90 (658)**	**.05**	**.018**
4. Math grade in seventh grade → math grade in 10th grade	1,092.34 (660)	*ns*	.002
5. Motivational beliefs in seventh grade → motivational beliefs in 10th grade	1,101.18 (665)	*ns*	.001
6. Math grade in seventh grade → motivational beliefs in 10th grade	1,106.27 (668)	*ns*	.004
7. Motivational beliefs in seventh grade → math grade in 10th grade	1,112.74 (671)	*ns*	.003
8. Math grade in 10th grade → educational and career interests	1,123.56 (680)	*ns*	.001
9. Motivational beliefs in 10th grade → educational and career interests	1,138.44 (692)	*ns*	.001

Note. Bolded pathways denote differences across math ability groups. CFI = comparative fit index.

math were more likely to continue to take math courses and have career interests in math at 12th grade. These findings are consistent with a critical feature of the expectancy-value perspective (Eccles, 2009): the explicit assumption that achievement-related decisions are made within a classroom context that presents each individual student with a variety of opportunities and choices that fulfill various developmental needs. Each achievement-related decision, such as enrolling in an advanced math course, holds both immediate and long-term consequences for their motivational beliefs.

The Link Between Students' Perceptions of Classroom Characteristics and Motivational Beliefs

Consistent with hypotheses derived from both stage–environment fit theory (Eccles et al., 1993) and self-determination theory (Deci & Ryan, 2000), teacher expectations, teacher social support, teaching for meaning, and promoting cooperation each predict changes in math expectancies and math subjective task values. Interestingly, the patterns of association of these various perceived classroom characteristics differ for expectancies and subjective task values. Both teacher expectations and teacher social support predict math expectancies more strongly than math subjective task values. In contrast, teaching for meaning predicts math subjective task values more strongly than math expectancies. Promoting cooperation predicts math subjective task values but not math expectancies. These differences are consistent with other studies showing that cooperative learning and teaching of material that is meaningful to the student increase both enjoyment and interest in the subject matter (Hidi & Harackiewicz, 2000). The same literature, however, suggests that these classroom characteristics should also impact student expectancies for success and ability self-concepts. My findings partially support these patterns. Promoting cooperation has indirect predictive association with math expectancies through its direct association with math grades. Thus, all four of these measures of classroom characteristics—teacher expectations, teacher social support, teaching for meaning, and promoting cooperation—have either direct or indirect predictive effects on students' motivational beliefs.

The Link Between Math Performance and Motivational Beliefs and Educational and Career Interests

According to the Eccles expectancy-value model (Eccles, 2009), the feedback students receive on their academic performance also influences their motivational beliefs and academic choices. My results support this prediction: Those students who earned higher grades in math also reported higher math expectancies and subjective task values and were more likely to continue with course work in math as well as pursue math-related jobs in the future than the students who earned lower math grades. Moreover, students' math expectancies and subjective task values positively predicted both the number of high school math courses taken and students' math-related career aspirations. The more positive a student's math expectancies or subjective task values were, the more likely he or she was to aspire to a math career and make decisions that would help him or her to pursue a math career.

More importantly, given prior findings and the Eccles expectancy-value perspective, students' beliefs regarding the importance of and their enjoyment of math are stronger predictors of course taking and career aspirations than either prior grades or math ability self-concepts. Thus, it seems to suggest that promoting the subjective task value students attach to math is critical to increasing both the number of math courses taken and interest in math-related careers for both boys and girls. This finding suggests that parents and teachers should devote time and effort to developing student interest in math as well as their mathematical knowledge and skill.

The Mediating Effects of Motivational Beliefs

Consistent with my hypothesis, classroom environments that facilitate person–environment fit promote student course taking and career aspirations in math through their associations with changes in student expectancies and subjective task values. In particular, my studies suggest that students' expectancies and subjective task values in math are enhanced when they are provided with challenging tasks in a classroom environment that also provides emotional and cognitive support, meaningful material to learn and master, and appropriate support of their personal goals and interests. These findings are consistent with other studies showing the critical role teachers can play in facilitating students' motivation during the early secondary school years (Eccles et al., 1993; Wigfield et al., 2006). Teachers can also influence student attainment of specific skills and interests through the opportunities they create in the classroom (via structure and types of activity) for the development of domain-specific ability self-concepts.

Furthermore, students' math expectancies and subjective task values fully or partially mediated the relations between classroom characteristics and students' educational and career interests. My results support the premise that adaptive classroom environments positively affect both the number of math courses taken and math-related career aspirations, directly and indirectly, by enhancing student expectancies and subjective task values. Classroom climate research has been criticized for lack of theoretical framework (H. Patrick et al., 2007), and this study demonstrates the value of integrating the expectancy-value model, stage–environment fit theory, and self-determination theory to understand processes that link the students' perceptions of classroom characteristics to learning motivation, course enrollment, and occupational aspirations. My findings show that perceptions of different aspects of the classroom environment are significantly related to student motivation and career interests and explicate the processes by which these constructs interact.

My model shows that the links between math motivational beliefs in 10th grade and high school math-related interests and choices in 12th grade can be traced back to students' motivational beliefs in seventh grade. This indicates that earlier educational experiences can have long-term impact on future achievement motivations and career interests. Thus, teachers need to address students' motivational beliefs about math before students enter high school, at least as early as seventh grade. Therefore, one potential avenue to increase student expectancies and subjective task values, as well as future educational and career aspirations related to math, is to create optimal math classroom environments in earlier grades.

The Moderation Effect of Gender

The multigroup analyses examining the moderating effect of gender support my tentative hypotheses that teacher expectations and promotion of cooperative learning have greater predictive impact on girls than on boys. This finding is consistent with some of the assumptions in the gender literature. In general, there is less expectation for girls to perform well in math than for boys. Thus, girls may need more external support in developing stable high expectancies, and their expectancies for themselves are likely to be more easily promoted or undermined by external feedback, such as teacher expectations (Jussim & Harber, 2005). Furthermore, boys tend to prefer competitive learning activities while girls tend to prefer cooperative ones (Halpern, 2004). For example, boys are more apt to respond to a model of teaching in which right answers are emphasized. Boys also tend to focus on reaching a conclusion quickly and, often, individually (Geist & King, 2004). On the other hand, girls prefer cooperative tasks that emphasize mastery over ranking. In addition, boys tend to get bored more easily than girls and thus require additional instructional interventions to keep them attentive and on task (Gurian, Henley, & Trueman, 2002). Teachers need to be aware that different instructional strategies may differentially privilege girls or boys. To be sure, this is not an argument to avoid using one or another approach—indeed, girls need experience dealing with competitive environments, just as boys benefit from learning how to thrive in cooperative, mastery-focused contexts. However, it is a caution to teachers, particularly in the current era of increased emphasis on student performance on high-stakes tests, that they should be mindful that the same practices that motivate some students to increase their expectancies-values may actually contribute to lower motivation and a lower sense of competence in other students.

What do the results have to say about gender differences in aspirations for math-related careers? Consistent with other studies, the girls in this study reported lower math expectancies and were less likely to consider careers in math-related fields than the boys (Wigfield et al., 2006). However, they took just as many high school math courses, got just as good grades in math, and attached as much subjective task value to math as their male peers. So why did they differ in their math expectancies and their interest in pursuing careers in math-related fields? My study suggests that part of the answer may lie in their experiences in the math classes. The girls in this study perceived their teachers as holding lower expectations for them than for the boys, and perceived teacher expectation is the strongest predictor of change in the students' math expectancies, as well as being a strong predictor for subjective task values. In addition, perceived teacher expectation is a stronger predictor for girls than for boys, making this source of influence even more salient for the girls. It is hard to know if the math teachers in this study actually held lower expectorations for the girls than for the boys. However, two item questions in the data set might reflect their expectations for each of their students: "How much natural talent does this student have for math?" and "How well is this student performing compared to how well you believe he or she could?" There was no gender effect for the first question; in contrast, in the second question, teachers rated the boys as underachieving ($M = 2.25$) to a greater extent than the girls ($M = 2.96$) on a scale from 1 (*far below their ability*) to 4 (*the maximum of their ability*), $t(1, 2925) = 2.31$. It is possible that teachers are interacting differently with boys and girls in ways that communicate higher expectations for the boys (Dweck, 1986; Graham, 1991). Even if this is not the case, the logic behind stereotype threat phenomena suggests that it does not really matter whether there is a real difference or not (Steele & Aronson, 1995) as long as the perception exists. The fact that girls believe their teachers hold lower expectations for them is enough to negatively affect their motivational beliefs and achievement behaviors, and according to this study, this should be particularly true for those girls who have the highest math ability and the highest math subjective task values—the very girls who would be most likely to consider math-related careers. So the difference in perception of teacher expectation between boys and girls might explain the gender difference in math-related career aspirations.

The girls in this study viewed their teachers as being less likely to be teaching for meaning than did the boys, and teaching for meaning was a strong predictor of subjective task values. The gender difference in levels of perceived teaching for meaning might reflect the fact that the teachers were more likely to stress the association of math with activities, careers, and domains that interest boys, such as engineering or the physical domain. If this assumption is true, then the boys would be more likely than the girls to feel that their math teachers were teaching for meaning, and this would lead to increases in the subjective task values the student attaches to math, which, in turn, would lead to an increase in the probability of aspiring to a math-related career. Thus, there may be a critical spiral of stereotypes or biases acting on gender differences that exist before the students enter the math class. To interrupt this spiral, math teachers may need to relate their teaching and learning activities to areas of interest to girls. In this sample, the girls were more likely than the boys to view their teachers as providing opportunities for cooperative learning and providing more social support. Unfortunately, these classroom characteristics were not as influential in predicting change in subjective task values as perceived teacher expectations and teaching for meaning—the two areas in which the girls reported lower scores than the boys.

The Moderation Effect of Math Ability

It is interesting to note that support for autonomy, as measured by having a voice in how the class is run, was not related significantly to either motivational beliefs or educational and career interests of the population at large. This might reflect differential preferences for such opportunities. In previous studies, researchers asked the students if they had opportunities for decision making in their classroom and if they wanted such opportunities (Eccles et al., 1993). Many students indicated that they did not want such opportunities and preferred to let the teacher make these decisions. In this study, I found that support for autonomy measured in terms of classroom decision making varied as a function of the students' actual level of math performance: autonomy support was positively related to high achievers' expectancies but unrelated to low achievers' expectancies. This finding is consistent with other evidence that the association between autonomy support and expectancies/academic self-concepts depends on the students' academic achievement levels (B. C. Patrick et al., 1993). My findings suggest that high expectancies are more likely to develop in a classroom with the optimal levels of academic ability combined with developmentally appropriate provision of autonomy (Deci & Ryan, 1985; B. C. Patrick et al., 1993). Accordingly, this finding has practical implications for teachers. Students who are more competent academically may need more autonomy support to facilitate motivation. An autonomous learning environment may function as a self-regulation strategy that high achievers can use to motivate themselves in the face of both easy and challenging tasks (Church, Elliot, & Gable, 2001). Autonomous learning opportunities for high achievers could include less structured guidance, more activities tailored to students' interests, and more decision-making opportunities. On the other hand, students who are less competent academically, anxious about having autonomy, or uncomfortable relying on unknown strategies may need more structure to enhance their expectancies/academic self-concepts. Increased structure could take the form of more guidance and the presentation of specific learning strategies to utilize. Teaching for meaning, another form of support for autonomy, positively predicted both math expectancies and subjective task values for all students. All students also benefit from teacher practices that are perceived to be sensitive to their interests. In contrast, teacher practices that support student autonomy benefit some students more than others and should be applied accordingly.

Strengths and Limitations

Several design features contributed to the strength of the current study. First, the use of cross-lagged and autoregressive techniques within the SEM framework allowed me to take advantage of the longitudinal nature of the data for examining the effects of perceived classroom characteristics as well as mediating processes on students' educational and career interests. These statistical techniques also attended to issues of selection bias inherent in nonexperimental research designs. This approach yielded a more conservative estimation accounting for intraindividual differences, within-time covariance among classroom factors, motivation, interests, and the influence of important covariates, including prior academic achievement and expectancies-values. In addition, the use of multiple waves of data enabled me to investigate whether classroom experiences in junior high school can have long-term implications for development of career aspirations and interests. This is a first step in our efforts to understand the long-term impact of experiences in classroom settings on life span development.

While the current study makes significant contributions to the existing research on how early classroom experiences matter for students' motivation and educational and career interests, some limitations and caveats should be noted. First, this study's sample comprised primarily European American students from middle-class income families and thus is not representative of the general population. Therefore, generalizing from this sample must be done with caution. Recent research has shown that ethnic differences in educational and occupational expectations are likely to influence the model discussed in this study. For example, parental beliefs in cultures with strong educational values may have greater influence on youth beliefs (Zarrett, Malanchuk, & Eccles, 2005). Replication of the findings in this study is needed using a study of more ethnically diverse samples. Second, I only examined the impact of the classroom context on students' motivational beliefs and choices. A more comprehensive examination would take into account other contexts such as family. More integrated, cross-context studies will allow us to investigate the full complexity of social experience on students' beliefs, interests, and choices (Wang, Dishion, Stormshak, & Willett, 2011). Finally, I only examined students' math classroom experiences at seventh grade. Recent studies have shown that taking math in the seventh grade rather than waiting until the ninth grade is predictive of subsequent interest and enrollment in higher level math courses (Chouinard & Roy, 2008; National Council of Teachers of Mathematics, 2000). Thus, the choice to take seventh-grade math, as opposed to waiting until ninth grade, is likely to be important in students' trajectories through high school math curriculum and aspirations for jobs requiring high levels of math training. However, I could not test this hypothesis because I only had classroom experience data from the seventh grade. In addition, future studies need to look at similar processes at other grade levels. Another avenue for future research is to examine similar models for the physics and biological sciences. The investigation of different subject domains would provide further information concerning classroom context, processes, and choices.

Conclusion

Given recent trends in school reform related to student-centered learning and teaching for meaning, it is particularly important that we develop a greater understanding of how teachers create supportive class environments and how different aspects of the learning environment influence student motivation and future educational and career interests (Blumenfeld, Marx, Krajcik, & Soloway, 1996). The findings of my study have practical implications for teachers that can be applied to increase student motivation and, ultimately, interest and pursuit of education and careers in math. Specifically, students are more likely to have greater expectancies-values in math, which in turn lead to taking more math courses and aspiring to a math occupation, when they are encouraged to cooperate, interact with, and help their classmates during lessons; when they view the curriculum and teaching as meaningful and relevant to their lives; when they perceive their teacher as understanding and supportive; and when they feel their teachers have high expectations for their learning achievement.

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