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The Ethnic Context and Attitudes toward 9th Grade Math

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Attitudes toward 9th Grade Math

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Abstract

The present study examined the relations between ethnic context and attitudes about 9th grade math in youth from different ethnic groups who had recently transitioned to high school. The large sample comprised African American, Latino, White, and Asian youth (n = 2265, 55% girls, M_{age} = 14.6 *yrs*.) A new questionnaire was developed assessing four math attitudes (perceived competence, feelings of belonging, perceive importance and anxiety in math) and two ethnic context variables (perceived same-ethnic peers in one's math class and perceptions of the school ethnic climate). Participants listed the math course they were taking in 9th grade and then completed the questionnaire based on that class. Perceiving more same-ethnic classmates in math was related to more positive attitudes about perceived competence and feelings of belonging in math. Significant interactions between the two ethnic context variables were documented suggesting that a positive ethnic climate buffered some of the negative effects of few same-ethnic peers on perceived competence and belonging. Implications of the findings for understanding the social-motivational underpinnings of high school course-taking among multiethnic youth were discusseds.

Keywords: math attitudes, 9th course taking, ethnic context

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Contexto étnico y actitudes hacia las matemáticas en 9º grado

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Resumen

El presente estudio examinó las relaciones entre el contexto étnico y las actitudes hacia las matemáticas de los jóvenes de 9º curso de diferentes grupos étnicos, quiénes habían pasado recientemente a secundaria. La amplia muestra incluyó jóvenes afroamericanos, latinos , blancos, y asiáticos (n = 2265,55% niñas, M_{edad}=14,6 años). Se desarrolló un nuevo cuestionario para evaluar cuatro actitudes hacia las matemáticas (competencia percibida, sentimientos de pertenencia, importancia percibida, ansiedad en matemáticas) y dos variables del contexto étnico (percepción de los compañeros de la misma etnia en la clase de matemáticas y percepciones del clima étnico escuela). Los participantes cursaron matemáticas en 9º y después respondieron al cuestionario basándose en esa clase. Percibir a más compañeros del mismo grupo étnico en matemáticas estuvo relacionado con actitudes más positivas sobre la competencia percibida y sentimiento de pertenencia en matemáticas . Se recogieron interacciones significativas entre las dos variables de contexto étnico que sugieren que un clima étnico positivo atenúa algunos de los efectos negativos de algunos compañeros de su misma etnia en competencia percibida y pertenencia. Se discuten las implicaciones de los resultados para la comprensión de los fundamentos socio- motivacionales en la elección de cursos de la escuela secundaria entre la juventud multiétnica.

Palabras clave: actitudes hacia las matemáticas, 9º curso, contexto étnico

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The transition to high school can be a stressful experience for just about anyone (see Benner, 2011). For most students, 9th grade is their first exposure to a fully departmentalized curriculum, near universal academic tracking, the accumulation of credits, and other constant reminders of graduation requirements. The size and bureaucratic structure of most urban high schools also undermine a sense of belonging and connection at a time when adolescents are particularly concerned with finding their niche and fitting in (Crosnoe, 2011). In light of such challenges, it is not surprising that researchers have found a general decline in motivation and achievement during the transition to high school from which some students never fully recover (e.g., Reyes, Gillock, Kobus, & Sanchez, 2000).

Relatively little is known about the high school transition of adolescents of color despite the fact that they face particular kinds of vulnerabilities beyond the normative challenges described above. For example, Black and Latino youth do more poorly in high school on virtually every academic indicator (NCES, 2014); they are also at greater risk of dropping out (Rumberger, 2011) or being "pushed out," given racial disparities in school discipline leading to suspension (Skiba et al., 2011). Failure to successfully navigate the high school transition has high stakes and the waters can be especially turbulent for ethnic minority youth.

In this article we capitalize on a large and predominantly ethnic minority sample to examine the high school transition experience of students from different racial/ethnic groups. The context for our study is students' experience in ninth grade math (e.g., Algebra I). It is well-documented that 9^{th} grade achievement is critical in predicting whether youth stay in or drop out of high school and that 9^{th} grade math is often the critical gatekeeper course (e.g., Neild, 2009). Students in American public high schools who do not pass basic Algebra by the end of 9^{th} grade have restricted opportunities to take advanced mathematics courses in high school, which may ultimately limit their options to pursue careers in science, technology, engineering, and math (the STEM fields) (e.g., Long, Conger, & Iatorola, 2012). These restricted opportunities could mostly befall African American and Latino youth. It is known that Black and Latino high school students are less likely than their White and Asian peers to pass Algebra I as 9^{th} graders, less likely to subsequently take more advanced math courses that make them college-ready, or to even enjoy the same payoffs when they do reach the higher levels (Riegle-Crumb & Grodky, 2010). We investigate African American, Latino, White, and Asian students' 9th grade math course taking, their attitudes about the math course in which they are enrolled, and whether those attitudes are shaped by the ethnic context, defined as students' perceived representation of their own ethnic group in their math class and the perceived ethnic climate of the school as a whole.

Attitudes toward Math

We draw on our expertise as motivation researchers to study attitudes toward 9th grade math in relation to three of the most important constructs in the field: *Can I do it?* which taps perceived competence and expectations for the future; *Do I want it?* which assesses perceived value or importance; and *Am I worried about my whether I can do it*?" which captures achievement anxiety (see review in Graham & Weiner, 2011). Perceived ability and importance have emerged as important motivation constructs in the expectancy X value model of Eccles, Wigfield and colleagues (e.g., Eccles, 2005; Wigfield, Tonks, & Klauda, 2009). In the course- taking literature based on this model, it has been documented that high school students persist more, select more advanced courses, and actually do better in math when they believe that they have the ability to do well and that doing well is important for their future (Simpkins, Davis-Keane, & Eccles, 2006; Simpkins, Fredericks, & Eccles, 2012). Similarly, research on achievement anxiety, including math anxiety, has shown that students who worry too much about how they will perform actually do more poorly (see Zeidner, 2014). Anxiety has both an emotional component (e.g., sweaty palms, racing heartbeat) and a cognitive component (inefficient attention deployment) that together can deplete the resources that individuals need to successfully master the task at hand.

We introduce a new construct relevant to attitudes about math that we define as math belonging. As a social contextual variable, belonging is part of a larger school climate construct that assesses the extent to which students feel connected to their environment – that they are able to find their niche, feel accepted and respected, and generally "fit in" (Gottfredson, 1984). This variable has mainly been studied by asking students about how much they feel like they belong at school with such questions as " I feel like I am a part of this school" and "I feel respected and valued at this school" (e.g., Benner & Graham, 2009). Employing similar measures, a growing literature has documented the positive consequences of perceived belonging for school adjustment (e.g., Crosnoe, Johnson, & Elder, 2004; Gillen-O'Neel & Fuligni, 2013).

We adapted the school level measure to assess students' feelings of belonging in their 9th grade math class. In high school, students move from class to class throughout the school day and are exposed to different sets of peers and teachers, suggesting that a more course-specific measure of belonging might be important. In research assessing domain-specific belonging of men and women enrolled in calculus at an elite university, Good, Rattan, and Dweck (2012) developed a multi-dimensional measure in which the college students who reported high belonging in a "math setting" expressed a commitment to take more advanced college math. Math belonging, therefore, may have motivational significance. Our measure, emerging from the school climate literature, is the first to our knowledge to focus on a specific high school math course as opposed to a more general math community and to include an ethnically diverse sample drawn from multiple high schools with varying levels of academic achievement.

The Ethnic Context

What characteristics of the ethnic context are related to attitudes about 9th grade math in a primarily ethnic minority sample? One important characteristic might be the perceived representation of one's ethnic group in math class. For example, when I look around my 9th grade math class, do I see few or many students of my ethnic group? In studies of perceptions of school-level feelings of belonging, it has been documented that students feel more like they belong as the number of same-ethnicity peers increases (Benner & Graham, 2009; Fuller & Doan, 2010). More same-ethnic peers is also related to less perceived discrimination at school, suggesting that a critical mass of schoolmates "like me" serves an important protective function (Bellmore, Nishina, You & Ma, 2012; Benner & Graham, 2013; Seaton & Yip, 2009). We therefore hypothesized that attitudes about 9th grade math belonging would be greater as the perceived representation of one's ethnic group in math increased. It is not known whether this ethnic context variable is related to perceived competence, importance, or anxiety.

A second ethnic context variable examined in this research was school ethnic climate, a measure of the extent to which a school is perceived by students to promote a culture of status equality and positive interactions between students from different ethnic groups (Green, Adams, & Turner, 1988). For example, do students believe that the adults in their school treat all students fairly? Are the norms of different ethnic groups supportive of crossing racial boundaries in the formation of friendships? While limited, the empirical literature on racial/ethnic climate in secondary schools (as opposed to college) indicates that a positive climate is related to more engagement and better achievement among multiple ethnic groups (e.g., Green, Adams, & Turner, 1988; Mattison & Aber, 2007). Given our interest in the peer ethnic context, we focused on a measure of ethnic climate that probed the extent to which peers in the school were perceived as supporting positive intergroup interaction. It was unclear whether any positive effects of peer ethnic climate would generalize to course-specific contexts such as attitudes about math. Such studies do not exist. Thus, for all of our attitude measures, we examined the independent effects of ethnic climate and perceived ethnic representation as well as their interaction. We tested the hypothesis that a positive ethnic climate might buffer any negative effects on students' math attitudes of perceiving few same-ethnicity peers in their 9th grade math class.

Overview of the Study

Capitalizing on a large multiethnic sample that had recently transitioned to high school, we examined attitudes toward 9th grade math of African American, Latino, White, and Asian youth. We drew on the motivation literature to examine perceived competence, importance, and anxiety about math. A new measure of perceived math belonging was also examined. We identified the level of math in which each student was enrolled (i.e., Algebra I or advanced) and assessed attitudes about that math course as a function of perceived same-ethnic representation and school ethnic climate. We expected that perceiving more same-ethnic classmates in math would be related to more positive attitudes about math, especially math belonging.

We did not have specific predictions about the main effects of general school ethnic climate. Rather, we tested for interactions between the two ethnic context predictors suggesting that better attitudes might be maintained even in the face of few classmates "like me" if peers at school were perceived as supporting a positive ethnic climate.

Method

Participants

Participants were 3,245 9th grade students (M_{age} = 14.6 *yrs.*, *SD* = 0.54) taking part in a larger longitudinal study. Students represented the first two cohorts of a 3-cohort study recruited over three consecutive years. They were initially recruited at 6th grade in 2009 (C1) or 2010 (C2) from 20 middle schools in southern and northern California that varied in ethnic diversity. Ten schools had one majority ethnic group (i.e., Latino, African American, White, or Asian), 10 schools had two groups that were relatively equally balanced (e.g., White and Asian), and 6 schools were very ethnically diverse. We targeted only 6th grade classrooms in these schools and we successfully recruited about 78% of eligible 6th graders in each school. In 2012 or 2013 the students finished middle school and transitioned to about 190 high schools in those same regions. We then re-recruited the participants in their new high school All participants had both written parental consent and student assent; consent and assent were originally obtained when students were in middle school, and then re-obtained when students transitioned to high school, with a re-consent rate greater than 80%. Based on student self-report, the ethnic breakdown of the sample was 33% Latino, 19% White, 14% Asian, and11% African American, with the remaining 23% comprised of small groups who identified as American Indian, Middle Eastern, Pacific Islander, Filipino, South Asian (e.g., Indian or Pakistani), multi-ethnic/biracial, or Other. The sample for this research included only youth in the 4 major pan-ethnic groups (Latino, White, Asian, and African American) with complete data (N = 2,265, 55% girls). This analytic sample was 44% Latino (*n* = 998), 27% White (*n* = 583), 18% Asian (*n* = 399), and 13% African American (n = 285). Our Latino and Asian subsamples can be further distinguished by generational status and country of origin. The great majority (72%) were second generation (at least one parent born outside of the U.S.). Latinos were primarily of Mexican origin; Asians were about 70% East Asian (mainly Korean and Chinese) and 30% Southeast Asian, primarily Vietnamese.

The 190 high schools that these students attended represented a full range of ethnic diversity (see below), socioeconomic backgrounds (SES), and academic achievement levels. The proxy for school SES was the percent of students eligible for free or reduced lunch prices (*M* = 47%, *SD* = .22, range = 2%-99%). The indicator of school level achievement was the California Academic Performance Index (API), which ranges from 200 to 1000, with a score 800 designated as proficient. For our sample's API, *M* = 795, *SD* =71, range = 590-948.

Procedure

Participants were surveyed in non-academic classes during the Spring semester of their 9th grade year. The measures used in this study were part of a larger questionnaire that was programmed into individual *iPads* on which students directly responded. Instructions for completing the survey were audiotaped and all students worked at their own pace. Two graduate students circulated around the room to assist individual students as needed. The entire survey took about 45 minutes to complete. Students received a $20 honorarium.

Measures

Math level. Students were asked to report their 9th grade math class. Of the student responses, 36% listed Algebra I, 34% listed Geometry, 20% listed Algebra II, and the remaining 10% listed a math class in another category (e.g., pre-algebra, calculus, integrated math). From these responses, we generated 2 levels: *Algebra I* (*n* = 956) for those listing that core course and *Advanced Math* if the student listed Algebra II or Geometry (*n* = 1,434). The courses of the 10% of students reporting other math classes were considered to be too heterogeneous or school specific to be reliably classified; these students were not included in the analyses. The fact that more students overall were in advanced math is consistent with a recent trend in some states, including California, for students to take introductory Algebra in 8th grade (Domina & Saldana, 2012; Stein, Kaufman, Sherman, &

Hillen, 2011). However, there were ethnic differences in the distribution of students across these two math levels. African American and Latino students were almost equally likely to be in Algebra I or Advanced Math: for African Americans, 56% in Algebra I and 44% in Advanced Math; for Latinos, 52% vs. 48%. White and Asian students, in contrast, were much more likely to be in Advanced Math: for White students, 29% in Algebra I and 71% in Advanced Math; for Asian students, 15% in Algebra I and 85% in Advanced Math.

Attitudes toward math. A new questionnaire was developed for this study to examine students' attitudes toward 9th grade math. After listing their math class, students indicated how much they agreed with 18 statements about their experiences in that class. The items were designed in part to capture the four attitudes we wished to examine in this research: perceived competence (e.g., "I solve math problems without too much difficulty"), importance (e.g., "Math is one of the most important subjects a person can study"), anxiety (e.g., "I feel stressed out during math class"), and belonging (e.g., "I feel like I fit in with the other students in my math class"). Each item was rated on a 5-pont scale (1 = *no way!* to 5 = *for sure yes!*). The 18 statements were subjected to a factor analysis, described in the Results section, which examined the underlying structure of this new math attitudes measure.

Same-ethnic representation in math. To measure perceived representation of same-ethnic peers in math class, participants were asked "How many students from your ethnic group are in your math class?" Using a 7-point scale, response options were 1 = "none or hardly any (less than 10%)," 2 = "a few (10-20%)", 3 = "some (20-40%)," 4 = "about half (40-60%)," 5 = "more than half (60-80%)," 6= "most (80-90%)," or 7 = "all or almost all (90-100%)." Responses were then converted to a 5-point scale in order to achieve equal 20% intervals between categories. That is, a response of 1 or 2 was aggregated into the lowest representation level (less than 20%) and a response of 6 or 7 was aggregated into the highest representation level (more than 80%). Responses therefore ranged from 1 to 5 (M = 2.4, SD =1.32).

Ethnic climate. Students completed a 4-item measure of racial/ethnic climate at school adapted from the larger School Interracial Climate Scale (Green et al., 1988). The items assessed the degree to which the school culture promoted interactions between students of different ethnic groups (e.g., “Students are able to make friends with kids from different racial groups”). Ratings were made on a 5-point scale that ranged from 1 (*no way*) to 5 (*for sure yes*), with higher scores denoting more positive interethnic climate (α = .69).

High school ethnic diversity. Using student enrollment data from the California Department of Education website (retrieved December 1, 2014, from http://data1.cde.ca.gov/dataquest/), each high school’s ethnic diversity was computed using Simpson’s Index (1949):

$$D_c = 1 - \sum_{i=1}^{g} p_i^2.$$

where *p* is the proportion of students in a school who belong to ethnic group i. P^2i is summed across groups in a school and then subtracted from 1. The index ranges from 0 to 1, with higher scores indicating more ethnic diversity (i.e., greater probability that any two randomly selected students will be from a different ethnic group). Simpson’s index of the high schools in our sample ranged from .00 to .78 (*M* = .61, *SD* =.12), indicating a full range of diversity.

Results

Factor Analysis of Attitudes toward Math

The 18 items in the Attitudes Toward Math questionnaire were subjected to an exploratory factor analysis, using principal component analysis as the extraction method, with varimax rotation. Four conceptually meaningful factors were extracted, accounting for 61% of the variance in students’ ratings. Table 1 shows the items comprising each factor and their factor loadings. For items that loaded on more than one factor, we chose the factor loading that was conceptually more meaningful.

The first factor accounted for 35% of the variance (eigenvalue = 6.30) and included agreement with four statements (e.g., “I’m good at math” and “I solve math problems without too much difficulty”). We labeled this factor *Perceived Math Competence*. The second factor accounted for 10% of the variance (eigenvalue = 1.78) and included six items (e.g., “I have good friends in my math class” and “I feel comfortable in math class”). We labeled this factor *Math Belonging*. The third factor, labeled *Perceived Importance*, accounted for 9% of the variance (eigenvalue = 1.60) and was comprised of five items (e.g., “High school math is helpful no matter what job I have”). The final factor accounted for 7% of the variance (eigenvalue = 1.18) and included three items (e.g., “Studying math makes me feel nervous”). We labeled this factor *Math Anxiety*. The remaining analyses treat these factors as separate math attitude measures: perceived competence (α = .75), belonging (α = .80), importance (α = .80), and anxiety (α = .70).

Table 1
Rotated Component Matrix showing factor loadings for Attitudes toward Math questionnaire

Items	Factor Loadings			
	Factor 1: Math Competence	Factor 2: Math Belonging	Factor 3: Math Importance	Factor 4: Math Anxiety
My math teacher thinks I understand math well.	**.754**	.229	.151	.060
I solve math problems without too much difficulty.	**.707**	.028	.165	.053
I'm good at math.	**.700**	.105	.284	.295
I feel stressed out during math class.	-.621	-.079	-.075	**-.547**
My math teacher helps me when I have difficulty in math class. *	**.504**	.443	.088	.003
I feel respected in math class.	.282	**.680**	.124	.143
I have good friends in my math class.	-.036	**.672**	.229	-.048
I feel like I fit in with other students in my math class.	.155	**.664**	.221	.073
I feel like nobody pays attention to me in my math class. *	.031	**.641**	-.028	.383
I often feel left out in math class. *	.267	**.520**	-.012	.484
I feel comfortable in math class.	.454	**.490**	.296	.308
Math is one of the most important subjects a person can study.	.127	.164	**.788**	-.043
High school math is helpful no matter what job I have.	.154	.174	**.776**	-.027
I want to take as much math as I can when I'm in school.	.195	.165	**.747**	.182
I try to say as little as possible in my math class.	.035	-.346	.064	**-.645**
Studying math makes me feel nervous.	-.490	-.063	.033	**-.621**
Math is boring *	.197	.007	**.487**	.615
I only take math because I have to. *	.143	.063	**.547**	.600

Note. An asterisk indicates the item was reverse coded. Bolded values represent the *reverse-coded item

Descriptive Analysis

A 4 (ethnicity) x 2 (gender) x 2 (math level) factorial ANOVA was conducted on each math attitude. Means and standard deviations for each attitude as a function of ethnicity, gender, and math level are shown in Table 2. Because of the large number of tests involving main effects and interactions, only findings significant at $p < .01$ are reported. There were main effects of gender for all four attitudes. Girls reported lower perceived competence, less importance, less belonging, and more anxiety than boys: $F(1, 2248) = 13.81$, 13.27, 14.65, and 20.28 respectively for competence, belonging, importance, and anxiety (all *p*s < .001). There were also main effects of math level for belonging: $F(1, 2248) = 6.80$ and importance: $F(1, 2248) = 30.11$ (both *p*s < .01). Students in advanced math felt more like they belonged and perceived the course as more important than did their peers in Algebra I. There was only one significant ethnicity main effect and that was for importance: $F(3, 2248) = 18.55$, $p < .001$. White students ($M = 3.1$) perceived math as less important than did African American ($M = 3.3$), Latino ($M = 3.4$, and Asian students ($M = 3.3$) (all *p*s < .01). These latter three groups did not differ from one another. There were no significant 2-way or 3-way interactions involving gender, math level, and ethnicity for any of the attitude measures.

Table 3 shows correlations between the four attitude measures and the two context variables, combined across gender and ethnicity. Competence, importance, and belonging were all positively related and each was negatively correlated with anxiety (e.g., the more students felt liked they belonged in their math class, the less anxious they felt). Of the ethnic context measures, perceived same-ethnic classmates correlated with belonging whereas a more positive ethnic climate correlated positively with competence, belonging, and importance and negatively with anxiety. The two contexts variables were not significantly related to one another.

Table 2
Means and standard deviations of each math attitude as a function of ethnicity, gender and math level

Measure		Math Competence		Math Belonging		Math Importance		Math Anxiety	
		M (*SD*)		*M* (*SD*)		*M* (*SD*)		*M* (*SD*)	
		Alg. I	Adv.	Alg. I	Adv.	Alg. I	Adv.	Alg. I	Adv.
African-American	M	3.60 (.76)	3.73 (.86)	3.75 (.74)	3.80 (.81)	3.25 (.81)	3.48 (.79)	2.52 (.83)	2.51 (.90)
	F	3.56 (.82)	3.58 (.82)	3.71 (.76)	3.61 (.79)	3.11 (.90)	3.34 (.85)	2.62 (.90)	2.57 (.94)
Asian	M	3.56 (.73)	3.57 (.65)	3.63 (.47)	3.63 (.62)	3.22 (.74)	3.42 (.74)	2.51 (.69)	2.63 (.78)
	F	3.46 (.75)	3.48 (.69)	3.58 (.70)	3.64 (.63)	3.23 (.75)	3.31 (.80)	2.69 (.85)	2.74 (.74)
Latino	M	3.50 (.72)	3.67 (.78)	3.69 (.63)	3.84 (.63)	3.33 (.78)	3.59 (.86)	2.56 (.80)	2.54 (.82)
	F	3.32 (.85)	3.42 (.80)	3.51 (.76)	3.68 (.72)	3.15 (.84)	3.34 (.82)	2.89 (.95)	2.83 (.88)
White	M	3.61 (.88)	3.72 (.70)	3.60 (.68)	3.84 (.54)	2.92 (.79)	3.40 (.87)	2.48 (.74)	2.47 (.78)
	F	3.42 (.83)	3.49 (.79)	3.38 (.78)	3.58 (.74)	2.69 (.96)	3.03 (.92)	2.76 (1.02)	2.79 (.93)

Note. Alg. I = Algebra I, Adv. = Advanced Level Math; M = Male, F = Female

Table 3
Correlations between variables

Measure	1	2	3	4	5	6
1.Math Competence	-	.540**	.487**	-.533**	.025	.165**
2.Math Belonging		-	.476**	-.506**	.075**	.210**
3.Math Importance			-	-.387**	.023	.075**
4.Math Anxiety				-	.018	-.084**
5.Math Same- Ethnic representation					-	-.041
6. Ethnic Climate						-

Note: * = p < .05, ** = p < .01, *** = p < .001

Hierarchical Linear Regression Analysis

Mixed-Effects Hierarchical Linear Modeling REML (Restricted Maximum Likelihood) was used to examine if attitudes toward math varied as a function of math level, perceived same ethnic peers in math class, and ethnic climate. Since the residuals were normally distributed and there was no evidence of heteroscedasticity, all assumptions for hierarchical regression were met. Our analysis also allowed for the handling of complex error structures that could result from the nesting of high schools in our study (Stata, 2005). Intercepts were treated as random and slopes were treated as fixed. At Level 1 we included gender (boys as the reference group) and ethnicity (Whites as the reference group) as covariates and at Level 2 we added high school ethnic diversity as a third covariate. Thus, the main analyses reported controlled for gender, ethnicity, and school level diversity.

Three models were tested for each math attitude measure. Model 1 tested if there were significant main effects of the two ethnic context predictors (perceived same-ethnic peers in math class and ethnic climate) on attitudes toward math. Model 2 tested for significant 2-way interactions and Model 3 examined the 3-way interaction between math level (Algebra I as the reference group), perceived same-ethnic peers, and ethnic climate.

The findings for perceived math competence and math belonging are displayed in Table 4. Coefficients are unstandardized values. We begin with Model 3 because lower order effects are always conditional on higher order effects. For perceived competence, Model 3 shows a significant three-way interaction between ethnic climate, math level, math same-ethnic representation ($\beta = .09$, $p < .05$). This interaction is depicted in Figure 1. The left panel shows the results for Algebra I and the right panel displays results for Advanced Math.

For Algebra I, there was a significant simple slope of same-ethnic representation on perceived competence when ethnic climate was held at 1 *SD* below the mean. In other words, every 1-unit increase in perceived math same-ethnic representation was associated with a ($b = .07$, $z = 2.84$, $p < .01$) increase in students' perceived math competence when they thought the ethnic climate in their school was especially negative. Just focusing on the intercepts when there were few same-ethnic peers (i.e., 1 SD below the mean on same-ethnic representation), it is evident that a positive ethnic climate functioned as a buffer; students perceived themselves as more competent in math even when there were few same-ethnic classmates if the overall school ethnic climate was judged as favorable. These intercepts are all significantly different from one another (all *p*s < .001). For students in advanced math (right panel of Figure 1) none of the slopes were significant. As the ethnic climate was rated more positively, perceived math competence increased regardless of the number of perceived same-ethnic peers.

Table 4
Hierarchical linear model results for perceived math competence and math belonging
Table 4 (Continued)
Hierarchical linear model results for perceived math competence and math

	Perceived Math Competence			**Math Belonging**		
Parameter	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Constant	2.64*** (.18)	2.11*** (.32)	1.63*** (.38)	2.38*** (.15)	2.02*** (.27)	2.00*** (.32)
Female	-.20*** (.03)	-20*** (.03)	-.20*** (.03)	-.16*** (.03)	-.16*** (.03)	-.16*** (.03)
African American	.08 (.06)	.08 (.06)	.08 (.06)	.15** (.05)	.15** (.05)	.15** (.05)
Asian	-.03 (.05)	-.03 (.05)	-.03 (.05)	.06 (.04)	.05 (.05)	.05 (.05)
Latino	-.06 (.04)	-.06 (.05)	-.06 (.05)	.11** (.04)	.11** (.04)	.11** (.04)
Advanced Math Level	.09* (.04)	.10 (.26)	1.06* (.51)	.10** (.03)	.04 (.22)	.07 (.43)
Math Same-Ethnic Representation	.02 (.01)	.24* (.09)	.45** (.13)	.04*** (.01)	.22** (.08)	.22* (.11)
Ethnic Climate	.24*** (.03)	.36*** (.06)	.47*** (.08)	.28*** (.02)	.36*** (.05)	.36*** (.07)
Ethnic Climate x Same-Ethnic Representation		-.05* (.02)	-.10** (.03)		-.04* (.02)	-.04 (.03)
Advanced Math x Same-Ethnic Representation		.01 (.03)	-.40* (.19)		-.01 (.02)	-.02 (.16)
Advanced Math x Ethnic Climate		-.01 (.06)	-.23* (.12)		.02 (.05)	.01 (.10)
Ethnic Climate x Advanced Math x Same-Ethnic Representation			.09* (.04)			.00 (.04)

belonging

	Perceived Math Competence			**Math Belonging**		
Parameter	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
High School Ethnic Diversity	-.21 (.19)	-.20 (.19)	-.19 (.18)	-.14 (.16)	-.13 (.16)	-.13 (.16)
Between-school Variance	.01 (.01)	.01 (.01)	.01 (.01)	.01 (.00)	.01 (.00)	.01 (.00)
Between-observation variance	.57 (.02)	.57 (.02)	.57 (.02)	.40 (.01)	.40 (.01)	.40 (.01)

Note: * = $p < .05$, ** = $p < .01$, *** = $p < .001$; High School Ethnic Diversity is a Level 2 variable

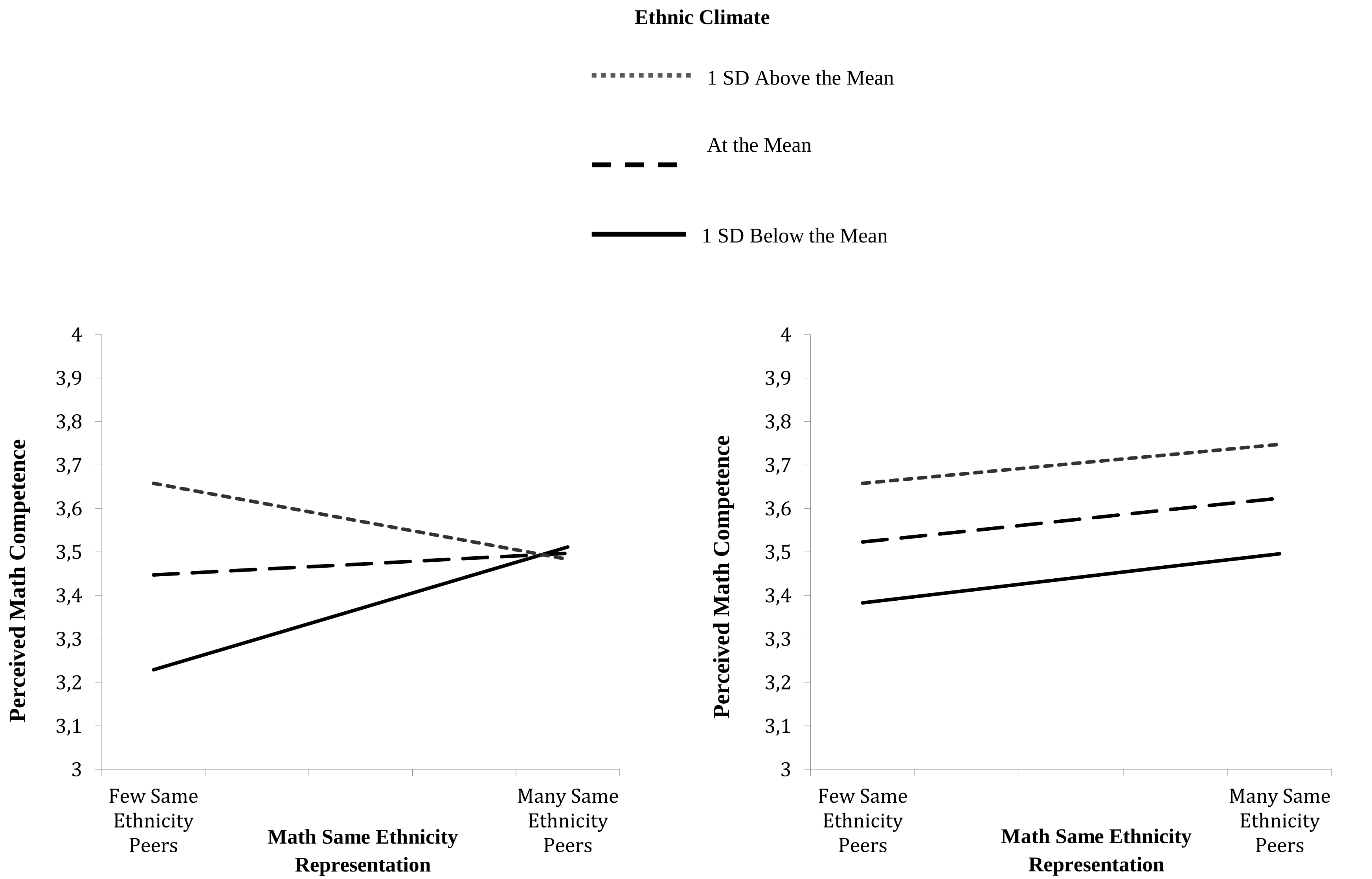

Figure 1. The three way interaction between ethnic climate, math level, and math same-ethnic representation on perceived math competence (left panel = Algebra I, right panel = advanced math)

For math belonging, there was no significant 3-way interaction between math level, representation, and ethnic climate. The 2-way interactions in Model 2 were therefore interpreted. A significant interaction between ethnic climate and same-ethnic representation was found ($\beta = -.04$, $p < .05$) (see Figure 2). We found a significant simple slope of math same-ethnic representation when ethnic climate was held at 1 *SD* below the mean and at the mean. Every 1-unit increase in math same-ethnic representation was associated with a ($b = .07$, $z = 4.41$, $p < .001$) increase in math belonging when ethnic climate was 1 *SD* below the mean and a ($b = .04$, $z = 3.89$, $p < .001$) increase in math belonging when ethnic climate was at the mean. Having more same-ethnic peers in class therefore mattered most for feelings of belonging when the school ethnic climate was perceived as low or average. As with perceived competence in Algebra I, a positive ethnic climate appeared to buffer the negative effects of having few classmates “like me” in both Algebra I and advanced math.

The results of the hierarchical modeling for math importance and anxiety are shown in Table 5. There were no 2- or 3-way interactions for either outcome. We therefore interpret the main effects in Model 1 of math level, ethnic representation, and ethnic climate, controlling for gender, ethnicity, and ethnic diversity. For both importance and anxiety, there were significant main effects of ethnic climate. A one-unit increase in ethnic climate was associated with a ($\beta = .16$, $p < .001$) increase in math importance and a ($\beta = -14$, $p < .001$) decrease in math anxiety. There was also a main effect of math level for importance, such that being in advanced math compared to Algebra I was associated with a ($\beta = .24$, $p < .001$) increase in math importance.

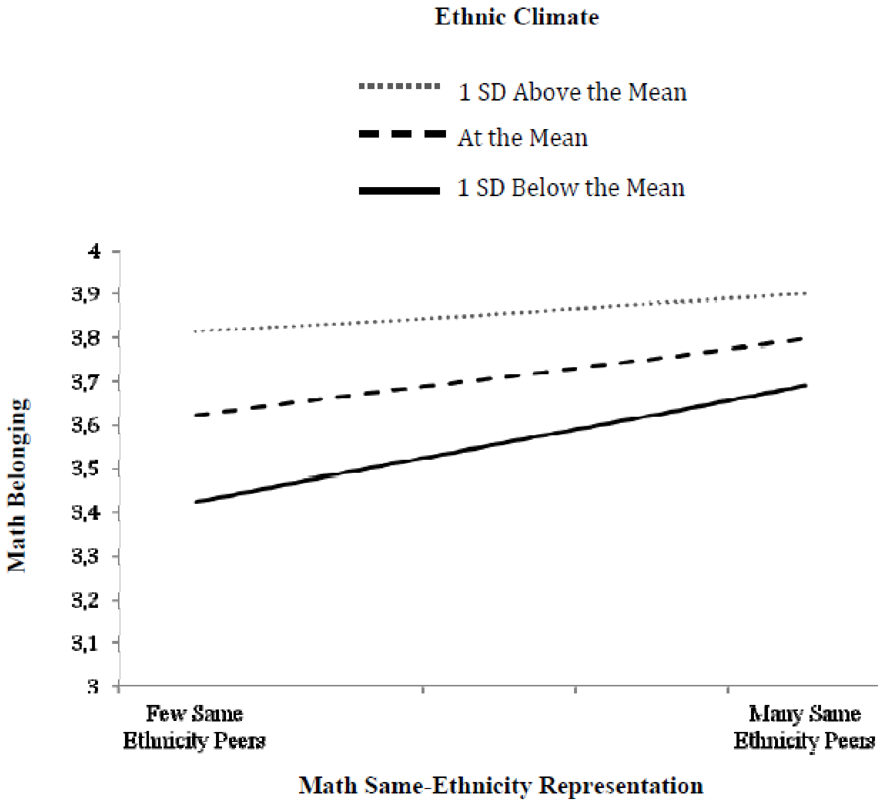

Figure 2. Two-way interaction between ethnic climate and same-ethnicity representation for math belonging

Table 5

Hierarchical linear model results for math importance and math anxiety

	Math Importance			Math Anxiety		
Parameter	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Constant	2.39*** (.19)	2.23*** (.34)	2.25*** (.42)	2.95*** (.21)	3.28*** (.36)	3.01 (.43)
Female	-.23*** (.04)	-.23*** (.04)	-.23*** (.04)	.27*** (.04)	.27*** (.04)	.27*** (.04)
African American	.28*** (.06)	.28*** (.06)	.28*** (.06)	-.06 (.07)	-.06 (.07)	-.06 (.07)
Asian	.25*** (.06)	.25*** (.06)	.25*** (.06)	.01 (.06)	.01 (.06)	.01 (.06)
Latino	.33*** (.05)	.32*** (.05)	.32*** (.05)	.08 (.05)	.08 (.05)	.08 (.05)
Advanced Math	.24*** (.04)	.01 (.29)	-.03 (.56)	-.01 (.04)	-.18 (.29)	.35 (.57)
Math Same-Ethnic Representation	.02 (.01)	.13 (.10)	.12 (.15)	-.00 (.01)	-.09 (.11)	.02 (.15)
Ethnic Climate	.16*** (.03)	.20** (.07)	.19* (.09)	-.14*** (.03)	-.22** (.07)	-.16 (.09)
Ethnic Climate x Same-Ethnic Representation		-.03 (.02)	-.03 (.03)		.02 (.02)	-.00 (.03)
Advanced Math x Same-Ethnic Representation		.01 (.03)	.03 (.20)		-.02 (.03)	-.24 (.21)
Advanced Math x Ethnic Climate		.05 (.06)	.06 (.13)		.05 (.06)	-.07 (.13)
Ethnic Climate x Advanced Math x Same-Ethnic Representation						.05 (.05)
High School Ethnic Diversity	-.19 (.18)	-.18 (.18)	-.18 (.18)	.24 (.22)	.24 (.22)	.24 (.22)

Table 5 (Continued)

Hierarchical linear model results for math importance and math anxiety

	Math Importance			Math Anxiety		
Parameter	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Between-school	.00	.00	.00	.02	.02	.02
Variance	(.00)	(.00)	(.00)	(.01)	(.01)	(.01)
Between-observation	.69	.69	.69	.72	.72	.72
variance	(.02)	(.02)	(.02)	(.02)	(.02)	(.02)

Note: * = p < .05, ** = p < .01, *** = p < .001; High School Ethnic Diversity is a Level 2 variable

Discussion

The results presented here offer new insights into how particular ethnic context variables can shape attitudes toward math during the critical 9th grade transition. We found that perceived competence and feelings of belonging in math varied as a function of both ethnic climate and perceived representation of same-ethnic classmates. In particular, a strong ethnic climate appeared to buffer the negative effects of perceiving few classmates of one's own ethnicity in math. To our knowledge, there are no prior studies on how course-specific attitudes are systematically related to ethnic context variables.

How the Ethnic Context Matters

Why might it matter for perceived math competence and belonging if there are few versus many classmates "like me" in math? We suggest that the answer to this question may relate to the role of friendships. Other research documents that having friends in one's courses affects course-taking decisions (Riegle-Crumb, Farkas, & Muller, 2006; Tyson, 2011). Using longitudinal data from the nationally representative Add Health sample, Riegle-Crumb et al. (2006) found that when girls' 9th grade friendship groups were predominantly other girls doing well academically, girls were more likely to enroll in pre-calculus or calculus by 11th or 12th grade. In an ethnography of students attending ethnically diverse high schools in North Carolina, Tyson (2011) found that for Black students in particular, having friends in their classes was an important component of perceived fit and confidence that they could do well in advanced courses. As one African American 11th grader in advanced math disclosed about the importance of friends:

> If you don't understand, like me and my friends, we'll discuss even if on the phone three-way or something, we all talking about something and then somebody will be like 'I didn't understand such and such today.' You have two people or two friends that can say, 'Well, this is what I got out of it.' So then you're going to have your friends as your backbone (p. 154).

Both of these studies, then, highlight the importance of friends in course-taking decisions and satisfaction. We know that most close friends tend to be of the same race/ethnicity; this is a basic principle of friendship formation known as homophily (McPherson, Smith-Lovin, & Cook, 2001). Same-ethnicity preference is particularly strong during adolescence when race and ethnicity take on heightened significance (see review in Graham, Taylor, & Ho, 2009). We suggest that the positive effect of having more same-ethnic peers in math on perceived competence and belonging occurs in part because these peers are also more likely to be close friends. Having same-ethnicity (and same-gender) friends in one's courses provides both academic and social support.

Perceived ethnic climate and the perceived number of same-ethnic peers interacted in intriguing ways to predict competence and belonging in math. For both attitude measures, believing that peers in the school supported cross-ethnic interactions buffered the negative effects of having few same-ethnic peers (friends) in math. Thus, even though same-ethnic friendship opportunities in math class were rare, cross-ethnic friendships might be especially encouraged when the ethnic climate is positive. In the context of course-taking decisions in high school, cross-ethnic friends may also be important sources of social capital, defined as the resources that flow through relationship ties (e.g. Coleman, 1988). These resources might include information about what courses to take as well as the norms about what courses other students are taking (Crosnoe, Cavanaugh, & Elder, 2003; Stanton-Salazar & Dornbusch, 1995). At present, we know almost nothing about the differences between same-ethnic and cross-ethnic friends as sources of information about academic course-taking. Nor do we know very much about *how* the overall ethnic climate at school supports or discourages cross-ethnic interactions. These are fruitful topics for future research.

Our ethnic context variables had fewer effects on math importance and math anxiety. This suggests that other ethnicity-related constructs might be more central for understanding the predictors of math importance and anxiety in our predominantly ethnic minority sample. One likely construct is stereotype threat (Steele, 1997). Stereotype threat is the awareness that individuals have about negative stereotypes associated with their group – such as the stereotype associating being Black with intellectual inferiority. Stereotype threatened students often are dividing their attention between the task itself and ruminating about the meaning of their performance (e.g., what does this say about me or about members of my ethnic group?). Such ruminations have been shown to both arouse anxiety (Schmader, Johns, & Forbes, 2008) and cause students to downplay the importance of doing well in school, a phenomenon known as *disidentification* (Osborne, 1997). Examining stereotype threat in relation to math anxiety and importance would require different measures and methods than those utilized in this research. But what that literature tells us is that there may be particular ethnic context variables that map onto specific motivational processes, including different attitudes about high stakes courses such as 9^{th} grade math.

9^{th} Grade Math Level

There were few differences in our results as a function of 9^{th} grade math course level. Only for perceived competence were there differences based on whether students were enrolled in Algebra I or the more advanced Geometry and Algebra II (the significant effects were for Algebra I). More than half of our participants were enrolled in the advanced course, including close to half of African American and Latino youth. The fact that they were enrolled in the advanced course means that they took Algebra I in 8th grade, a trend consistent with course intensification in California public schools (Stein et al., 2011). On the one hand, this is encouraging since prior research indicates that African American and Latino youth are less likely to be enrolled in advanced math courses in 9th grade (Riegle-Crumb, 2006). Enrollment in more advanced math in 9th grade is also the strongest predictor of taking the most advanced courses such as pre-calculus and trigonometry later on (Domina & Saldana, 2012). On the other hand, policy analyses have also documented that course intensification, specifically the earlier completion of Algebra I, is not uniformly beneficial to all students, especially Black and Latino youth (e.g. Liang, Heckman, & Abedi, 2012). The main argument for the low pay-off of course-taking intensification is poor student preparation. The students simply do not have the requisite skills to master the content of the more challenging math courses. We propose that greater attention to the social contextual factors, especially the ethnic context, is also needed. There might be important factors other than academic preparation that help explain why students of color sometimes do not choose to enroll in the most advanced math courses even when they have the opportunity to do so.

Limitations of the Research

Although we believe that our findings offer new insights into the motivational and contextual underpinnings of 9th grade math, we also acknowledge the limitations of the study. First, we studied attitudes about math exclusive of math performance per se. Our reasons were both practical (students' grades were not yet available to us in some schools) and conceptual. Our study was exploratory with a focus on novel measures of the ethnic context and tests of novel hypotheses about the role of ethnic context specifically on math attitudes. Future research should examine how ethnic context influences both math attitudes and achievement.

Second, we examined the subjective perception of same-ethnic peers in math class rather than the actual numbers of such peers. Objective data were not feasible because it would require having the math class rosters with ethnicity information of our 2000 participants in close to 200 high schools.

But we believe that examining subjective perception of peers "like me" is important in its own right, especially when one's outcomes of interest are psychological processes related to vulnerability, social support, and perceptions of fitting in (see Bellmore et al., 2012 and Morales-Chicas & Graham, 2014 for recent examples). Third was our limited approach to school-level characteristics. Our sample transitioned to many high schools that varied on a number of features including ethnic diversity, SES, and academic orientation. We only controlled for ethnic diversity at the school level in our analyses. Future research should examine whether math attitudes within ethnic context are moderated by other relevant school characteristics. Finally, our data were cross sectional, examining self-reports of attitudes and ethnic context at the same time. It will be important to explore how the ethnic context variables identified in this research influence math attitudes and performance over time.

A Final Note

The public education system in the United States is experiencing dramatic changes (escalation) in course-taking requirements for high school graduation, which means that student progress in 9th grade is more high stakes than ever. These curricular changes are largely motivated by laudable goals: raise academic standards in struggling school districts, reduce the racial achievement gap, and level the playing field so that *all* students will be prepared for post-secondary education and successful entry into the workforce. Most of the discourse around course intensification and increasing graduation requirements comes from policy analyses or research on structural characteristics like poverty and under-resourced schools that contribute to academic inequality (e.g., Domina & Saldana, 2012). We argue that social-motivational analyses are also relevant to this discourse and particularly those analyses that can address the larger ethnic context in which high school course-taking unfolds.

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