Role of Mathematics Self-Efficacy and Motivation in Mathematics Performance Across Ethnicity

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ABSTRACT **The authors evaluated self-efficacy and motivational orientation across Hispanic and Caucasian students to predict variables related to mathematics achievement, including mathematics performance and students' plans to take additional mathematics courses. Path models were analyzed for 358 students in Grades 9 and 10 who attended a West Texas high school and for the sample split by ethnicity. The tested models provided adequate goodness of fit to the data, supporting the finding that self-efficacy predicts motivational orientation and mathematics performance. Tests of each model parameter across ethnicity revealed 1 significant difference, suggesting that the relationship between prior mathematics achievement and self-efficacy was stronger for Hispanic students. Findings indicate that similar motivational systems exist to predict mathematics achievement across ethnicity; however, Caucasian students do not place as much emphasis on prior mastery experiences as do Hispanic students, suggesting that other factors are active in influencing their self-efficacy.**

Key words: ability and motivation, ethnicity, mathematics self-efficacy, motivational orientation

In American society, the importance of mathematics knowledge is apparent in the employment arena as well as in everyday activities. Despite its importance, many persons continue to find that the application of mathematical knowledge at even basic levels is difficult (Bruning, Schraw, & Ronning, 1999) and, therefore, they lack the skill to secure employment in mathematics-related fields (Rivera-Batiz, 1992). Because capability in mathematics is important in technological fields and is becoming increasingly important in typical employment settings, mathematics courses often are viewed as the gateway to economic enfranchisement (Moreno & Muller, 1999; Rivera-Batiz; Schoenfeld, 2002). When students of particular groups are absent from advanced mathematics courses, they are not only denied a mathematics education but also the opportunity to experience economic freedom and choice (Miller, 1995).

With an unemployment rate almost twice that of their Caucasian counterparts (U.S. Department of Labor, 2003), Hispanic Americans clearly experience disadvantages in the employment arena. One drawback is the extremely high number of Hispanic students who drop out of public schools or who end their education early. Although dropout rates for Caucasian and Black students steadily declined from 1972 until leveling out in the early 1990s, dropout rates for Hispanic students have remained constant and at a higher level than the rates for other groups (National Center for Education Statistics [NCES], 2002). The number of Hispanic students who completed high school and immediately transitioned to college also remained relatively the same between 1972 and 2000, which increased the gap between such Caucasian and Hispanic students (NCES). The number of Hispanic Americans who went on to complete some college increased between 1971 and 2001; however, this increase was less for Hispanic Americans than for either Caucasian or Black Americans (NCES, 2002). Of those Hispanic students who do enter college with intent to major in a mathematics-related field, many do not continue past calculus to achieve a mathematics-related baccalaureate degree (Moreno & Muller, 1999).

Those statistics indicate that many Hispanic students likely have not received the mathematics background necessary to succeed economically in a technological society. Furthermore, the success of current attempts by public schools to address that issue is questionable. Although Hispanic students made significant gains in mathematics achievement at all grade levels throughout the 1980s (Carpenter et al., 1988), a gap continued to exist between the mathematics performance of Hispanic and Caucasian students, and in the 1990s, it again began to grow (Lee, 2002). A review of variables typically thought to influence inequity in academic performance such as family conditions, changes in youth culture, and changes in schooling

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practices did not produce any substantive explanation for the growth (Lee). Because the number of Hispanic schoolchildren increased 11 percentage points from 1972 (NCES, 2002), the investigation of all variables associated with mathematics education clearly is warranted.

When one considers that attention was directed at the economic implications resulting from the inadequate preparation of Hispanic students in mathematics over a decade ago (Wiley, 1989) and that the Hispanic population has experienced rapid growth beyond any other large ethnic group (Chapa & Valencia, 1993), the limited number of studies that researchers have generated to evaluate and address this issue is surprising. Some have described the trends in the mathematics achievement of Hispanic students (e.g., Carpenter et al., 1988; DeBlassie & DeBlassie, 1996), whereas others have investigated predictors of poor mathematics outcomes for Hispanic students (e.g., Butty, 2001; Moreno & Muller, 1999). However, with the exception of Bempechat, Nakkula, Wu, and Ginsburg (1996), few have investigated how personal qualities, such as self-efficacy and motivation, relate to the mathematics achievement of Hispanic youth. Although researchers have consistently found that personal beliefs, which influence motivational variables (Bandura, 1993), can play an important role in the prediction of mathematics performance (e.g., Hackett & Betz, 1989; Pajares & Graham, 1999; Pajares & Kranzler, 1995), the investigation of how these constructs are related across ethnicity has been limited.

Therefore, in this study, we evaluated self-efficacy and motivational orientation to determine how they predict variables related to overall mathematics achievement, including mathematics performance and student plans to take additional mathematics courses, among Hispanic and Caucasian students. We developed a theoretical model to incorporate how the current literature suggests that self-efficacy and motivation influence mathematics achievement. First, we hypothesized that ability and prior mathematics achievement would influence mathematics performance not only directly but also indirectly through mathematics self-efficacy. Second, we expected that mathematics self-efficacy would predict students' motivational orientations. Finally, we expected that mathematics self-efficacy, motivational orientation, and mathematics performance would influence students' plans to take additional mathematics courses.

Because these constructs and their relationship to mathematics achievement have been evaluated through predominately Caucasian samples, we expected that these relationships are relevant for Hispanic students as well. To ensure that the model was not only conceptually invariant across the two groups but also that the importance of individual parameters did not vary, we tested individual models for the groups as well as individual parameters across the groups. Without that second step, we could only provide evidence that the same associations were present, not that the relationships were of the same strength. By focusing on the role of personal qualities in the mathematics achievement of Hispanic students, we hoped to facilitate a broader and more specific investigation into low Hispanic student involvement in mathematics.

Ability and Mathematics Performance

Although investigation of the relationships between motivational variables and mathematics achievement across ethnicity has been limited, the same is not true for the relationship between ability and various types of academic performance. A significant and positive relationship between ability and academic performance has been well supported across multiple groups with a variety of measures (e.g., Carvajal & Pauls, 1995; Eaves, Williams, Winchester, & Darch, 1994; Kaufman, 1973; Martel, McKelvie, & Standing, 1987; McGrew & Hessler, 1995; Wiese, Lamb, & Piersel, 1988). For example, Garcia and Stafford (2000) found that ability predicts reading decoding and comprehension in the same manner across Caucasian and Hispanic students. In similar findings, Keith (1999) determined that ability predicts reading and mathematics. As a result, the description of general cognitive ability as a superior predictor of educational level (Plomin, 1999) is not surprising.

Although ability appears to influence mathematics performance directly, other variables also play an important role in the relationship. That is most evident when considering the differences found across the mathematics performance of children from various nations. Although large overall differences have been found between the mean level of mathematics achievement scores among Japanese, Chinese, and American elementary school students, the association between general cognitive ability and mathematics performance is the same—higher ability leads to higher mathematics performance (Uttal, Lummis, & Stevenson, 1988). Because no evidence confirms that American children are less intelligent than their Asian counterparts (Stevenson & Lee, 1990), and differences in the mathematical skills of American and Chinese students have remained with ability controlled (Geary et al., 1997), other variables are implicated in the prediction of mathematics performance. We believe that the same logic is relevant for the differences in mathematics performance found across ethnicity within the United States. As a result, variables such as beliefs about ability, including self-efficacy, require evaluation for their role in mathematics performance and achievement.

Self-Efficacy and Mathematics Achievement

When confronted with specific tasks, individuals use a self-referent process to judge their ability to self-regulate and succeed in the activity. That process is referred to as self-efficacy and develops from prior mastery experiences, vicarious learning, verbal persuasion, and evaluations of emotional states (Bandura, 1997). Self-efficacy has been shown to significantly influence academic achievement (Bandura, 1993; Zimmerman & Bandura, 1994) and has been associated with semester and final-year grades, student class work, homework, and student examinations (Pintrich & DeGroot, 1990). Self-efficacy beliefs may result in students' use of a wide variety of cognitive strategies as well as cognitive engagement (Pintrich & DeGroot). Students who believe they can accomplish a task successfully will continue to work on the activity despite its challenges. With such persistence, students are more likely to experiment with a larger number of strategies in their attempts to solve a problem. As a result, self-efficacy appears to mediate the effects that ability has on academic performance (Bandura, 1993).

Pajares and Kranzler (1995) found that the direct effects of ability on mathematics performance decreased when students' mathematics self-efficacy also was considered, which supports a mediating relationship. When solving mathematical problems, students who report a high level of self-efficacy will likely expend greater effort, attention, and perseverance, especially when problems are difficult (Pajares & Kranzler). Pajares and Graham (1999) found similar results while statistically controlling for additional motivational variables, including anxiety, self-concept, self-regulation, value, and engagement. Although mathematics self-efficacy correlated with the other measured motivational variables, self-efficacy alone was able to predict mathematics performance at both the start and end of the school year.

Bandura (1993) suggested that perceived self-efficacy influences human behavior not only through cognitive processes but also through motivational processes. The highly efficacious student will likely choose to engage in mathematical tasks, therefore meeting the need for autonomy and competence. As a result, the student will likely perceive his or her investment in the task as intrinsically driven. The perception that individuals possess about what causes their behavior can be viewed in terms of locus of causality. Students who attribute their involvement in an academic task to choice and enjoyment are described as intrinsically motivated, whereas those who attribute their involvement to controlling forces outside of themselves are described as extrinsically motivated (Deci & Ryan, 1985). That motivational orientation appears to be predicted by self-efficacy, and also influences one's choices to continue involvement in mathematics courses.

Motivational Orientation and Mathematics

Researchers who investigated the role of motivational orientation in mathematics achievement have measured this construct in a variety of ways across studies. Schiefele and Csikszentmihalyi (1995) did not specifically target the effects of intrinsic and extrinsic motivation on mathematics performance. Instead, they measured student interest because they contended that it served as an antecedent to intrinsic motivation, which contributed to the prediction of student grades and course level. Wolters, Yu, and Pintrich (1996) evaluated the association of motivational beliefs and mathematics achievement by using three goal orientations; two were noted as having close associations to intrinsic and extrinsic orientations. They found that the extrinsic goal orientation was associated with negative academic outcomes. Stipek et al. (1998) and Nichols (1996) evaluated the mathematics performance of students after instructional methods promoting autonomy and self-determination, precursors to the development of intrinsic motivation, were introduced in the classroom. Increases in students' conceptual understanding of mathematical tasks were documented for both studies.

Finally, Valas and Slovik (1993) evaluated the effects of teachers' controlling strategies, such as their emphasis on assessment and willingness to provide choices, on their students. The authors found that the students' perceptions of their teachers' controlling behavior in the classroom had a significant impact on their intrinsic motivation a year later. Even so, Valas and Slovik did not determine that intrinsic motivation is a significant predictor of mathematics achievement, but they did substantiate that teachers' increased controlling strategies were linked to lowered mathematics performance. Furthermore, Valas and Slovik suggested that mathematics achievement predicted intrinsic motivation, predominately through indirect effects. They found that students' mathematical self-concept mediated the effects of mathematics achievement on intrinsic motivation. Although the self-concept variable was not labeled as self-efficacy, the authors noted that the measure was based on Bandura's (1986) more recent definitions of self-efficacy.

Because motivational orientation is a more global construct than self-efficacy and also involves an emotional component beyond its cognitive element, motivational orientation is likely linked to important outcomes related to mathematics achievement, such as the intent to continue taking mathematics courses rather than performance. Intrinsic motivation is marked by the positive feelings that result when one experiences autonomy and self-determination (Ryan & Deci, 2002). In such circumstances, individuals engage in tasks simply for the sake of doing so. Therefore, one would expect that enjoyment would result. That relationship also is valuable because affective variables are important for predicting one's overall achievement in mathematics (Schiefele & Csikszentmihalyi, 1995). Students who enjoy mathematics will likely work on mathematical tasks when they are not required, will be open to taking a greater number of mathematics courses, and will consider pursuing a career related to mathematics. As a result, understanding both self-efficacy and motivational orientation lends insight into mathematics achievement. Unfortunately, those variables have been investigated in the United States predominately through the use of Caucasian samples. We were interested in whether the same relationships are present for Hispanic students.

Purpose and Predictions

The purpose of the present study was to evaluate a theoretical model that describes relationships involving personal qualities, including self-efficacy and motivational orientation, and variables associated with mathematics achievement, such as performance and the intent to take additional mathematics courses, across Hispanic and Caucasian students (Figure 1). The resulting path model tested the relations among six correlated factors: (a) ability, (b) mathematics self-efficacy, (c) motivational orientation, (d) prior mathematics achievement, (e) mathematics performance, and (f) intention to enroll in additional mathematics courses. Our goal was to substantiate the relationships found between personal qualities and mathematics achievement in a Hispanic sample.

Although we expected to find support for the theoretical model across ethnicity, we also had to be certain that the strength of each relationship across Hispanic and Caucasian students was the same. As a result, we tested not only the model for its goodness of fit across ethnicity but also the strength of each parameter across ethnicity to evaluate the model's invariance across the two groups.

Method

Participants

All students enrolled in high school algebra were selected from a public high school in west Texas, where the school district reported that 41.41% of its students were eligible for free meals. The high school received an accountability rating of "acceptable" during the year that data was collected for this study; 78.2% of Hispanic students and 94.9% of Caucasian students passed the Texas Assessment of Academic Skills Mathematics examination in the 10th grade. The school's mathematics curriculum was aligned with the state's standards (Texas Education Agency, 2001) and, thus, with standardized testing. Ninth graders enrolled in geometry courses also were included in the sample because the failure to include this segment would have eliminated the more advanced mathematics students for this age group.

Participants included 317 ninth-grade and 100 tenth-grade students; ages ranged from 14 to 17 (M = 14.72 years, SD = .74 years). Fifty-three percent of the students described themselves as Hispanic, and 30% identified themselves as Caucasian. African American students comprised 4.6% of the sample; 3.6% of the remaining descriptions did not fit into the aforementioned groups. Thirty-nine students (9.4%) did not report their ethnicity. Although all students were included in the total sample analyses, only the reports of Caucasian and Hispanic students were evaluated in group analyses. That decision reflected the purpose of this study and was not an indication of a lack of importance of the mathematical skills of students who belonged to other ethnic groups.

Measures

General mental ability. We used the Cattell Culture Fair Intelligence Test (Cattell, 1973) to measure the general ability of participants. The measure was based on Cattell's (1971) theory of *fluid abilities,* which assumes that such abilities involve information-processing skills that reflect a child's ability to adapt and learn from the environment as time passes. Estimates of the validity associated with test scores reported by its developers were derived from multiple studies comparing the relationship of the Culture Fair Test to various other measures of general intelligence, including the Wechsler Adult Intelligence Scale, Raven's Progressive Matrices, Differential Ability Tests, Stanford-Binet Test of Intelligence, and Wechsler Intelligence Scale for Children (Cattell, 1973). An average correlation coefficient of .70 was reported for scores on the short form. A second correlation coefficient average of .81 was reported between the short form and the pure intelligence factor. Other researchers also have reported high correlations between the Culture Fair Intelligence Test and the Wechsler Adult Intelligence Scale (Watson & Klett, 1974) and the Raven's Progressive Matrices (Heinzl, Janouskova, Cizek, & Sevcik, 1971). The factor analysis of the instrument, including Scales 2 and 3, also has

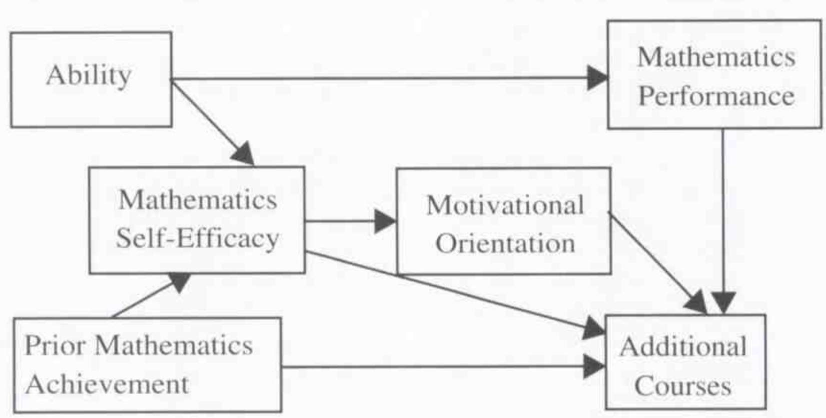

FIGURE 1. Path model evaluating motivational variables and mathematics achievement.

supported the presence of broad factors that represent visualization, speediness, and fluency, as well as fluid and crystallized intelligence (Undheim, 1981).

The test is available in three levels that correspond to the participant's age. In this study, we used the short form of the second scale, which is appropriate for 8- to 14-year-olds as well as for adults. The test can be group administered and consists of four subtests that involve completing series, classifying, solving matrices, and evaluating conditions. Items are hand scored yielding a total that can then be converted to percentiles according to norms derived from a standardization sample. An internal consistency estimate of .76 is reported in the test manual for the short form of Scale 2. The Kuder-Richardson Formula 20 estimates for this study's total, Caucasian, and Hispanic samples were .71, .75, and .63, respectively.

Mathematics self-efficacy. To assess students' mathematics self-efficacy, we used a task-specific mathematics self-efficacy instrument created by Pajares and Graham (1999) to assess the level of confidence of end-of-year eighth-grade students. The high school algebra teachers reviewed the instrument and confirmed its relationship to the students' curriculum, therefore providing evidence of content validity. Evidence of predictive validity also exists—Pajares and Graham found that students' self-efficacy scores can predict mathematics performance at the start and end of the first year of middle school.

Students were asked to endorse their level of confidence in correctly solving 20 grade-appropriate algebraic problems on the basis of an 8-point Likert-type scale that ranged from *not confident at all* to *completely confident.* Directions on the instrument stated, "Suppose that you were asked the following math questions in a multiple choice test tomorrow. Please indicate how confident you are that you will give the correct answer to each question." For example, one item presented the following: In one school, 65% of the graduates went on to college. If there were 1,500 graduates, how many went on to college? Students were instructed not to work the problems, and scores were derived by summing the items; higher scores indicated a greater amount of confidence than did lower scores. Pajares and Graham (1999) reported consistent estimates of reliability across samples, with Cronbach's alpha coefficients at or near .94, and noted their similarities to coefficients obtained from similar instruments in previous investigations. For the present sample, Cronbach's alpha reached .95, and .92 and .87 for the Caucasian and Hispanic samples, respectively.

Motivational orientation. We assessed motivational orientation by using Harter's (1980) Scale of Intrinsic Versus Extrinsic Orientation in the Classroom. We selected that measure for its appropriateness across age levels. Although all of the students in the sample were either 9th or 10th graders, we expected that they would differ considerably in reading levels. The scale is comprised of five subscales that have been supported through factor analysis, which in turn form two higher order factors. Harter (1981) described the first cluster, which consists of the following subscales: Preference for Challenge versus Preference for Easy Work Assigned, Curiosity/Interest versus Teacher Approval, and Independent Mastery versus Dependence on the Teacher. The second cluster of subscales was defined by Independent Judgment versus Reliance on Teacher's Judgment and Internal versus External Criteria for Success/Failure.

Harter (1981) interpreted the first higher order factor as representing whether a child is motivated to engage in the mastery process, and the second higher order factor as explaining more cognitive-informational structures, or how much the student has learned about the manner in which school works. "For example, third graders are very intrinsic on the first cluster, demonstrating strong intrinsic mastery motivation, but are very extrinsic with regard to the second cluster, reflecting their dependence on the information provided by the teacher" (Harter, 1981, p. 309). In contrast, the pattern for ninth-grade students is the opposite. On the basis of her findings, Harter (1981) recommended that (a) the use of the term intrinsic motivation should be precise and (b) only the first higher order factor, mastery process, was truly motivational in nature. Because the purpose of the present study was to investigate motivational aspects to predict mathematics achievement, we did not include the informational subscales in the analyses, and we evaluated only the first higher order factor. The inclusion of such informational variables would possibly have concealed the effects of the motivational information of interest, as a child could conceivably be intrinsic on one of the clusters, but extrinsic on the other (Harter, 1981).

Participants were presented with 30 items comprised of two short statements that described students. Although the participants were asked to complete all items, the cluster of interest for the present study included only 18 items. We initially asked the students to decide which description was most like them, then asked whether this statement was "only sort of true" or "really true" for them. We recoded several items at the direction of the scoring key prior to calculating total scores. We derived total scores by summing the values selected by the students. Each item was scored on a scale ranging from 1 to 4; the lowest score indicated *maximum extrinsic orientation,* and the highest score suggested *maximum intrinsic orientation.* Internal consistency estimates reported in the test manual were derived from the Kuder-Richardson Formula 20, and yielded reliabilities ranging from .78 to .84, .68 to .82, .70 to .78, .72 to .81, and .75 to .83, for the following subscales: Challenge, Independent Mastery, Curiosity, Judgment, and Criteria, respectively. A reliability estimate for the total score was not reported because the author stated that the use of the total score was not intended. Cronbach's alphas for the factor that we used in the present study for the total, Caucasian, and Hispanic samples were .88, .90, and .86, respectively.

Prior mathematics achievement. We assessed students' prior mathematics achievement by asking them to provide their usual course average as stated on their latest report card (i.e., ranging from 0 to 100). Because course averages often reflect the subjectivity of grading, that value likely included a more global evaluation of achievement, rather than simply performance. Furthermore, assessing prior achievement through self-report was preferred because our interest was the manner in which students viewed their past performance. In a school climate of standardized testing, which involved frequent preparation examinations and grade comparisons, we believed that students would be well aware of their own academic standings. Student reports ranged from a low of 40 to a high of 100. Although many students appeared to round to either tens or fives, a number of students seemed to record a specific grade. For example, groups of 12 students reported averages of 78, 89, and 93. As a result, we believe that we collected meaningful information about how students viewed their typical standing in mathematics courses.

Mathematics performance. Students were asked to complete 20 problems that were similar to those on which they had previously rated their confidence in solving, which were included on the mathematics self-efficacy instrument. We used similar, rather than identical, items to measure mathematics performance to address the possible artificial inflation of the correlation between mathematics self-efficacy and performance as a result of correlated specifics (Marsh, Roche, Pajares, & Miller, 1997). The test problems were based on those developed by Pajares and Graham (1999), who reported Kuder-Richardson Formula 20 reliability coefficients of .78 and .86. We used dummy coding to score the items dichotomously, correct or incorrect, and totaled them to derive a raw score. A Kuder-Richardson Formula 20 estimate of reliability calculated for the present total sample reached .85. Estimates for the Caucasian and Hispanic samples reached .92 and .87, respectively.

Intention to take additional mathematics courses. We asked students whether they planned to take additional mathematics courses; they responded *yes, maybe,* or *no* on a 3-point Likert-type scale.

Procedures

Approximately 2 weeks prior to the anticipated test date, the mathematics teachers were invited to participate and assist in the collection of data and were trained in the collection procedure. Teachers also confirmed that the selected algebra problems on the mathematics performance measure were consistent with grade-level expectations as well as with their current curriculum. Teachers read verbatim from a script, which provided an introduction explaining the purpose of testing to the students as well as instructions for each of the included instruments. The measures were presented to all students in the same order without counterbalancing. The measurement of mathematics self-efficacy prior to mathematics performance was necessary because self-efficacy would have been affected if students had the opportunity to attempt to work the actual problems first. However, we administered the remaining measures, which could have been counterbalanced, in a standardized fashion to ensure the most economical use of students' typical instructional time. The test was administered during the students' regular 90-min mathematics period, and they completed the entire process, on average, in approximately 1 hr.

Statistical Analyses

We conducted path analyses by using LISREL 8.52 (du Toit & du Toit, 2001) to test the adequacy of the hypothesized model for each group, which included the causal relations among the six manifest variables. We chose path analysis because it is a confirmatory technique that uses only observed variables. We established a clear and well-developed theoretical background that involved the variables of interest. Because the variables were measured directly with instruments associated with valid and reliable test scores on the basis of a thorough review of their development and use, we did not investigate measurement in the tested models. Instead, we chose path analysis because it is a confirmatory technique that uses only observed variables. We did not use assessment of fit through the evaluation of chi-square because of the extensive amount of criticism that this method has received; however, the statistic has been reported. The chi-square value has been criticized for its sensitivity to sample size and lack of robustness to the violation of basic underlying assumptions, which results in the greater likelihood of a significant finding when differences are only trivial in a large sample and inaccurate probability levels in small samples and samples violating the underlying assumptions (Bentler, 1990; Tabachnick & Fidell, 1996).

We selected alternative goodness-of-fit indices for this study on the basis of recommendations reported by Hu and Bentler (1999). We also used a two-index presentation strategy in which we evaluated the maximum likelihood (ML)-based standardized root mean square residual (SRMR) and the ML-based comparative fit index (CFI). We used that combinational rule of CFI $< .95$ and SRMR $> .09$ because Hu and Bentler (1999) suggested that when $N \leq 250$, as it is in our group analyses, and a Type I error is being avoided, the CFI and SRMR combination is likely more appropriate.

We did not consider modification indices in the present study because of multiple concerns. The alteration of the direction of several relationships in the model would have made little sense because the performance measure occurred later in time than the measurement of the motivational variables. The decision not to modify the current model also was based on the strong cautions made by others concerning the appropriateness of such procedures (MacCallum, Roznowski, & Necowitz, 1992). The cautions include the "generalizability" of the model beyond the original sample as well as the difficulty of consistently cross-validating models when the sample size is not large. MacCallum, Roznowski, & Necowitz emphasized the importance of an a priori model based on theory, which we constructed and successfully tested in this study. Therefore, no additional models were evaluated.

Finally, we used multiple-group models to evaluate the equality of regression coefficients. We initially tested a baseline model that included Hispanic and Caucasian models, with no parameters constrained. We next compared subsequent constrained models with the baseline model, constraining each regression coefficient one at a time. We used chi-square difference tests to compare each restrictive model with the baseline model. Nonsignificant chi-square difference tests suggested that the constrained regression coefficient remained consistent across ethnicity, whereas significant chi-square tests suggested that the regression coefficients differed because the model was degraded.

Results

Preliminary Analyses

Following data screening, 358 participants were available for subsequent analyses. Twenty-one percent of the Caucasian students reported that they were taking algebra for the second time, compared with 40% of the Hispanic students. Despite their lack of success in mathematics, 65% of the Hispanic students described the subject as "useful"; 57% of the Caucasian students responded similarly. Only 42% of the Hispanic students reported that they planned to take any additional mathematics courses, compared with 63% of the Caucasian students.

Table 1 shows the means and standard deviations for all variables calculated for the total sample as well as for the different groups, on the basis of ethnicity. Reports of mathematics self-efficacy differed significantly for Caucasian and Hispanic students. Caucasian students reported more confidence than did their Hispanic counterparts regarding their ability to successfully complete the mathematics problems, $t(342) = 4.83$, $p < .001$, indicating a moderate effect size evidenced by a point biserial correlation coefficient, $r = .25$. In addition, Caucasian students scored significantly higher on the ability and mathematics performance measures, $t(342) = 6.83$, $p < .001$, and $t(342) = 6.59$, $p < .001$, than did Hispanic students. Point-biseral correlation coefficients revealed moderate effect sizes, $r = .35$ and $r = .34$, respectively. Finally, Caucasian students reported significantly higher, $t(337) = 4.80$, $p < .001$, prior mathematics achievement than did Hispanic students. The point-biserial correlation coefficient revealed a moderate effect size, $r = .25$.

To determine whether differences in mathematics performance would remain across the two groups with ability statistically controlled, we conducted an analysis of covariance.

TABLE 1. Variable Means and Standard Deviations Across Samples

Sample	Ability	Prior achievement	Mathematics self-efficacy	Motivational orientation	Mathematics performance	Additional courses
Total[a]						
M	32.21	82.77	115.66	43.48	8.52	1.68
SD	4.69	8.38	30.50	8.66	4.97	0.76
Caucasian[b]						
M	34.16	85.46	124.51	44.09	10.41	1.51
SD	4.02	6.66	24.12	8.12	5.11	0.73
Hispanic[c]						
M	30.80	81.18	108.49	42.51	7.08	1.80
SD	4.54	8.51	32.04	8.46	4.09	0.78

[a]$N = 358$. [b]$n = 114$. [c]$n = 187$.

TABLE 2. Correlation Matrix for the Total Sample

Variable	1	2	3	4	5	6
1. Ability	—	.35**	.36**	.24**	.56**	.28**
2. Prior achievement		—	.52**	.37**	.45**	.27**
3. Mathematics self-efficacy			—	.38**	.47**	.38**
4. Motivational orientation				—	.31**	.31**
5. Mathematics performance					—	.37**
6. Additional courses						—

**$p < .01$.

Including ability as a covariate, we continued to find a statistically significant difference, $F(1) = 11.88$, $p = .001$, across the mathematics performance of Hispanic and Caucasian students. Therefore, we continued to investigate the role of personal qualities in mathematics achievement because ability alone did not appear to account for all the variation in the students' mathematical skills.

Table 2 shows the correlations between all six measures for the total sample. Correlational analyses for the total sample indicated that the variables were related as specified by theory and in the predicted directions. The correlations for Caucasian and Hispanic students also revealed associations in the predicted direction on the basis of theoretical review (see Table 3). On the basis of preliminary analyses, the expected differences were found across ethnicity, and the associations between variables appeared to be similar for Hispanic and Caucasian students.

Path Analyses

Path model for total sample. We used the LISREL 8.52 program (du Toit & du Toit, 2001) containing the SIMPLIS programming language to conduct the path analysis of the total sample, followed by the analyses of the individual groups across ethnicity. For all models, maximum likelihood estimation was used, and parameter estimation matrices were positive definite, with no parameter estimates outside their permissible range. We transformed all scores into z scores prior to evaluation to allow for easier interpretation of path coefficients. We found evidence to support adequate model-to-data fit ($CFI = .98$, $SRMR = .06$) for the full sample. The chi-square estimate of 22.49 was significant ($p < .001$), suggesting a poor model-to-data fit; however, this estimate was likely elevated because of the somewhat large sample size.

The parameter estimates of the model were all significant at $p < .01$ (see Figure 2). Students' ability and prior mathematics achievement accounted for 30% of the variance in mathematics self-efficacy; mathematics self-efficacy, ability, and prior mathematics achievement accounted for 42% of the variance in mathematics performance. Mathematics self-efficacy accounted for 15% of the variance in students' motivational orientation, and motivational orientation in conjunction with mathematics self-efficacy and mathematics performance accounted for 20% of the variance in students' plans to take additional mathematics courses. Although the parameter estimate for the path between ability and mathematics performance remained significant ($r = .41$, $p < .01$), the bivariate correlation coefficient between ability and mathematics performance ($r = .56$) was slightly reduced, suggesting some mediation, or translation of the effects of ability through mathematics self-efficacy. Evidence for the mediation of prior mathematics achievement through self-efficacy to influence mathematics performance also was present; the bivariate correlation coefficient of $r = .45$ declined to a path coefficient of $r = .19$.

Path model for Caucasian sample. We found evidence to support adequate model-to-data fit ($CFI = .96$, $SRMR = .07$) for the Caucasian sample. The chi-square estimate of 11.30 was significant but only at $p < .05$. The parameter estimates for that model are presented in Figure 3. All parameter estimates were significant at $p < .01$, with the exception of the path from prior mathematics achievement to mathematics performance and the relationships between mathematics

TABLE 3. Correlation Matrix for Caucasian and Hispanic Students

Variable	1	2	3	4	5	6
			Caucasian students (n = *113*)			
1. Ability	—	.32**	.33**	.15	.64**	.27**
2. Prior achievement		—	.33**	.38**	.42**	.26**
3. Mathematics self-efficacy			—	.31**	.46**	.37**
4. Motivational orientation				—	.20*	.21*
5. Mathematics performance					—	.37**
6. Additional courses						—
			Hispanic students (n = *180*)			
1. Ability	—	.28**	.29**	.25**	.43**	.21**
2. Prior achievement		—	.54**	.33**	.38**	.25**
3. Mathematics self-efficacy			—	.40**	.41**	.33**
4. Motivational orientation				—	.33**	.32**
5. Mathematics performance					—	.31**
6. Additional courses						—

$^*p < .05$. $^{**}p < .01$.

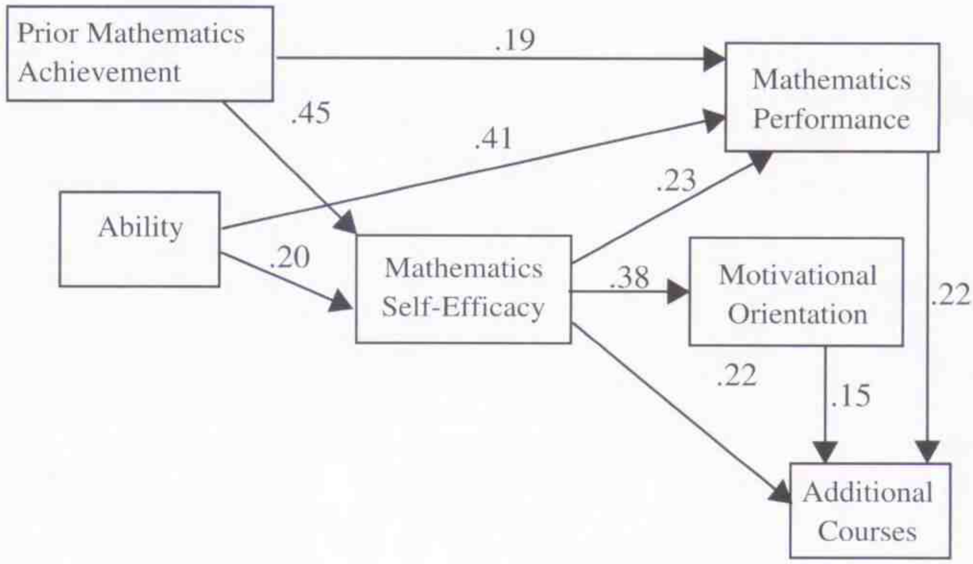

FIGURE 2. Path model evaluating motivational variables and mathematics achievement for the total sample.

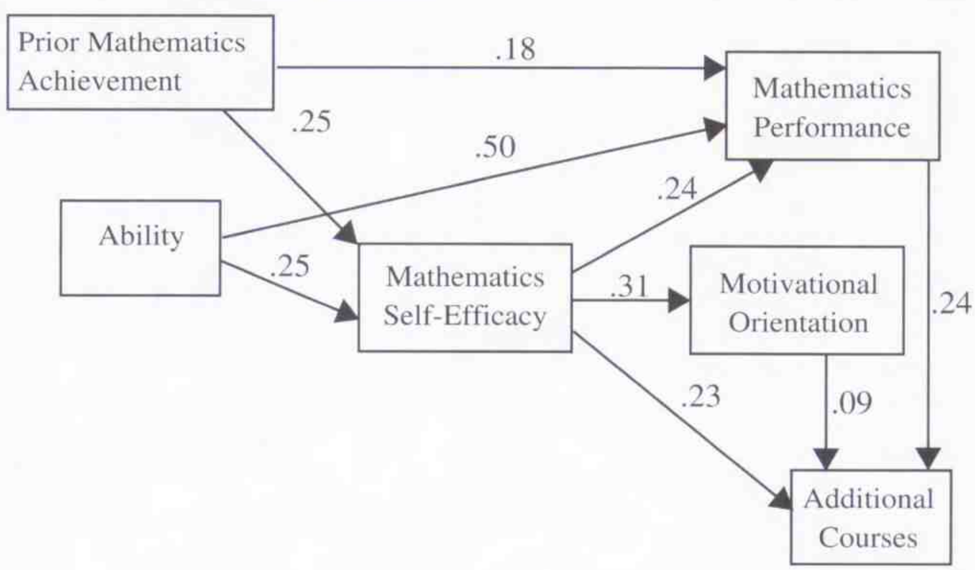

FIGURE 3. Path model evaluating motivational variables and mathematics achievement for the Caucasian sample.

self-efficacy and mathematics performance and students' intent to take additional mathematics courses, which were significant at $p < .05$. Finally, the path from motivational orientation to plans for taking additional mathematics courses was not statistically significant.

We found evidence to support the mediation of the effects of ability on mathematics performance through mathematics self-efficacy—the parameter estimate between ability and mathematics performance ($r = .50$) was smaller than the bivariate correlation ($r = .64$). However, the parameter estimate remained significant ($p < .01$). Greater evidence was present for the mediation of the relationship between prior mathematics achievement and mathematics performance—the parameter estimate ($r = .18$) was smaller than the bivariate correlation ($r = .42$). Furthermore, the parameter estimate was significant at only the $p < .05$ level. Ability and

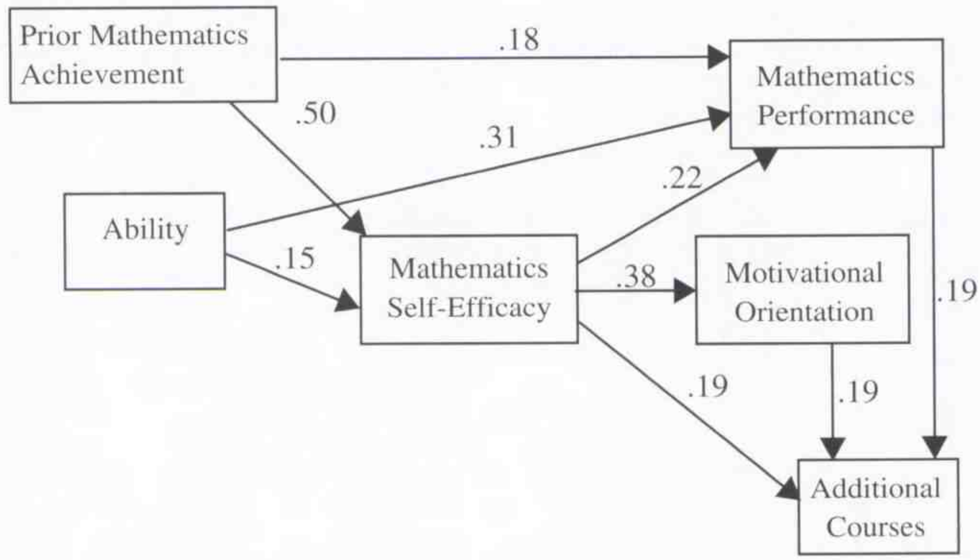

FIGURE 4. Path model evaluating motivational variables and mathematics achievement for the Hispanic sample.

TABLE 4. Test of Chi-Square Differences Between Constrained and Baseline Models

Parameter constrained	*DF*	χ^2	*DF* Δ	χ^2 Δ	*p*
Baseline model (no constraints)	14	28.61			
Ability to self-efficacy	15	29.61	1	1.00	< .90
Ability to mathematics performance	15	31.20	1	2.59	< .90
Prior achievement to self-efficacy	15	35.10	1	6.49	< .025
Prior achievement to mathematics performance	15	28.60	1	–.01	< .95
Self-efficacy to motivational orientation	15	29.50	1	.89	< .90
Self-efficacy to mathematics performance	15	28.67	1	.06	< .90
Self-efficacy to additional courses	15	28.69	1	.08	< .90
Motivational orientation to additional courses	15	29.19	1	.58	< .90
Mathematics performance to additional courses	15	29.07	1	.46	< .90

prior mathematics achievement accounted for 16% of the variance in mathematics self-efficacy, and mathematics self-efficacy, ability, and prior mathematics achievement accounted for 50% of the variance in students' mathematics performance. Mathematics self-efficacy accounted for 9% of the variance in motivational orientation. Motivational orientation, mathematics self-efficacy, and mathematics performance accounted for 19% of the variance in student plans to take additional mathematics courses.

Path model for the Hispanic sample. We also found adequate model-to-data fit (CFI = .98, SRMR = .06) for the Hispanic sample. The estimate for chi-square was 11.32 and significant only at $p < .05$. All parameter estimates were significant at $p < .01$, with the exception of the paths between (a) ability and mathematics self-efficacy, (b) mathematics achievement and prior mathematics achievement, (c) mathematics self-efficacy and students' intent to take additional mathematics courses, and (d) mathematics performance and students' intent to take additional mathematics courses, which were significant at $p < .05$. The parameter estimates for the Hispanic sample are shown in Figure 4.

As in the Caucasian model, evidence for the mediation of ability on mathematics performance through self-efficacy was noted, but a significant reduction in the original bivariate correlation ($r = .43$) was not present; the parameter estimate between ability and mathematics performance ($r = .31$) remained significant at $p < .01$. However, the original bivariate correlation ($r = .38$) between prior mathematics achievement and mathematics performance that was significant at $p < .01$ was reduced to a path coefficient ($r = .18$)

that was significant only at the $p < .05$ level. Ability and prior mathematics achievement accounted for 31% of the variance in mathematics self-efficacy, whereas mathematics self-efficacy, ability, and prior mathematics achievement accounted for 29% of the variance in mathematics performance. Sixteen percent of the variance in motivational orientation was accounted for by mathematics self-efficacy, and motivational orientation in conjunction with prior mathematics self-efficacy and mathematics performance accounted for 16% of the variance in students' plans to take additional mathematics courses.

Multiple-group analyses. We tested the baseline model that included the Hispanic and Caucasian models with no constrained parameters. The resulting goodness-of-fit indices ($CFI = .97$, $SRMR = .06$) indicated an adequate model-to-data fit. Chi-square for the baseline model was 28.61, $p < .01$, suggesting poor model-to-data fit; however, the larger sample size of the combined groups likely influenced this estimate. Subsequent models were tested that constrained each parameter estimate at a time. Those subsequent models that each held one regression coefficient constant across the two groups were then individually compared with the baseline model. Tests of the chi-square differences between each constrained model and the baseline model are reported in Table 4. Results indicated that the only parameter that significantly differed across the two groups was the estimate from prior mathematics achievement to mathematics self-efficacy. All other parameter estimates remained consistent across Hispanic and Caucasian students.

Discussion

As expected, students' beliefs and motivation played an important role in mathematics achievement. Perhaps more important, the current findings suggest that when educators encourage the development of those personal qualities to improve mathematics achievement, similar goals should be set to meet the needs of Hispanic and Caucasian students. Therefore, our results provide basic information by extending self-efficacy theory and motivational orientation to Hispanic students, and also provide practical information by informing educators how self-efficacy and motivational orientation influence mathematics performance across ethnicity.

Our comparison of the mathematics performance of students across ethnicity yielded results consistent with the current body of literature reporting that Hispanic students' mathematics performance is significantly below that of their Caucasian peers (Catsambis, 1994; Lee, 2002). That lower performance was not likely caused by a lack of advanced courses because all participants were enrolled in algebra or had recently completed the course. In addition, the poor mathematics performance of Hispanic students did not appear to result from a lack of value placed on mathematics because a greater percentage of Hispanic students than Caucasian students reported that mathematics was useful.

Although the scores of Hispanic students on the ability measure were significantly below those of their Caucasian peers, we do not believe that this is the reason behind Hispanic students' lower mathematics performance. Subsequent analyses revealed that the differences remained despite statistically controlling for ability. In addition, the strength of the relationship between ability and mathematics performance was not significantly different across ethnicity; however, this relationship was stronger for Caucasian students than for Hispanic students, suggesting that ability may not be as important for Hispanic students in the development of self-efficacy. That finding was further evident in the amount of variance accounted for in mathematics performance. Ability, prior mathematics achievement, and self-efficacy accounted for only 29% of the variance in the mathematics performance of Hispanic students, whereas these same variables accounted for 50% of the variance in the mathematics performance of Caucasian students. Ability appeared to have a reduced effect on the self-efficacy and mathematics performance of Hispanic students, although the differences across individual parameters were not significant; therefore, Hispanic students may not place as great an emphasis on evaluating their ability in the academic setting as do Caucasian students.

However, others have suggested that the importance placed on ability is an important factor that contributes to the mathematics performance of Hispanic students. Bempechat, Nakkula, Wu, and Ginsburg (1996) evaluated the relationship between students' attributions concerning failure and success and mathematics performance across ethnicity. They found that students who attribute their success to ability or who attribute failure to a cause other than ability achieve greater levels of mathematics performance. Although results of the sample from the Hispanic students revealed a pattern similar to the significant relationship found between ability attributions and mathematics performance of the Caucasian students, the relationship was not significant for the Hispanic group. That finding could be related to the smaller Hispanic sample size; however, that also could mean that the relationship found for this group resulted by chance. Finally, those students were selected from only the Boston area; however, differences in acculturation may exist among Hispanic students who reside in various parts of the country. The concern that our findings might not generalize to Hispanic students who reside in another part of the United States is relevant for all aspects of the present study and should be considered in future research.

In this study, Hispanic students also described their prior mathematics achievement in terms that suggested that their lack of success in mathematics existed prior to the present research. Because mastery experiences often lead to increased self-efficacy (Bandura, 1997), it is not surprising that we found that Hispanic students reported significantly less confidence in their ability to use their skills and knowledge effectively to successfully complete mathematics problems than Caucasian students did. That finding is unfortunate because prior mathematics achievement, as well as ability, are translated through mathematics self-efficacy to influence mathematics performance. In other words, the beliefs that students possess about their ability to successfully complete mathematics problems predict their mathematics performance, even when those beliefs might not match actual ability or levels of prior achievement. In addition, prior mathematics achievement played a stronger role in that relationship for Hispanic students than it did for Caucasian students. Furthermore, reports of higher earlier mathematics achievement lead to greater enjoyment of mathematics, a relationship that was also stronger, although not significantly, for Hispanic students than for Caucasian students. That finding suggests that Caucasian students might have had other experiences, likely not available to Hispanic students, that influenced their feelings of efficacy.

Perhaps having a greater number of opportunities to build confidence in mathematics protects one's self-efficacy. For example, Caucasian students who receive a grade below their expectations in mathematics might discount that information because they are frequently sent messages by parents or authority figures that a career in architecture is an option. However, Hispanic students who receive a lower grade than expected may be more likely to use that information to adjust feelings of efficacy, as they have little additional information that offers a contradiction. Such messages, or lack thereof, are likely subtle and pervasive, and can be described as verbal persuasion. Other influences on self-efficacy would include the availability of models. Again, Caucasian students likely have a greater opportunity than do Hispanic students to encounter individuals who are similar and who have succeeded in mathematics-related fields. As a result, Caucasian students likely receive a greater amount of information that can positively influence their feelings of efficacy, protecting them from the negative effects of a low grade or reprimand. That rationale is consistent with Bandura's (1997) self-efficacy theory in that individuals' self-efficacy can be influenced by factors other than mastery experiences, such as verbal persuasion and observational learning.

That influence on self-efficacy is important because self-efficacy predicts not only students' mathematics performance but also other motivational variables that influence aspects of overall mathematics achievement. As suggested by Bandura (1993), mathematics self-efficacy predicts changes in students' motivational orientation. Students who report higher self-efficacy also report greater intrinsic motivation. Because students who have confidence in their ability to use knowledge effectively to solve mathematics problems likely seek more challenging mathematics tasks and courses related to mathematics than do those who do not possess such confidence, they likely experience greater feelings of autonomy and competence, both of which are precursors to intrinsic motivation. Those students who have low mathematics self-efficacy may enroll in mathematics courses and seek out mathematical tasks only when they have to do so because of pressures from parents or requirements from educators. As a result, those students report greater levels of extrinsic motivation because they determine that their involvement in mathematics is predominately caused by external forces.

Intrinsic motivation frequently is deemed more advantageous in the educational setting than is extrinsic motivation (Stipek, 1992). Therefore, in the present study, it is not surprising that students who reported greater intrinsic motivation also reported plans to take additional mathematics courses. Because students who feel competent in their ability to complete mathematical tasks are more likely to consider careers that require a greater mathematics background, we believe that the development of motivational orientation through mathematics self-efficacy is yet another important outcome to encourage.

Our results clearly indicate that self-efficacy plays an important role in predicting mathematics performance and motivation for Hispanic and Caucasian students. Educators can focus on mathematics self-efficacy that will likely improve the mathematics performance of all students. However, educators also must recognize that Hispanic students may not have the same opportunities enjoyed by Caucasian students to receive verbal persuasion and to view models that encourage participation in mathematics-related activities. As a result, schools need to be certain that educators are discussing with all students (a) the possibility of taking advanced mathematics courses, (b) college opportunities and requirements, and (c) careers related to mathematics. Furthermore, schools should seek out Hispanic models, such as teachers and local professionals, to demonstrate success in mathematics. Of course, these strategies are most relevant for secondary students who may already be behind in mathematics. Future research is necessary to determine how mathematics self-efficacy develops across the school years and what implications can be made to facilitate its development.

Continued investigation of the role of personal qualities in the mathematics achievement of Hispanic youth would benefit from addressing the limitations of the present study. First, researchers should consider selecting measures that employ not only self-report but also objective and subjective reports from others, such as educators, parents, and peers. Our reliance on self-report, although important because of the nature of the self-perspective variables under study, may have caused certain individuals or possibly groups to attempt to portray themselves in either a positive or negative light. Although that issue may have affected the present results, the consistency of the findings with current theory as well as employment and achievement testing statistics suggests that students were honest in their responses. Even so, a greater variety of data sources could have provided more information concerning the school context and home environment, resulting in an even better understanding of the development of self-efficacy and, in turn, mathematics outcomes.

A second limitation was that our study lacked counterbalancing because of time constraints created by educators waiting for students to complete all the measures before presenting the group-administered test of ability. All students completed the ability test first in a group administration. As a result, students who felt unsuccessful may have responded to the subsequent mathematics questions in a manner that conveyed a lack of confidence when, in fact, that deficiency resulted from the ability testing experience. (Students were not informed of their correct or incorrect responses.) That issue could affect the basic understanding of the role of self-efficacy in mathematics achievement; however, this concern may not be as relevant for the educational environment in which routine and schedules are set to address the practical issues of ensuring time spent in core courses while meeting basic needs, such as eating lunch and socializing. In the classroom setting, students are often confronted with one academic task following the next and in the same order throughout each school day. If students' beliefs or performance are altered because of that order, they are still subject to the consequences. In the event that that issue was relevant in the present study, the results likely reflect what actually happens in the classroom; therefore, their results are still meaningful.

Finally, researchers should be aware that multiple models may fit any one data set (MacCallum, Roznowski, & Necowitz, 1992). As a result, our findings should be viewed as a much-needed starting point to understand how personal qualities influence mathematics outcomes across students of varying ethnicities. Although our conceptual understanding of the role of personal qualities across ethnicity appeared to be correct, we found that specific qualities may hold greater importance for some groups. That finding suggests that a continued effort to understand the role of well-accepted relationships across ethnicity may reveal how educators can alter environments to ensure the mathematics success of all students and, ultimately, their economic possibilities.

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