Hispanic High Schoolers and Mathematics: Follow-Up of Students Who Had Participated in Two-Way Bilingual Elementary Programs

Kathryn Lindholm-Leary
San Jose State University

Graciela Borsato
Stanford University

Abstract

Research shows a serious underrepresentation of Hispanic students entering the math, science, and engineering fields, possibly fueled by a large gap in math achievement between Hispanic and Euro-American students. The current study addressed this concern by examining the general school-related attitudes, coursework, and achievement, with a focus on math for 139 high school students—Hispanics who were previous English language learners, native English-speaking Hispanics, and Euro-American English speakers—who had been enrolled in a two-way bilingual program throughout elementary school. The results showed that all three groups of students had positive attitudes toward math and school in general and were scoring at grade level in math. They were taking higher level college preparation math courses and getting mostly average grades (B's and C's) in those courses. These results suggest that the two-way bilingual program may provide the academic preparation and schooling attitudes, including in mathematics, that enable all three groups of students to be more successful than the average Hispanic and low-socioeconomic status students described in the literature.

Introduction

Nationally, the academic performance of Hispanic students is considerably below majority norms. According to the Presidential Advisory Commission on Educational Excellence for Hispanic Americans (2003), the nation is "losing

Hispanic American students all along the education continuum" (p. 1): One in every three Hispanic Americans has not completed high school, and among those who do complete high school, only 53% enroll in postsecondary education after graduation, compared to 66% of non-Hispanic Whites. The commission has further warned that the present crisis in educating Hispanic children threatens the ability of the United States to compete economically. Indeed, as the demographic trends shift toward a higher representation of Hispanics in the United States (24% of the U.S. population by 2050, U.S. Census Bureau, 2000), the academic attainment of Hispanic students becomes crucial. According to the latest projections of the Bureau of Labor Statistics, the growth rates (2000–2010) will be faster, on average, for occupations requiring a postsecondary degree (a vocational certificate or an academic degree) than for occupations requiring less education or training (Hecker, 2001). Hispanic students' underachievement in education reduces the number of workers with the skills to assume these higher level occupations.

Of particular concern is the serious shortfall in the number of Hispanic students entering the science, mathematics, engineering, and technology fields. According to the 2000 National Assessment of Educational Progress report, the large gaps in mathematics achievement between non-Hispanic White and Hispanic students (as well as between non-Hispanic White and Black students) have remained unchanged since 1990. Moreover, in 2005, only 51% of Hispanic students passed the mathematics portion of the California High School Exit Examination, while this proportion was 80% for non-Hispanic Whites (California Department of Education, 2005). Even though Hispanic students are now taking and completing more upper level high school mathematics and science courses than a decade ago, the proportion that do so is still noticeably behind rates for non-Hispanic White students (Committee on Equal Opportunities in Science and Engineering, 2000). Unfortunately, research findings suggest that Hispanic students, as a group, are provided fewer opportunities in school to acquire high-order skills in mathematics compared to their non-Hispanic White counterparts (Strutchens & Silver, 2000). As Clark (1999) points out, the lack of preparation in mathematics among underrepresented minorities (Blacks, Hispanics, and American Indians) in the early elementary grades results in lower enrollment and success in secondary-level school programs. As a consequence, underrepresented high school students start college less prepared than their non-Hispanic White peers (Committee on Equal Opportunities in Science and Engineering).

Limited proficiency in English also presents a considerable challenge to academic success. In 1999, 1% of non-Hispanic White and non-Hispanic Black children had limited English proficiency, compared with 23% of children of Hispanic background and 12% of children of other races (National Institute of Child Health and Human Development, 2002). Among Hispanic immigrant students educated in the United States, 45% of high school dropouts report speaking English "not well" (Fry, 2003).

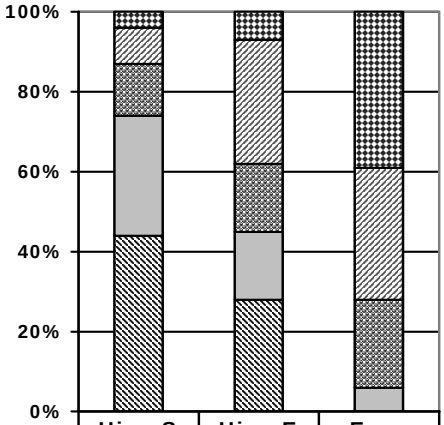
Two-way bilingual programs (also known as dual language education programs) are designed to provide a high-quality educational experience for language-minority students and to promote higher levels of academic achievement (Lindholm-Leary, 2001). Two-way programs integrate native English-speaking students and native Spanish-speaking students with content instruction administered through both languages. The extant research indicates that two-way programs that are implemented correctly have very positive student outcomes at the elementary and early middle school levels (Lindholm-Leary; Lindholm-Leary & Borsato, in press). However, there is a dearth of information on the academic outcomes at the middle and high school levels for students who attended a two-way bilingual program in elementary school. In order to help fill this void, the purpose of this study is to describe mathematics achievement and attitudes toward schooling and mathematics for a group of Hispanic and Euro-American high school students who had been enrolled in a two-way bilingual program throughout elementary school.

Method

Participants

A total of 139 students in Grades 9–12 participated in the study. All of these students had been enrolled in a two-way bilingual program since kindergarten or first grade and through elementary school at one of three public schools in California. The sample consisted of 63 boys (45%) and 76 girls (55%), and approximately equal numbers of ninth or tenth graders (51%) and eleventh or twelfth graders (49%). Students were categorized into one of three groups on the basis of their ethnicity and language background. Although all students were bilingual at the time of the study, they were classified according to whether they started elementary school as a native English speaker or a native Spanish speaker. There were 92 (66%) Hispanic Spanish-speaking (Hisp-S) students, 29 (21%) Hispanic English-speaking (Hisp-E) students, and 18 (13%) Euro-American English-speaking (Euro) students. The distribution of Hisp-E, Hisp-S, and Euro students was not significantly different across the two-grade levels (Grades 9–10: 47% of Hispanics and 60% of Euro; Grades 11–12: 53% of Hispanics and 40% of Euro).

About two thirds of the students (67%) lived with both biological parents, 14% with a single mom, 10% in a blended family, and 9% in some other situation. Students in the three ethnic and language groups differed significantly with respect to their mother's level of education ($\chi^2 = 43.9$, $p < .0001$). As Figure 1 indicates, higher levels of mother's education were represented among Euro students, followed by Hisp-E students and then by Hisp-S students (72% of Euro, 38% of Hisp-E, and 13% of Hisp-S had mothers with at least some college education), and the lowest levels of education were represented among



	Hisp-S	Hisp-E	Euro
College degree	4	7	39
Some college	9	31	33
High school graduate	13	17	22
Some high school	30	17	6
Elementary	44	28	0

Figure 1. Mother's level of education.

Hisp-S students (74% of Hisp-S compared to 45% of Hisp-E and 6% of Euro had mothers who had not graduated from high school).

Consistent with the differences in the mother's education across the three groups, students differed significantly in terms of their participation in the free and reduced-price lunch program in elementary school (76% of Hisp-S and 55% of Hisp-E compared to 29% of Euro participated, $\chi^2 = 15.6$, $p < .0001$).

Procedure

All students in the study were contacted through their current teachers and asked to complete a questionnaire. They filled out the questionnaire on their own and returned it in a sealed envelope. The questionnaire consisted of questions concerning attitudes toward school, current schooling path and college ambitions, parent and teacher support, and typical grades in language arts/social studies and mathematics/science. Most of the items were rated on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Other items requested demographic information (ethnicity, mother's educational background, participation in free lunch program, household composition).

Students' scores from norm-referenced achievement tests in English for the subtest of mathematics were collected for students when they were in Grade 2 to provide a starting point for measuring math achievement in English (n = 97), in Grade 6 for the end of elementary school (n = 46), and in Grade 9 for high school (n = 19). Achievement scores were only available for a subset of the students at these particular grade levels. No norm-referenced achievement data were available for students in Grades 10–12 as students were not tested at these grade levels.

Representativeness of Follow-Up Sample

In looking at whether these follow-up students in the sample reported here are representative of their classmates in the two-way bilingual programs when they were all in second grade, we examined the second-grade free and reduced-price lunch participation and math achievement of the follow-up students with those of their second-grade cohort classes. Although the percentage of Hisp-S students that had been eligible for free and reduced-price lunch program was approximately the same for both groups (76% of the Hisp-S follow-up students compared to 77% of the second-grade Hisp-S cohort), there were almost twice as many English speakers in the follow-up sample that were from a low-income family compared to their second-grade classmates (55% of Hisp-E students in the follow-up sample compared to 35% of Hisp-E students in the second-grade cohort, and 29% of Euro students in the follow-up sample compared to 15% of Euro students in the second-grade cohort).

Table 1 presents students' achievement in Normal Curve Equivalent (NCE) scores in mathematics on norm-referenced achievement tests taken in English when the students were in second grade. Data are available for a subset of the follow-up students (n = 97) and for a larger cohort of second graders in two-way programs who had been classmates of the follow-up students in second grade (n = 323). As Table 1 shows, follow-up Hisp-S students had begun second grade with scores that were very low (NCE = 29), follow-up Hisp-E students had scored below grade level (NCE = 40), and the achievement scores of follow-up Euro-American students had been in the average range (NCE = 46). In comparing the follow-up sample with the two-way students in their second-grade cohort (see Same two-way cohort in Table 1), it is clear that, on average, the students in the follow-up sample scored significantly lower than their two-way peers in second grade, $F(1, 419) = 32.7$, $p < .001$. Thus, the follow-up group includes more low-scoring, or potentially at-risk students, with a larger percentage of students eligible for free and reduced-price lunch program (among English speakers but not Spanish speakers) and lower scores in mathematics compared to the average peers in the same two-way cohort.

Table 1

Mean Normal Curve Equivalent Scores and Standard Deviation for Math Achievement in English in Grade 2

	Hisp-S		**Hisp-E**		**Euro**	
	M	*SD*	*M*	*SD*	*M*	*SD*
Follow-up students (*n* = 97)	29.3	27.5	40.0	23.6	46.0	37.9
Same two-way cohort (*n* = 323)	43.4	21.6	52.6	21.5	63.6	25.3

Note. Scores are averaged for all students for whom second-grade scores were available and categorized by ethnic/language background. Same two-way cohort includes all Hisp-S (*n* = 184), Hisp-E (*n* = 35), and Euro (*n* = 104) classmates who were part of the same two-way cohort as the follow-up students. As a group, follow-up students' (Hisp-S: *n* = 69; Hisp-E: *n* = 11; Euro: *n* = 17) scores are significantly lower than the non-follow-up students' scores, $F(1, 419) = 32.7$, $p < .001$.

Results

General Attitudes Toward School and College

The majority of students of all backgrounds agree that they want to go to college (*M* = 4.5), that getting a good education is the best way to have a better life when they are older (*M* = 4.7), that getting good grades is important (*M* = 4.4), and that good grades are important for getting into college (*M* = 4.5). Further, on a scale from 1 (*not important*) to 4 (*very important*), students' average rating on the importance of doing well in school was 3.6. As Table 2 indicates, there were no significant ethnic or language differences among Hisp-S, Hisp-E, and Euro students on any of these items.

Self-Efficacy and Study Habits

In assessing the self-efficacy and study habits of the students, Table 3 shows that overall students had positive perceptions of their scholastic ability and approach to school work: "I am a good student" (*M* = 4.0); "I am good at my schoolwork" (*M* = 3.9); and "I can do almost any problem if I keep working at it" (*M* = 3.9). Agreement was moderate for the items "I like challenging problems" (*M* = 3.4); "I take time to figure out my schoolwork" (*M* = 3.7); "I usually get my homework done on time" (*M* = 3.7); and "I go back over schoolwork I don't understand" (*M* = 3.5). While Euro students tended to have slightly higher averages, there were no significant differences across the three ethnic and language groups for any of these items.

Table 2

Attitudes Toward School and College: Comparing Ethnic and Language Groups

	Hisp-S (*n* = 92)		**Hisp-E (*n* = 29)**		**Euro (*n* = 18)**		**Differences (*Eta*^{2})**
	M	*SD*	*M*	*SD*	*M*	*SD*	
I want a college degree	4.6	0.81	4.6	0.63	4.1	1.1	None (.03)
Getting a good education is the best way to have [a] better life when I'm older	4.7	0.76	4.6	0.56	4.2	0.81	None (.04)
It is very important to get good grades	4.5	0.73	4.4	0.86	4.2	0.55	None (.01)
Good grades [are] important to get into college	4.5	0.97	4.5	0.63	4.5	0.79	None (.00)
[Importance of doing] well in school[a]	3.6	0.81	3.8	0.77	3.4	0.85	None (.02)

Note. Scores range from 1 (*disagree strongly*) to 5 (*agree strongly*).

[a] Scores range from 1 (*not important*) to 4 (*very important*).

Coursework in Mathematics

In terms of the students' coursework in mathematics (see Figure 2), most students were enrolled in higher level math, with only 6% of students at both grade levels enrolled in basic math. At the ninth- and tenth-grade levels, there was no statistically significant relation between course taking and ethnic or language background. However, twice as many Euros (63%) compared to Hispanics (30%) were taking Algebra 2, though the 30% difference in Algebra 2 was offset by 27–30% of Hispanic, but no Euro, students enrolled in Geometry. At the eleventh- and twelfth-grade levels, one student in each ethnic or language group was enrolled in basic math. Algebra and Geometry accounted for 39% of Hisp-S and 54% of Hisp-E students. Another third (31–36%) from each group were taking Algebra 2. The biggest difference was in Trigonometry or Calculus, where 28% of Hisp-S, no Hisp-E, and 50% of Euro students were

Table 3

Self-Efficacy, Study Habits, and Attitudes Toward Math: Comparing Ethnic and Language Groups

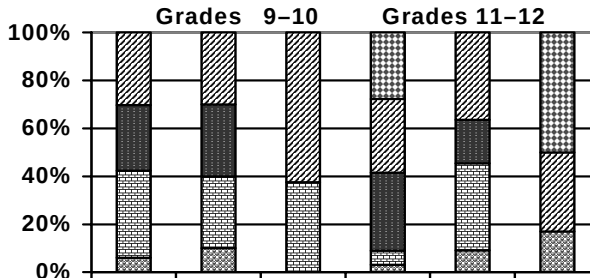
	Hisp-S (*n* = 92)		**Hisp-E (*n* = 29)**		**Euro (*n* = 18)**		**Differences (*Eta*^{2})**
	M	*SD*	*M*	*SD*	*M*	*SD*	
I am a good student	4.0	0.74	4.0	0.68	3.9	0.87	None (.00)
I am good at my school-work	3.9	0.79	3.9	0.74	4.1	0.80	None (.01)
I like challenging problems	3.5	0.75	3.4	0.94	3.3	1.3	None (.01)
I take time to figure out schoolwork	3.6	0.83	3.6	0.86	3.9	0.90	None (.01)
I go back over work I don't understand	3.5	0.92	3.6	0.78	3.5	0.51	None (.00)
I can do almost any problem if I keep working at it	3.9	0.93	3.9	0.88	4.1	0.76	None (.01)
I usually get my homework done on time	3.7	0.94	3.6	0.91	3.9	1.0	None (.01)
I like math	3.4	1.2	3.5	1.1	3.8	0.86	None (.01)

Note. Scores range from 1 (*disagree strongly*) to 5 (*agree strongly*).

enrolled. This difference in distribution of math coursework across ethnic or language groups at the 11th- and 12th-grade levels was statistically significant ($\chi^2 = 16.9$, $p < .05$).

Attitudes Toward Mathematics

Over half of all students say they "like mathematics" ($M = 3.5$), though the score lies between neutral and agreement. As Table 3 indicates, there were no ethnic or language group differences for this item. Student attitudes were not associated with the math course in which they were enrolled: Half of students in Geometry and Algebra 2, 57% of students in Algebra, and 67% of students in Trigonometry or Calculus agreed that they like math.



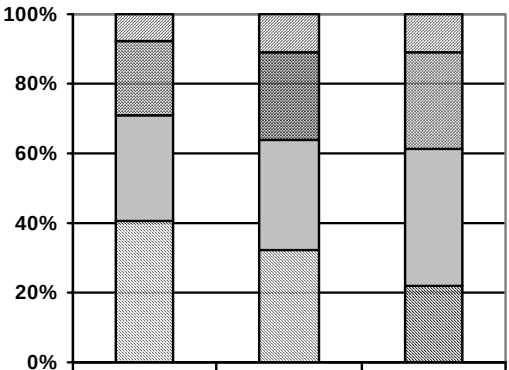
	Hisp-S	Hisp-E	Euro	Hisp-S	Hisp-E	Euro
Trigonometry/ calculus	0	0	0	28	0	50
Algebra 2	30	30	63	31	36	33
Geometry	27	30	0	33	18	0
Algebra	36	30	38	6	36	0
Basic	6	10	0	3	9	17

Figure 2. Coursework in mathematics.

Achievement in Math and Science

As mentioned previously, the Hispanic students scored low to below grade level in mathematics tests taken in English when they were in second grade. By the time they were in sixth grade, the follow-up students for whom the data are available (n = 46) scored slightly above to well above grade level on a norm-referenced standardized test of mathematics in English (Hisp-S: NCE = 59; Hisp-E: NCE = 60; Euro: NCE = 70). By ninth grade, as a group, the follow-up students for whom data are available (n = 19) were scoring in the average range (NCE = 47). Hispanics, both English and Spanish speakers, achieved an average NCE of 47, though the NCE for all Hispanics, both native English and Spanish speakers, in the state was only 40.

Figure 3 presents students' self-reported grades in math and science. As Figure 3 indicates, 29% of Hisp-S, 36% of Hisp-E, and 39% of Euro students received A's or A's and B's; 31% of Hisp-S, 32% of Hisp-E, and 39% of Euro earned B's and C's; and, 41% of Hisp-S, 32% of Hisp-E, and 22% of Euro obtained B's, C's, and D's. Although Hispanic students tended to receive more B's, C's, and D's than Euro students, there was no statistically significant difference in the distribution of grades across the three ethnic or language groups (χ^2 = 3.7).



	Hisp-S	Hisp-E	Euro
Mostly As	8	11	11
A & B	21	25	28
B & C	31	32	39
B & C & D	41	32	22

Figure 3. Grades in mathematics and science.

Discussion

The results presented in this study suggest that students who participated in the two-way bilingual program have positive attitudes toward math and school in general. Although the number of students for whom achievement data were available was very limited, it appears that these students scored average on standardized tests of mathematics by the end of elementary school and they continued to receive about average to above average grades in mathematics (A's, B's, and C's) in high school. The attitudes toward math of Hisp-S students are fairly positive and not significantly different from those of Hisp-E and Euro students. In addition, these students were enrolled in higher level math courses. While there were more Euro students enrolled in higher level math (Trigonometry or Calculus) than Hispanic students, the preponderance of Hispanic students, both English and Spanish speakers, were enrolled in Algebra 2, Geometry, or Algebra 1—all college preparatory classes.

To summarize, the Hispanic students participating in this study, particularly the potentially at-risk previous English language learners, appear to be more successful than the average Hispanic students depicted in the literature (Presidential Advisory Commission on Educational Excellence for Hispanic Americans, 2003), despite their very low-socioeconomic level and parental education level. Furthermore, although not enough of these students are receiving the A and B grades they need to get into the better universities, there are some previous English language learners who are earning these

grades, and most Hispanic students are taking higher level college preparation math courses and they report getting mostly average grades (B's and C's) in those courses. Even though in the absence of a control group no causal relationship can be inferred, the results presented here suggest that the two-way bilingual program may provide the academic preparation and schooling attitudes that enable these students to be more successful than the average at-risk Hispanic and low-socioeconomic students described in the literature. These Hispanic students in this sample can potentially be groomed for future careers in science, math, engineering, and technology.

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