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Compounding Inequalities: English Proficiency and Tracking and Their Relation to Mathematics Performance Among Latina/o Secondary School Youth

Eduardo Mosqueda
University of California, Santa Cruz

In this article, the author examines whether disparities in mathematics performance might be exacerbated by the track placement of native and non-native Latina/o English speakers in the Education Longitudinal Study of 2002. The effect of track placement on the mathematics performance of English Learners (EL) differed as a function of their level of English proficiency. The scores of Latinas/os with low levels of English proficiency in the general track were similar to the scores of students in the college track with comparable levels of English proficiency. The scores of non-native English speakers in the college track with high levels of English proficiency, however, were higher than those of their peers in the general track and nearly as high as those of native English speakers in the college track. Implications for the potential development of the mathematics language register of ELs are discussed.

KEYWORDS: English language learners, English learners' mathematics achievement, urban mathematics education, urban schools

After the passage of the *Immigration Act of 1965*, which eliminated quotas for immigrants entering the United States from foreign countries, a surge in immigration contributed to a pronounced increase in the number of students who were not proficient English speakers in U.S. public schools. The U.S.-born children of these immigrants number an additional 30 million. More than half of these immigrant and U.S.-born children are of Latin American descent (U.S. Census Bureau, 2000). Consequently, during the 2001–2002 school year, about 1 in 10 U.S. public school students was not proficient in English and was designated Limited English Proficient (LEP).[1] It is this student population that is the primary fo-

[1] The term *English Learner* (EL) is used interchangeably with the term *non-English proficient*. Both terms are used in place of the federal designation of *Limited English Proficient* (LEP) (unless citing from another source) because EL more appropriately represents students in the process of developing English proficiency as a second language rather than as having linguistic deficits or limitations.

EDUARDO MOSQUEDA is an assistant professor in the Department of Education at the University of California, Santa Cruz, 1156 High Street, Santa Cruz, CA, 95064; email: mosqueda@ucsc.edu. His research interests include the mathematics education of English language learners and equity in mathematics education.

cus of this article—non-native English-speaking Latinas/os, particularly those with low-levels of English Language proficiency (i.e., English Learners, whom I refer to as ELs).

Among Latinas/os, the majority of immigrants and, to some extent, the children of immigrants are typically non-native English speakers. Non-native English speakers are confronted with unique challenges in school related to their level of English proficiency. Unfortunately, research specifically documenting the academic and linguistic needs of ELs is limited, with the majority focusing on English language literacy in the elementary grades. Little research focuses on the achievement of ELs in content area courses, particularly in the area of mathematics and at the secondary school level (August & Hakuta, 1997; Meltzer & Hamann, 2004). A focus on secondary school mathematics is important, particularly for Latina/o ELs, because it is one of the strongest indicators of high school graduation and college matriculation. Research has shown that high school students who complete advanced mathematics courses (i.e., algebra 2, trigonometry, pre-calculus, or calculus) are more likely to graduate from high school and are twice as likely to attend college compared to students who are enrolled in low-level mathematics courses (Adelman, 1999, 2006).

The purpose of this study is to explore whether disparities in the mathematics performance between Latina/o[2] native and non-native English speakers might be exacerbated by their academic track placement. More specifically, I examine whether placement in a general or college preparatory track might have a differential effect on mathematics performance and, in turn, whether this relates to the level of English proficiency of non-native English speakers (compared to native English speakers). A distinguishing feature of this study is the focus on Latina/o ELs and whether the effect of track placement on their mathematics performance differed as a function of their level of English proficiency. This study expands on research that has quantitatively examined the relationship between English proficiency and academic tracking using school district level data (cf. Callahan, 2005; Wang & Goldschmidt, 1999), and analyzes this relation using a nationally representative subsample of tenth-grade Latina/o students in the Education Longitudinal Study of 2002 (ELS: 2002).

Here, I focus exclusively on Latina/o students because they make up the largest language minority group in the United States and because of the enduring underperformance in mathematics of too many Latinas/os students. Latinas/os comprise nearly 80% of the EL population in the United States (Kindler, 2002). Among Latinas/os, ELs not only perform poorly on standardized tests in mathe-

[2] Throughout this article, when reporting aggregated data on specific racial, cultural, and/or ethnic groups (e.g., Latina/o, non-native English speakers, English learners, etc.), I acknowledge the significant *within* group variation embedded (and made invisible) in such data, specifically in regards to academic achievement/performance.

matics compared to their English-speaking peers (Abedi, 2004; Abedi & Lord, 2000) but also they are the lowest achieving group on the National Assessment of Educational Progress (NAEP) among all racial and ethnic groups (U.S. Department of Education, 2004). In addition, Latina/o students, and ELs in particular, are no longer concentrated in a handful of the states with high proportions of Latina/o immigrants (i.e., California, Florida, Illinois, New York, and Texas). Current trends show that Latinas/os are rapidly expanding to new destinations in the United States such as Midwestern and Southern states where there is often a limited understanding of how to best meet the academic needs of the recent school-aged Latina/o population (Ruiz-de-Velasco & Fix, 2000). Therefore, the low performance of Latinas/os in mathematics (as measured by aggregate standardized test scores), especially among ELs, should be a national concern.

Too many Latina/o students, including those who are English proficient and non-English proficient, repeatedly underachieve in U.S. public schools. The test scores (as an aggregate) for Latinas/os are often described as pervasively, disproportionately, and persistently low over time relative to similar outcomes for Whites (Valencia, 2002). A performance disparity on the NAEP appears as early as the 4th grade and persists through high school for Latina/o students (again, as an aggregate) (Smith, 1995). While scores for Latinas/os collectively have increased over the last 15 to 20 years, the differences in mathematics achievement between Latinas/os and Whites have remained steady over the same time (Smith, 1995). In a recent meta-analysis, Latina/o performance demonstrated increases but so too did the performance of the other comparison racial and ethnic groups, with Latina/o gains lagging those of their comparison peers (Capraro, Capraro, Yetkiner, Rangel-Chavez, & Lewis, 2009).

The low achievement of many Latinas/os at the secondary school level, however, is more profound than what mere aggregate mathematics standardized test scores imply because disproportionate numbers of Latina/o students are denied access to rigorous content (Capraro, Young, Lewis, Yetkiner, & Woods, 2009). A study by Ortiz-Franco (1999) revealed that Latinas/os made only small gains in their *basic* mathematics skills between 1970 and 1990, while their performance in mathematical problem solving requiring *high-level*, problem-solving skills did not improve over the same period. Scholars agreed that the lack of improvement in the application of complex mathematics concepts is a cause for concern and merits continued and persistent investigation (Gutiérrez, 2002, 2007; Khisty, 1995; Moschkovich, 1999; Secada, 1992, 1996; Tate, 1997). Presently, over 43% of all teachers in U.S. public schools have at least one EL student in their classrooms (Zehler, Fleishman, Hopstock, Pendzick, & Stephenson, 2003). Yet, few of these teachers are adequately prepared to educate ELs. A national survey showed that teachers with at least three ELs in their classroom had received, on average, a mere 4.0 hours of LEP inservice training within the last 5 years (Zehler et al., 2003). Unless effective research-based strategies are developed to meet their linguistic needs, ELs are likely to continue to underachieve academically at disproportionate rates nationally.

The rapid growth of Latinas/os and the dearth of research on how to best meet their academic and linguistic needs contributes to the widespread application of misguided beliefs about the role of language in instruction of ELs, which, in turn, negatively affects their achievement (Flores, 1997; Khisty, 1995; Secada, 1992). There is a long-standing myth in mathematics education that English proficiency is not an issue because mathematics is a "universal language." As a result, many educators believe that students' English proficiency has a minimal effect on their mathematics learning (Mather & Chiodo, 1994). However, longstanding empirical research that documents the relationship between English language skills and mathematics achievement refutes this myth (Cuevas, 1984; Cocking & Mestre, 1988; De Avila, 1988). This body of research has found strong positive correlations between the English proficiency of ELs and their mathematics achievement on standardized tests. This correlation suggests that the failure to meet the linguistic and academic needs of ELs in mathematics classrooms can hamper their potential to further develop their mathematics language register.

English Proficiency and Developing a Mathematics Language Register

Research shows that English proficiency plays an important role in learning mathematics, specifically because of the complexity of rigorous secondary school mathematics content (August & Hakuta, 1997; Cuevas, 1984; Khisty, 1995) and the differences between the language used in mathematics courses and everyday language. In these advanced mathematics courses, both the language of instruction and the content are highly abstract and complex. Therefore, students' English proficiency must be considered in order to ensure that ELs are provided with opportunities to learn[3] (and comprehend) the complex mathematical concepts that mathematics teachers present (Garrison & Mora, 1999). For instance, research suggests that ELs need an "advanced level of control" of English to convert word problems into mathematical sentences and perform operations within abstract settings (Wong-Fillmore & Valdez, 1986, p. 663). The inability to comprehend instruction in their non-dominant language can create confusion and stifle an ELs' ability to learn mathematics content (Barnette-Clark & Ramirez, 2004).

[3] According to Croom (1997), *opportunities to learn* involve the equitable treatment of students from diverse racial and ethnic groups and female students in general. All students must be afforded equal access to learn high-level mathematics concepts as their upper- and middle-class White and/or Asian male counterparts. Moreover, classrooms should be non-threatening and supportive places that encourage all students to explore, conjecture, reason, and make decisions.

Considerable research demonstrates that mathematics alone is a language that is more complex than everyday English (Cuevas, 1984; Garrison & Mora, 1999; Gutiérrez, 2002; Khisty, 1995, 1997). The language of mathematics is described as a "register" of words, expressions, and meanings that differ from those of everyday language (Secada, 1992; Cuevas, 1984; Mestre, 1988). For example, the language of mathematics has specialized meanings for words and phrases such as "horizontal,""vertical,""subtract,""difference,""equivalence," and "inverse," to name a few, that differ from the everyday conversational and academic meanings that ELs are learning in their English-language arts courses (Ron, 1999).

Given the important differences between the language of mathematics and the everyday (English) language, non-native English speakers with low levels of proficiency face the added difficulty of becoming proficient in English while they also develop proficiency in the language of mathematics. Therefore, simply becoming proficient in English is not sufficient for students to become successful in mathematics. Cummins (1986) argues that, as students develop proficiency in English, it is necessary to distinguish between the language used in informal, everyday situations and the language necessary for communication in academic situations. His work suggests that the existence of a minimal threshold level of proficiency in English students must reach—a level of *cognitive academic language proficiency* (CALP)—to function effectively on academic tasks that are cognitively demanding (Cummins, 1986). Similarly, other recent research expands on the importance of students developing proficiency in *academic English* in order to experience success in content courses with English-only instruction (Meltzer & Hamann, 2004; Valdés, 2001).

Expanding Cummins' (1986) notion of academic language proficiency even further, mathematics education researchers argue that, to be successful in advanced secondary school mathematics courses, non-English proficient students must reach a "technical threshold" of English proficiency that is beyond the CALP threshold (Burns, Gerance, Mestre & Robinson, 1983). Dawe (1984) terms this *cognitive academic mathematics proficiency* (CAMP), which consists of cognitive knowledge (mathematics concepts and how they are applied) that is embedded in a language specifically structured to express that knowledge (as cited in Spanos, Rhodes, Corasanti Dale, & Crandall, 1988). In other words, CAMP is a level of proficiency that demands a high-level of competence in both English and in the language of mathematics. Other research supports this conclusion, but also adds that ELs require considerable proficiency in both their first and second language—Spanish and English—if they are to cope with the linguistic and cognitive demands of learning advanced mathematics (Cuevas, 1984).

Other Factors Influencing Mathematics Achievement

While English proficiency is important, it is but one factor that contributes to decreased academic attainment for many non-native English speakers. Institutional factors, such as tracking, play an important role in structuring the academic success and failure of Latinas/os in general, and Latina/o ELs in particular (Conchas, 2001, 2006; Gándara, 1995, 1997; Lucas, Henze, & Donato, 1990; Mehan, Villanueva, Hubbard, & Lintz, 1996; Olsen, 1995). Recent research focuses on mathematics tracking of Latinas/os, particularly those who are not proficient English speakers. A growing body of research analyzes the (unjust) practice of placing ELs in low-track classes and consistently finds low-track placements negatively affect students' achievement in mathematics (Callahan, 2005; Katz, 1999; Wang & Goldschmidt, 1999). Language proficiency interacts with other factors creating a compounding effect that further diminishes achievement. Research on Latina/o ELs suggests that English proficiency significantly factors into decisions about Latina/o ELs mathematics placement (Callahan, 2005; Gándara, 1999; Harklau, 1994a, 1994b; Lucas, 1997; Walqui, 2000). In their research on schools with large numbers of Latinas/os in the Southwest, for instance, Donato, Menchaca, and Valencia (1991) found that track assignments were strongly influenced by students' level of English-language proficiency, and resulted in remedial or vocational track placements. Furthermore, the placement of all ELs, including Latina/o ELs, in low-track classes is often justified by the assumption that these classes are not as difficult linguistically, compared to higher-level courses (Harklau, 1994b; Katz, 1999).

The research on tracking has illuminated differential opportunities to learn for Latina/o students, as a result of differences in access to challenging curriculum, low student expectations, and well prepared teachers resulting from low or high-track placements (Oakes, 1985). Such inequities are found to disadvantage students in the low track and advantage students in the high track.

The placement of Latina/o ELs in lower-track classes raises important questions about the rigor of the curriculum to which they are exposed, given the research that has found that low-level track curriculum is cognitively undemanding and focuses on memorization and repetition (Heubert & Hauser, 1999; Oakes, 1985; Oakes, Gamoran, & Page, 1992). For instance, research found that students placed in low-tracks worked at a low cognitive level on tasks that are profoundly disconnected from the skills they need to learn because instruction is often geared predominantly toward multiple-choice tests (Darling-Hammond, 1991).

In contrast, the literature on tracking documents several educational advantages for students placed in high-track courses. Oakes (1985), for example, found that a primary advantage for students in high-track courses is the curricular emphasis on high-status knowledge (i.e., the knowledge required for students to take more advanced mathematics courses and attend college). Additionally, high-track courses emphasize higher-order cognitive tasks and focus on more open-ended types of discussions that lead to richer learning opportunities (Gamoran, 1987). Moreover, high academic tracks (most often) offer more highly qualified and better-prepared teachers (Oakes, 1985).

Finally, research on tracking has shown that once students are sorted into groups—those who receive high-quality education and those who receive inferior curriculum and teaching—that students often become "locked in" to these arrangements (Heubert & Hauser, 1999; Murphy & Hallinger, 1989; Oakes, Ormseth, Robert, & Camp, 1990; Oakes et al., 1992). Thus, Latinas/os placed in remedial mathematics courses that produce lower and slower rates of learning (Oakes et al., 1992) have a lower probability of receiving better track assignments in the future (Heubert & Hauser, 1999). The long-term effects of permanent placement in low-track courses are linked to lower academic achievement and higher dropout rates for Latina/o ELs (Medina, 1988; Rumberger & Larson, 1998; Romo & Falvo, 1996). Nonetheless, even acquiring a higher level of English fluency is rarely a guarantee for promotion into high-track courses (Olsen, 1997). A study of high school students in low-track courses found that after students became proficient in English they were only promoted horizontally in the tracking system (Valenzuela, 1999). Therefore, students with high levels of English proficiency are removed from the low-track English as a Second Language (ESL) classes and reassigned to the English-only, low-level track courses.

The use of English proficiency as a prerequisite for enrollment in rigorous mathematics courses is a source of unjust inequity for Latina/o ELs. Such practices are questionable because placement decisions are often made without an accurate assessment of a student's level of English proficiency (Duran, 2008; Martiniello, 2008; Solano-Flores, 2008; Valdés, 1998), mathematics background (Dentler & Hafner, 1997; Gándara, Rumberger, Maxwell-Jolly, & Callahan, 2003) or prior educational background in their native country (Ruiz-de-Velasco & Fix, 2000; Lucas, 1997). These practices continue to have negative long-term effects on the learning and subsequent performance of ELs because they delay the entry of ELs into those courses until they reach an "academic" level of English proficiency. Given that academic proficiency may take anywhere from 3 to 7 years to develop (Cummins, 1986; Ovando & Collier, 1998), by the time ELs develop a level of English proficiency deemed "appropriate" to handle the linguistic complexity of high-level secondary school mathematics content, it may be too late for them to take and to meet the mathematics requisites for graduation and college attendance.

As stated previously, in this study I build on other studies that have analyzed *whether* tracking impacts achievement and examine *how* track placement and English proficiency relates to mathematics achievement for Latina/o native and non-native English speakers at a national level. This investigation intends to characterize the breadth and scope of the challenges faced by Latina/o ELs in mathematics to highlight the urgent need for improvements that can assist in redressing disparities in ELs educational outcomes and, most important, ELs' opportunities to learn. This research is guided by the two research questions:

1. Why do native and non-native English speaking Latina/os who are placed in the general (low) academic track have lower mathematics achievement than their Latina/o peers in the college preparatory track?

2. How does the relation between academic tracking and mathematics achievement differ for native English speakers and non-native English speaking Latinas/os with high and low levels of English proficiency?

Methods

The data from the first wave of the Educational Longitudinal Study (ELS) of 2002 (ELS: 2002), a large nationally representative dataset provided by the National Center for Education Statistics (NCES) are used. The base year of the ELS: 2002 represents the first stage of a longitudinal study that will ultimately provide policy-relevant trend data about critical transitions experienced by a national probability sample of students as they proceed through high school and into college or their careers (Ingels, Pratt, Rogers, Siegel, & Stutts, 2004). The first wave, from which the subsample for this article is drawn, contains a sample of students in the 10th grade in 2002 and includes 15,362 students from a random sample of 752 public, Catholic, and other private schools. The dataset contains assessments of students in reading and mathematics performance in addition to measures of important student, family, teacher, classroom, and school characteristics. It also contains information on students' immigrant status, language proficiency, and track placement.

The analysis is based on the subsample of 2,234 first-generation Latina/o immigrants and U.S.-born second- and third-generation Latinas/os present in the ELS: 2002 dataset. Statistical power analyses (Light, Singer, & Willett, 1990) suggest that this sample size provides high power (.90) to detect small effects at typical social science levels of statistical significance.

Variables in the Models

Question Predictors. Non-native ($NONNATIV_{ij}$) is coded as 1 = non-native English speaker, 0 = native English speaking Latina/o. About 50.5% of the Latina/o students in this sample reported being non-native English speakers. In order to differentiate among the level of English proficiency of non-native English speakers, the cross-product $NONNATIV_{ij}*ENGPROF_{ij}$ is used. NONNA-

TIV_{ij} is described above. $ENGPROF_{ij}$ is a composite that ranges from 3 to 8 (low to high), based on each student's self-reported level of English proficiency.[4, 5] This weighted composite score is comprised of students' responses to four ordinal dimensions of self-reported English proficiency that includes how well students: "understand spoken English,""speak English,""read English," and "write English." For each of these dimensions of English proficiency, students provide one of the following four ordinal responses: "Very Well,""Well,""Not Well," or "Not at all." The inclusion of this interaction in a hypothesized regression model allows for the comparison between non-native English speakers with varying levels of English proficiency and their native English-speaking peers. Finally, the variable $GENTRACK_{ij}$ is a dichotomous predictor that indicates whether a student is placed in the general/vocational academic track or in the college preparatory track (1 = general/vocational track, 0 = college preparatory track). Approximately 52.6% of the students reported general track placement, and the remaining 47.4% reported being placed in the academic track.

Outcome Variable. Mathematics achievement ($MTHACH_{ij}$) represents an Item Response Theory (IRT) scaled mathematics achievement score (Ingels et al., 2004) variable for each student *i* in school *j*. The ELS: 2002 assessment itself contains items in arithmetic, algebra, geometry, data/probability, and advanced topics (Ingels et al., 2004). These scores are standardized to a mean of 50 and a standard deviation of 10 in the complete ELS: 2002 sample (Ingels et al., 2004). The test score for the subsample of Latinas/os is 45.7, with a standard deviation of 9.6 points on the ELS: 2002 assessment. IRT scores are used because they simplify the interpretation of the impact of predictors on the outcome. A one-point difference associated with the outcome variable equals one item correct on the ELS: 2002 assessment. See Table 1 for a more detailed description of all of the variables included in analysis.

Control Predictors. The analyses include a series of control predictors to account for individual background and school context variation that might impact the outcomes, and to assess the potential impact of selectivity bias. These controls include individual level gender, SES, parental education, and each immigrant student's prior level of education in their native country. Also included are controls for the instructional conditions of the classroom that pertain to the mathematics

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[4] English proficiency level of Latinas/os in the ELS: 2002 dataset was not assessed by a specialized instrument and instead was based on a self-reported measure. A limitation of such measures is that they suffer from self-report bias due to students over or under reporting their perceived level of English proficiency based on their own social and linguistic context. However, the English proficiency of all non-native English speakers in the sample was on the same "metric." While not ideal, this approach is one of a limited number of options available for nationally representative samples.

[5] Widely cited large-scale sociological studies of immigrants using similar types of datasets have used these same self-reported English proficiency measures and find that they are relatively reliable measures (Portes & Rumbaut, 2001).

teacher's professional preparation—whether a student's mathematics teacher had a mathematics degree and whether the teacher is certified. At level 2, are a set controls for selected aggregate measures of the school context such as the percentage of students that are placed in the general track, the percentage of all EL students, and the percentage of poor students within each school (the number of students within each school that qualify for free or reduced-priced lunch is used as a proxy for poverty). See Table 2 for a description of the definitions and coding of each variable in analysis.

Table 1
Descriptive Statistics of All Variables

Variable	Description	*n*	mean	s.d.	min.	max.
STUDENT BACKGROUND						
SES	Standardized SES composite	2222	8.12	2.50	1	13
FEMALE	Sex (0 = male and 1 = female)	2222	0.50	0.50	0	1
NON-NATIVE	Non-native English speaker (0 = native English speaker)	2222	0.51	0.50	0	1
IMMIGRATION STATUS						
FIRSTGEN	First generation immigrant	2222	0.15	0.42	0	1
SECGEN	Second generation immigrant	2222	0.25	0.43	0	1
THIRDGEN	Third generation immigrant	2222	0.60	0.48	0	1
TEACHER PREPARATION						
MTHMAJOR	Teacher has degree in mathematics and/or related field	2222	0.51	0.50	0	1
MTHCERT	Teacher is certified in mathematics	2222	0.76	0.43	0	1
SCHOOL CONTEXT MEASURES						
PCTLEP	Percent of 10th graders that are LEP students in the high school	524	0.78	0.81	0	4
PCTLUNCH	Percent of 10th grade students that qualify for free lunch	524	3.42	1.96	1	7
PUBLIC	School control (1= public high and 0 = Catholic or other private)	524	92.35	17.31	0	1
ENGLISH PROFICIENCY						
ENGPROF	Level of English proficiency	2222	6.90	1.22	3	8
TRACK LEVEL PLACEMENT						
GENTRACK	General track placement	2222	0.53	0.50	0	1

Table 2
Data and Coding of All Variables

Variable	Definition	Notes/Coding
STUDENT BACKGROUND		
SES	Standardized composite measure: family income, parent education, and occupational status	Range: -1.98–1.79
FEMALE	Students gender	1 = female, 0 = male
NONNATIV	Indicates whether the student is a non-native English speaker or a native English speaker	1 = non-native; 0 = native
IMMIGRATION STATUS		
FIRSTGEN	Indicates whether both the student and parent are foreign-born	1 = yes; 0 = no
SECGEN	Indicates whether the student is U.S.-born while at least one parent is foreign-born	1 = yes; 0 = no
THIRDGEN	Indicates whether both the student and parents are U.S.-born	1 = yes; 0 = no
TEACHER PREPARATION		
MTHMAJOR	Indicates whether student's mathematics teacher has a Bachelor's degree in mathematics and/or related field	1 = yes; 0 = no
MTHCERT	Indicates whether student's mathematics teacher is certified	1 = yes; 0 = no
SCHOOL CONTEXT MEASURES		
PCTLUNCH	Proxy for school SES measured by the percentage of 10th-grade students eligible for free or reduced lunch	1 = 0–5%; 2 = 6–10% 3 = 11–20%; 4 = 21–30% 5 = 31–50%; 6 = 51–75% 7 = 76–100%
PCTLEP	Percentage of 10th-grade LEP students enrolled	0 = None; 1= 1–10% 2 = 11–25%; 3 = 25–50% 4 = 51% or more
PUBLIC	Indicates whether the school is public or Catholic/other private	1= public 0= Catholic/private
ENGLISH PROFICIENCY		
ENGPROF	Weighted composite of self-reported level of English proficiency: ability to understand, speak, read, and write English	Range: 3–8
TRACK LEVEL PLACEMENT		
GENTRACK	Academic track placement of each respondent	1 = General/vocational 0 = College

Missing Data and Sample Weights

Multiple imputation is used to account for the common problem of missing data on surveys (Rubin, 1987). The multiple imputation procedure (PROC MI) in the SAS statistical software package uses information from the sample distributions of the variables themselves to replace missing values with randomly generated but contextually appropriate values. Using multiple imputation, five subsidiary datasets are generated, each with different randomly imputed values for the individual level. The hypothesized regression models are then fitted separately in each of the imputed datasets, and the results are averaged and corrected for the inclusion of the random variation in each of the imputed datasets. Because the imputed datasets have no missing values except for the dependent variable (which was not imputed), sample size is preserved. This process provides the best estimates given the stability of other factors for the true effect of the given variables. The ELS: 2002 student-level panel weights and school weights were applied to the analysis according to the guidelines provided for the Hierarchical Linear Models (HLM) software (Raudenbush & Bryk, 2002).

Data Analysis

Using HLM, the following four fitted multilevel models were evaluated in which the mathematics achievement of Latina/o students is modeled as a function of the control and question predictors. Multi-level modeling is well suited for this analysis as it can account for the clustering of students within schools. The first fitted model (M1) was the null or unconditional model that contained no predictors, and estimated the average mathematics achievement for the subsample of Latina/o 10th graders in the ELS: 2002 dataset. The second fitted model (M2) was the baseline control model, and included all the individual-level and school-level control predictors. The third model (M3) added the first of the key question predictors and presented the main effect of both English proficiency and track placement on mathematics achievement. The fourth fitted model (M4) examined the interaction effects between English proficiency and academic track placement.

To address the research questions, HLM was used to examine the main effects of how English proficiency and tracking might relate to the mathematics performance of Latina/o native and non-native English speakers with varying levels of English proficiency. The fitted multilevel regression model corresponding to the first research question was:

$$\mathrm{MTHSCORE}_{ij} = \beta_0 + \beta_1\mathrm{NONNATIV}_{ij} + \beta_2(\mathrm{NONNATIV}_{ij}*\mathrm{ENGPROF}_{ij}) + \beta_3\mathrm{GENTRACK}_{ij} + \gamma_1 Z_{ij}{}^{6} + \gamma_2 Z_j{}^{7} + (\varepsilon_{ij} + u_j)$$

[6] γ_1 is a parameter vector describing the impact of the individual-level controls Z_{ij}
[7] γ_2 is a parameter vector describing the impact of the school-level controls Z_j

To address the second research question, the main effects and statistical interactions between the English proficiency and tracking predictors were added to the multilevel model in the previous equation, as follows:

$$\begin{aligned}MTHSCORE_{ij} = {} & \beta_0 + \beta_1 NONNATIV_{ij} + \beta_2(NONNATIV_{ij}*ENGPROF_{ij}) + \\ & \beta_3 GENTRACK_j + \beta_4(GENTRACK_{ij} * NONNATIV_{ij}) + \\ & \beta_5(GENTRACK_{ij} * NONNATIV_{ij}*ENGPROF_{ij}) + \\ & \gamma_1 Z_{ij}^{4} + \gamma_2 Z_j^{5} + (\varepsilon_{ij} + u_j)\end{aligned}$$

Findings

The findings are reported for models 3 and 4 because they correspond to the research questions guiding this inquiry.

Model 3: English Proficiency and Tracking

Model 3 (see Table 3) addresses the first research question, which evaluated the main effect of native or non-native English status (NONNATIV), a student's level of English proficiency (ENGPROF), along with the academic track placement on the mathematics performance on the ELS: 2002 assessment. The parameter estimates indicate that Latina/o native English speakers, on average, scored higher than most non-native English speakers, and students in the college preparatory track scored higher than Latinas/os in the general track with some exceptions.

The results show that the aggregate test scores of Latina/o non-native English speakers with low levels of English proficiency, the Latina/o ELs, were lower than the aggregate test scores of non-native English speaking Latinas/os with higher levels of English proficiency.[8] Thus there was a positive relationship between mathematics achievement and English proficiency ($\beta = 1.14$, $p < .01$). More specifically, a one unit positive difference in the level of English proficiency of non-native English speakers is associated with a 1.14 positive difference in their aggregate mathematics score on the ELS: 2002 standardized test, all other predictors being equal. This difference in performance is equal to one-tenth of a standard deviation for every unit difference in English proficiency. Additionally, the results from model 3 show that placement in the general track had a negative effect on mathematics achievement. On average, general track placement is associated with a 2-point lower difference (or about one-fifth of a standard deviation) in aggregate mathematics test scores for both Latina/o native and non-native English speakers, compared to their peers in the college preparatory track.

[8] In the previous section, I described predictor ENGPROF as a cross product of non-native status and English proficiency (NONNATIV*ENGPROF).

Table 3
Final Estimated Hierarchical Linear Models

	Model 1	**Model 2**	**Model 3**	**Model 4**
FIXED EFFECTS	Coef. (*SE*)	Coef. (*SE*)	Coef. (*SE*)	Coef. (*SE*)
Intercept	45.46***	44.28***	44.31***	45.46***
	(0.46)	(0.73)	(0.74)	(0.77)
STUDENT BACKGROUND				
Socioeconomic status		2.89***	2.72***	2.72***
		(0.66)	(0.66)	(0.72)
Female (male omitted)		-0.26	-0.51	-0.49
		(0.59)	(0.59)	(0.57)
Non-native speaker		-2.05*	-9.94***	-14.19***
		(0.95)	(2.06)	(2.86)
IMMIGRATION STATUS				
First generation		0.33		
		(0.95)		
Second generation		2.84**	2.28**	2.28**
		(1.00)	(0.81)	(0.80)
TEACHER PREPARATION				
Mathematics and/or related		2.07**	1.94**	1.97*
		(0.66)	(0.71)	(0.72)
Certified		0.94	0.94	0.75
		(0.87)	(0.95)	(0.90)
SCHOOL CONTEXT MEASURES				
10th-grade % free lunch		-1.07***	-1.07***	-0.95***
		(0.27)	(0.27)	(0.26)
10th-grade % LEP		-0.88	-0.89	-0.54
		(0.54)	(0.54)	(0.48)
Public school		-1.11	-1.13	-1.25
(Catholic/other private omitted)		(1.82)	(1.83)	(1.62)
ENGLISH PROFICIENCY				
Level of proficiency			1.14**	1.62***
			(0.39)	(0.42)
TRACK LEVEL PLACEMENT				
General/vocational			-2.07**	-2.61**
			(.64)	(.93)
INTERACTIONS				
Non-native X Gen/voc				5.67**
				(2.05)

Non-native X Proficiency X Gen/voc				-.64** (0.21)
RANDOM EFFECTS				
Within schools (τ00)	18.30	11.19	11.97	11.19
Between schools (σ2)	66.20	62.01	60.20	59.90
Chi-square	1165.74***	995.34***	1028.03***	1004.99***

Note. [1]Variance component indicating whether there are differences between schools.[2] Indicates the amount of residual (unexplained) variance within schools.
* p< .05; ** p < .01; *** p<.001

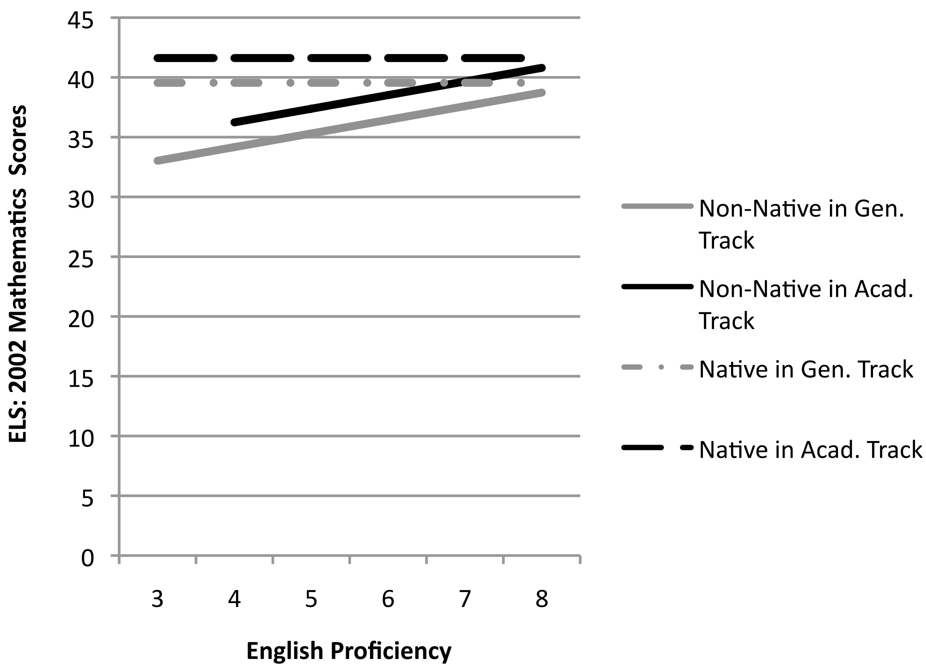

Figure 1. Main effects plot of mathematics performance on the ELS: 2002 assessment by English proficiency and tracking

Because the interrelationships of the variables were complex, they are illustrated graphically on the fitted plot in Figure 1 for students with a teacher who was both certified to teach and had a degree in a mathematics or related field, and with all other control predictors set to their mean in the Latina/o subsample. It is important to note that, because there was no measured variation in the English proficiency of *native* English speakers, in Figure 1 the horizontal line in the figure represents their mean mathematics achievement. Thus the horizontal fitted (dashed) line serves only as a reference for comparison with the mathematics achievement of non-native English speakers at their reported level of English proficiency.

Figure 1 shows that the main effect of academic tracking was similar for non-native English speakers at each level of English proficiency. It is also critical to note in Figure 1 that non-native English speakers at the lowest level of English proficiency (ENGPROF = 3) were not represented in the college preparatory track, instead the lowest level of English proficiency of students in the college preparatory track was four (ENGPROF = 4). Figure 1 illustrates another important relationship between native and non-native English speakers in the college and general track. Non-native English speakers at the *highest* level of English proficiency (ENGPROF = 8) performed at levels that were nearly equal to the students with the highest test scores in this study—Latina/o native English speakers.

These findings suggest that the relationship between English proficiency and academic achievement is compounded by low track placement. Within each academic track, the scores of non-native English speakers at the lowest level of English proficiency were over 6.5 points lower (or 0.66 of a standard deviation) below the scores of native English speakers. Additionally, the difference in test scores between native English speakers in the college preparatory track and non-native speakers in the general track with a low level of English proficiency were 8 points or 0.8 of a standard deviation lower than native English speakers.

Model 4: English Proficiency, Tracking, and their Interaction

To address the second research question, multilevel model 4 was fitted (see Table 3) to examine the statistical interactions between the track placement predictor (GENTRACK) and the English Proficiency level of non-native English speakers (NONNATIV and ENGPROF) relative to native English speakers. The analysis revealed statistically significant interactions between both general track placement and non-native English speaker status, and general track placement and English proficiency level. This interaction suggests that the impact of academic tracking on the mathematics test scores of Latinas/os *differed* as a function of the level of English proficiency of non-native English speaking Latinas/os. Given the nature of interaction terms, one cannot interpret these coefficients alone. Rather, they must be interpreted in conjunction with the main effects of the general track placement, non-native English speaking status, and the English proficiency predictors.

The results from Model 4 also suggest that English proficiency was more important for non-native English speakers in the college preparatory track than for their peers in the general track. The differences in the English proficiency coefficient predicting the mathematics achievement scores between non-native English speakers in the college track (β=1.62, p<.01) compared to those in the general track (β=0.98, p<.001) illustrate this important point (controlling for SES, gender, immigration status, teacher preparation, and the selected school context measures). For non-native English speakers in the college preparatory track, a one unit positive difference in English proficiency was associated with a 1.62 positive difference in mathematics achievement, on average. However, for non-native English speakers in the general track, on average, a one unit positive difference in English proficiency was only associated with a 0.98 positive difference in mathematics performance. For every one unit positive difference in English proficiency, this difference accounts for one-sixth of a standard deviation for non-native English speakers in the college track and only one-tenth of a standard deviation for students with similar levels of English proficiency in the general track. Additionally, the results from Model 4 also show that general-track placement was associated with a 2.61 points lower difference in mathematics test scores for both Latina/o native and non-native English speakers, compared to their peers in the college preparatory track. This difference in test scores was one-fourth of a standard deviation. However, as before, the lowest level of English proficiency in the college preparatory track was 4 compared to the lowest level in the general track that equaled 3.

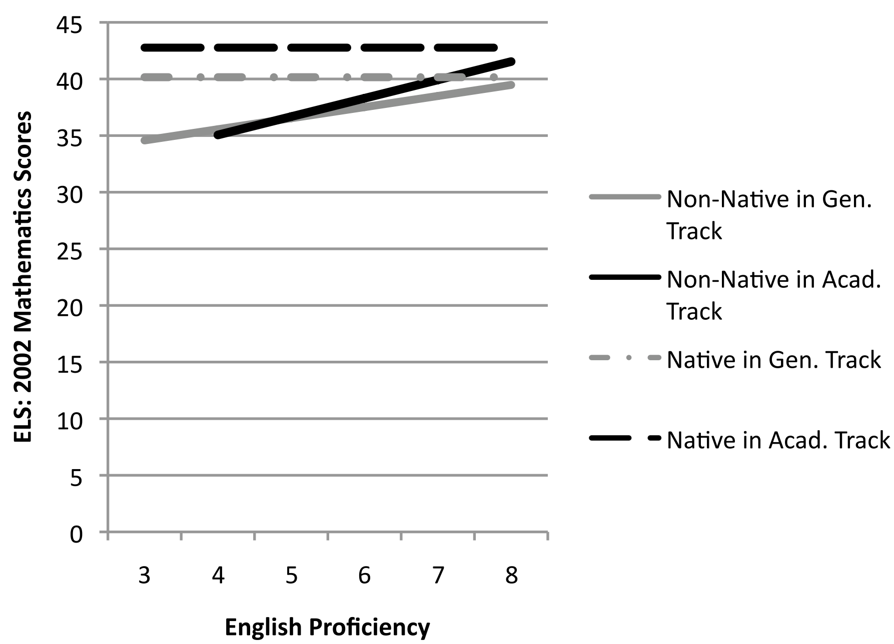

Figure 2. Interaction effects plot of mathematics performance on the ELS: 2002 assessment by English proficiency and tracking.

Due to the complexity in the interpretation, these findings are represented graphically in Figure 2, for students *with* credentialed teachers who also have a background in mathematics, and holding all other control predictors constant. In Figure 2, Latina/o non-native speakers in the college preparatory track with *high* levels of English proficiency scored as high as native English speakers in the same high track. However, the mathematics scores of Latina/o ELs in the college preparatory track were as low as the scores of ELs with the same low level of English proficiency in the general track.

Discussion

Present mathematics achievement patterns continue to reflect disparities in the mathematics performance of Latinas/os. Performance outcomes generally show that Latina/o students have disproportionately low standardized test scores compared to White students, and that the scores of Latina/o ELs are even lower. In spite of the extant research, we only have a limited understanding of the reasons for the persistence of these patterns of low performance for Latina/o ELs. This study examined multiple factors related to the mathematics performance of Latina/o native and non-native English speakers, including English proficiency and academic tracking while controlling for individual characteristics and important aspects of the school context. Particular attention was placed on the lowest achieving students, Latina/o ELs, to examine whether the relation between low levels of English proficiency and academic tracking exacerbated their already low mathematics scores on standardized assessments.

The findings revealed that the relationship between academic tracking and the level of English proficiency of non-native speaking Latina/o students is indeed an important predictor of their performance on standardized mathematics tests. The analysis showed that the mathematics test scores of Latina/o ELs are considerably lower than the test scores of both non-native English proficient students and native English speakers. For example, at the lowest level of English proficiency (ENGPROF = 3), Latina/o ELs score nearly 7 points—equaling over two-thirds of a standard deviation—below both Latina/o English proficient (ENGPROF = 8) and Latina/o native speakers. A test score difference of this proportion is substantial and alarming.

The findings also showed that tracking has a negative effect on the mathematics achievement of both Latina/o native and non-native English speakers. This finding suggests exposure to rigorous mathematics content plays an important role in mediating the mathematics test scores of all Latinas/os. Not surprisingly, and consistent with the aforementioned literature, Latina/o native and non-native English speakers with varying levels of English proficiency who are placed in the general academic track have lower mathematics achievement scores than their peers in the college preparatory track (Callahan, 2005; Wang & Goldschmidt, 1999). For all Latina/o students, the effect of low-track placement is linked to a lower test score of 2.6 points (or one-fourth of a standard deviation) on average, compared to students in the college preparatory track. This difference in test scores is also sizeable.

This study also examined whether the effect of tracking on mathematics performance differs by the level of English proficiency of non-native English speakers relative to the scores of native English speakers. These findings indicated that the level of English proficiency of non-native English speakers is more important for predicting the mathematics performance of ELs in the college track compared to ELs in the general track. The analysis also showed that the impact of tracking varies as a function of the level of English proficiency of non-native English-speaking Latinas/os. These findings revealed that while having a low level of English proficiency can disadvantage ELs in the college preparatory track, when non-native English speakers acquire a high level of English proficiency, they outperform their English-proficient peers in the general track, and score as high as native English speakers in the college preparatory track.

Although this study was not designed to identify the specific processes that explain the ways in which English proficiency matters more for Latina/o ELs in the college preparatory track compared to their peers in the general track, there are possible explanations and implications for this finding. For example, the unexpected finding that Latina/o ELs in the college preparatory track scored as low as ELs in the general track highlights how English proficiency is a more important factor for Latinas/os in the college track than for those in the general track. This finding, however, is explained in part by research reviewed earlier, which argues that sophisticated mathematics-specific discourse and the complexity of the rigorous mathematics content itself demands a high degree of English proficiency (Cuevas, 1984; Garrison & Mora, 1999; Gutiérrez, 2002; Khisty, 1995, 1997).

These findings also raise questions about the long-term effects of general track placement for Latina/o ELs after they reach a high level of proficiency in English that should be investigated in future research. The English proficiency level of Latina/o ELs will invariably improve over time, but if ELs are relegated to remedial mathematics instruction in the general tracks they will not benefit from the potential higher performance advantages associated with both high levels of English proficiency and access to college preparatory mathematics content that are reported in this study.

Findings from this study challenge the practice of making English proficiency a prerequisite for enrollment in rigorous mathematics courses. Given the complexity of mathematics language, deficit theories that limit ELs' opportunities to take challenging courses based on their level of English proficiency will continue to have long-term negative effects on their learning and test performance because this practice delays their entry into rigorous courses until they reach an "academic" level of English proficiency. Given that academic proficiency may take anywhere from 3 to 7 years to develop, by the time ELs develop a level of English proficiency deemed appropriate to handle the linguistic complexity of secondary school mathematics content, it may be too late for them to take and meet the mathematics requisites for graduation and college attendance. Furthermore, deficit-oriented practices that lead to the placement of ELs in low-level mathematics courses solely based on their English proficiency seem to unjustifiably use English proficiency as a proxy measure of an ELs' mathematics capacity.

Conclusion

This research lends support to the argument that the mathematics performance of Latina/o students on standardized tests is mediated by factors at the institutional level, along with individual-level characteristics. Therefore, explaining the achievement differences in mathematics test scores among Latina/o native and non-native English speaking students solely in terms of individual characteristics can lead to inappropriate conclusions given the impact that institutional factors, such as low-track placement, have on lower mathematics test scores.

The results of this study have important policy implications because of the dispersion of Latinas/os and Latina/o ELs to states without experience with how to best educate these students. A critical first step is that English proficiency not be used to limit their access to rigorous courses. States with increasing populations of English learners in particular must avoid reproducing practices that diminish the potential performance of ELs by not restricting their access to challenging mathematics courses.

Beyond policy implications, the higher mathematics performance of Latinas/os in the college preparatory track reported in this study suggests that future research should analyze the impact of instructional approaches that simultaneously promote learning the rigorous mathematics content of the college track as Latina/o ELs also develop both their proficiency in English and their mathematics language register. In other words, future research needs to investigate whether the provision of native language support can mitigate the negative relationship among the low English proficiency of ELs, track placement, and the mathematics performance patterns reported in this article.

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