Int. Migration & Integration (2014) 15:589–607
DOI 10.1007/s12134-013-0300-x

Mathematics Performance of Immigrant Students Across Different Racial Groups: An Indirect Examination of the Influence of Culture and Schooling

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Published online: 1 August 2013

Abstract Immigrant students are commonly assumed lower performers in US schools. Their inadequate English language skills and adaptation to the mainstream US school norms are often seen as obstacles to their successful school learning. However, whether and to what extent this assumption is sustainable for immigrant students' performances in mathematics is the question that has not been empirically explored. Proper answer to the question would help verify the popular assumption about the immigrant students and their learning in the mainstream US schools. Guided by the straight-line, segmented assimilation and cultural capital theories, this study examined this issue using US grades 4 and 8 datasets of Trend in International Mathematics and Science Study 2007 and 15-year-old dataset of Program for International Student Assessment 2009. It was found that there were substantial differences in the mathematics performances of students across different racial groups. Being immigrant students does not always mean they are lower performers than their mainstream peers. The immigrant students coming to the USA earlier did not always show worse mathematics

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performance over their immigrant peers who came to the USA later. These findings challenge the popular assumption that immigrant students' inadequate English language skills and adaptation to the mainstream US school norms are obstacles to their successful school learning and call for a deeper understanding about the academic performance of immigrant students in different content areas and at various stages of immigration across different racial groups.

Keywords Immigrant students · Mathematics performance

The last decade witnessed a huge number of immigrants coming to the USA and the education of immigrant children has become a contentious issue debated in the public media. Opposing views regarding English versus bilingual education and multicultural education versus standard-based schooling have been appearing in and framing the debates of public and educational policies (Smith-Davis 2004). Among these debates, the immigrant students are always labeled as second-language learners and are seen as a problem or challenge for teachers to teach because of these students' poor living situations, incompetent language, and cultural barriers in mainstream US schools (García et al. 2010; Sato et al. 2010). Sometimes, such a problem and challenge becomes too big for teachers to overcome. Thus, it is often used as an excuse to defend teachers against federal and public pressure for them to implement policy initiatives such as No Child Left Behind legislation (Fritzberg 2004; Hess 2006; Hess and Petrilli 2004) and Race to the Top policy (Sawchuk 2010) that hold teachers accountable for their student performances.

However, such debates over immigrant student learning in US schools often fuel a view about these immigrant students that their culture and formal education experiences in their home country have little value in their current school learning. It reinforces the idea of the superiority of the US mainstream school teaching and learning (Bracey 1999). Such a view of immigrant students and an idea of US schools and their teaching are problematic at least on three grounds.

First, this deficit view about the schooling and culture in immigrant students' home country conflicts conceptually with the assumption of culturally responsive teaching. According to this assumption, students' culture in their home country is seen as an important base for student learning and any teaching effective for students from different racial and cultural groups has to capitalize on the strengths and uniqueness of students' own cultural norms, traditions, and learning styles in order to improve their performance (Gay 2010; Ladson-Billings 1995).

Second, the biased view of US schools and their teaching is not supported by the findings in various comparative studies over the years, which showed that US students often underperform in mathematics, reading, and science those students of some educational systems from which a number of US immigrant students came (Fleischman et al. 2010; Mullis et al. 2005a; Organization for Economic Co-operation and Development (OECD) 2004, 2007; Stevenson et al. 1990). Such a view often compromised the efforts to identify the problems and ineffective teaching practices in US schools in order to improve its education system by learning carefully from the educational practices in other countries (Romberg 1997).

Third, the deficit view of immigrant students' schooling and culture in their native country often cannot sustain with empirical evidence of immigrant students' academic

performances. Existing empirical studies do suggest that immigrant students whose native languages are not English often struggle in their English language learning and consequently, have lower performance in English language arts (Crane et al. 2011). In other subject areas such as mathematics, although studies do show that some immigrant groups, e.g., Hispanic immigrant students, often showed lower mathematics performance than their non-immigrant White peers (Aldous 2006; Kaufman et al. 1998; Kao et al. 1996; Suárez-Orozco and Suárez-Orozco 2001), this is not always the case in the studies involving other immigrant students (Chen and Stevenson 1995; Kaufman et al. 1998; Kao et al. 1996; Rong 1988). Immigrant students from a particular country were not always poorer performers when compared with their non-immigrant peers and big differences in academic performance could exist among immigrant students depending on their racial backgrounds, immigration status, and the content area measured (Schleicher 2006).

These inconsistent findings from empirical studies pose a challenge to the existing view that assumes immigrant students' schooling and culture in their home country as a problem in helping them succeed in the host country. They ask for a more specific and refined empirical understanding about whether and to what extent the schooling and culture of particular racial groups of immigrant students in their native country help or weaken students' academic performances in other subject areas such as mathematics in US mainstream schools.

However, the existing relevant studies either examined one group of immigrant students or examined two or more groups but paid little attention to the extent to which different racial groups of immigrant students are exposed to the schooling and culture in their home country (Wang and Lin 2005). This study aims to examine whether and to what extent the deficit view of immigrant students' schooling and culture in their home country can hold true by analyzing the mathematics performance differences among US White, African, Hispanic, and Asian immigrant students with consideration of their levels of exposure to the schooling and culture in their home country. Specifically, drawing on US datasets from the Trend in International Mathematics and Science Study (TIMSS) 2007 and the Program for International Student Assessment (PISA) 2009, this study examined two questions. First, whether and to what extent the mathematics performances of White, African, Hispanic, and Asian immigrant students with different immigration status differ from their non-immigrant peers. Second, whether and to what extent the mathematics performances of White, African, Hispanic, and Asian immigrant students with different immigration status differ from each other within each racial population.

Theoretical and Empirical Bases

Theoretical Assumptions

Two lines of theoretical assumptions are used to frame the focus of this study. The first is the straight-line assimilation assumption, which contends that immigrants follow a straight line in assimilating into the host society (Gordon 1964; Park 1914). This assumption suggests that immigrant students of the first generation often have the lowest performance in the schools of the host society, but the performances of the subsequent generations will be improved as they blend into the mainstream

culture, adopt the norms of the schools, and become fluent in the language used in the host society (Gordon 1964; Park 1914). This theoretical assumption implicitly suggests the deficit view in the current debates of public and educational policy relevant to the immigrant students (Smith-Davis 2004). Central to the assumption is the idea that English language, school norms, and cultural values embedded in the mainstream schools of host society have ultimate advantage over those in the immigrant students' home society, which puts immigrant students at a disadvantage in achieving higher academic performances in the host society.

The cultural capital reproduction theory developed by Bourdieu (1977, 1984) further explains the mechanism through which the academic differences of immigrant students from different generations occur. It suggests that cultural capital is an asset as important as economic capital and social capital in contributing to one's school success (Bourdieu and Passeron 1979). Children from upper class often acquire better cultural capital necessary for them to be successful in schools (Bourdieu 1977), which can be passed on to them through their passive exposure to their parents' cultural capital and through their parents' active and deliberate transfer (Cheung and Andersen 2003). These cultural capitals include language codes norms and attitudes related to school learning, and particular ways of working with adults in school contexts (Bernstein 1971; Bourdieu and Passerson 1990; Heath et al. 1982; Willis 1977). Following this assumption, the earlier generations of immigrants often have lower school performance due to their lower socioeconomic status (SES) backgrounds and cultural capital in the host country. However, as they are gradually assimilated into the mainstream society through different generations, they would acquire more mainstream cultural capital necessary for school success in the host country. Based on this line of assumption, those immigrant students who come to the USA earlier and stay in the USA longer will gain better language and cultural competence and thus will have higher academic performances than those who come to the USA late and have less acquisition of mainstream culture and language (Gordon 1964; Park 1914).

The second line of theoretical assumption involves the segmented assimilation theory, which assumes that in their assimilation into the host society the immigrants take a bumpy course (Sakamoto and Xie 2006) in which they avoid the negative influences from the host society while adhering to those elements in the cultural legacy of their home country that are helpful for their adaptation. Following this assumption, whether immigrants have lower or higher academic performances in the mainstream schools of the host society depends ultimately on the kinds of influences they absorb from the host and home societies in relation to their learning of a particular content area (Portes and Zhou 1993). The more positive cultural influences they are exposed to in the host society and they bring from their own native society, the higher their academic performances will be and vice versa while the length of time they have been living in the host society does not ultimately determine their level of academic performance. This theory suggests that the academic achievements of different racial groups of immigrant students with various immigration statuses will vary based on the type of influences and the degree to which they are exposed to these influences in the host society and in their own culture (Gans 1992; Portes and Zhou 1993).

This study investigated the mathematics performance differences between different groups of immigrant students at various immigration stages both with their non-immigrant and immigrant peers within the four US racial groups. Through these

comparisons, we expect to verify whether and to what extent each line of theoretical assumptions is true and thus, provide necessary empirical evidences for enriching the current public and educational policy debates over the education of immigrant students in the USA and other immigrant countries.

Empirical Literature Review

Empirical evidences in the existing literature that support each line of theoretical assumptions were either limited or insufficient. Although supported by results from studies on the school performance patterns of European immigrants in the early twentieth century (Sassler 2006), the straight-line assimilation assumption has been challenged by studies involving other racial groups of immigrant students.

These studies show that African immigrant students were not always poorer performers compared with African American students as observed (Ogbu 1987, 1991); also, although Hispanic immigrant students increased their high school graduation rates from the first to the second generation, the high school completion rates for White and Asian immigrant students from the first to the second generation showed no differences compared with their non-immigrant White and Asian American peers (Rong and Grant 1992). In addition, drawing on the data from the National Education Longitudinal Study of 1988 (NELS:88), Kao and Tienda (1995) found that the first- and second-generation Asian immigrant students showed higher school grades and mathematics test scores, and were more likely to graduate from college than their third-generation counterparts but there was little difference between the first and second generation. Kaufman et al. (1998) found that the second-generation Asian immigrant students performed better than non-immigrant Asian American students in mathematics but did not find differences among different generations of Hispanic immigrant students. In addition, using data from NELS:88, Zhang (2003) found that at each grade level, performance differences between the first- and second-generation Asian immigrant students on all tests except that on reading were not significant after accounting for SES, ethnic origin, and language factors, but the first-generation students had higher mathematics scores than those of the third generation.

The above studies together showed that there was no clear pattern of academic performances among Asian and Hispanic subgroups of immigrant students, which seems to support the segmented assimilation theory. However, such a support comes with the following limitations compromising the findings of these studies and preventing a more refined interpretation.

First, the existing studies were often conducted with Asian or Hispanic immigrant students, very few involved both Asian and Hispanic immigrant students in a study and even fewer focused on White and African immigrant students. Virtually no studies were developed to compare the four major groups of the US immigrant students.

Second, immigrant students in these studies were often broadly categorized into the first, second, and third generations with little attention to the fact that the third generation immigrants are actually not immigrants in a strict sense as their parents and the students themselves are born in the host country. Additionally, there was little attention to the differentiation among the first-generation immigrant students. Such differentiation could provide a more useful context to examine whether the first-generation immigrant students who come to the USA earlier would perform better

than those who come to the US late and thus, explore indirectly the influences of immigrant students' exposure to the schooling and culture in their home country on their academic performances.

Third, some of the existing studies relied on measures of school performances that were qualitatively different from each other, which could prevent a more reliable synthesis and comparison of the performances of immigrant students from different groups. For example, some studies (Kao and Tienda 1995; Rong and Grant 1992) relied on nonstandard measures such as school grades and course completion, which could mean differently across different schools, districts, and areas in the USA.

This study examined whether and to what extent the prediction of each of the two lines of theoretical assumptions for the mathematics performance is true by addressing the above limitations and by investigating the mathematics performances of the four major racial groups of immigrant students with different levels of exposure to the schooling and culture in their home country using standardized measurements. Through this examination, we hope to identify the patterns of mathematics performances across and within different groups of immigrant students, which allows us to derive a more useful interpretation about the relative influences of the culture and schooling in immigrant students' home country and in the host society on their mathematics learning in the mainstream schools.

Methodology

Data Sources

US datasets of TIMSS 2007 and PISA 2009 are used as the data source for this study based on two considerations. First, both US datasets allow us to access the mathematics performances of different US immigrant students at various grade levels. TIMSS 2007 allows access to such data of the grades 4 and 8 immigrant students while PISA 2009 allows access to the 15-year-old immigrant students who were mostly in the tenth grade (Hopstock and Pelczar 2011).

Second, both datasets used carefully validated measures for assessing participants' mathematics performances but each dataset focused on different mathematics performance. For TIMSS 2007, the mathematics performances were assessed based on what students were supposed to learn from their school curriculum (Mullis et al. 2005a, b). For PISA 2009, the mathematics performances were assessed based on how students can use mathematics to solve authentic problems in real-world situations and real-life contexts (OECD 2010). Such difference allowed us to examine whether and to what extent immigrant student participants performed differently on what they were supposed to learn from the school curriculum and as needed by the society.

Third, both datasets provide the information that we could use to select representative samples for four major racial groups of immigrant students with different levels of exposure to the schooling and cultural influences in their home and host societies. With a two-stage and nonrandom sampling design, TIMSS 2007 US dataset contains a national representative sample of 7,896 fourth graders and 7,377 eighth graders, respectively (Foy and Olson 2009), and PISA 2009 US dataset has a national representative sample of 5,233 15-year-old students who were mostly in the tenth grade (Hopstock and Pelczar 2011).

Immigrant Group Coding

Based on students' self-reported racial and immigration background information from the student questionnaire, we first selected White, African, Hispanic, and Asian immigrant students based on the racial categorization in TIMSS 2007 and PISA 2009 US datasets, which used the classification scheme for race and ethnicity developed by the Office of Management and Budget (1997). This scheme states that "Hispanic or Latino" is an ethnicity category instead of a racial category. For the readability and consistence of this report, the term "racial groups" instead of "racial and ethnic groups" is used to indicate the major racial and ethnic groups in the USA, and the terms "White," "African," "Hispanic," and "Asian" are used for "White," "Black or African American," "Hispanic or Latino," and "Asian" immigrant students, respectively.

Then we classified students in each racial immigrant population into subgroups in terms of their levels of exposure to the schooling and cultural influences in their home country. Three groups of each racial immigrant population and a non-immigrant reference group below were identified from the fourth- and eighth-grade data in TIMSS 2007.

Group 1 includes the first-generation immigrant students who were foreign born with foreign-born parents but who migrated to the USA when they are older than 5 for the fourth grader and older than 10 for the eighth graders. This group of immigrant students is assumed to have relatively more exposure to the schooling, social, and cultural influences in their home country while relatively less exposure to those in the host society (Hurh 1990; Kim et al. 2003; Lee 2001).

Group 2 includes the first-generation immigrant students who were foreign born with foreign-born parents but migrated to the USA at age 5 and younger for the fourth-grade students and at age 10 and younger for the eighth graders. This group of immigrant students has less exposure to the schooling and cultural influences in their home country but relatively more exposure to those influences in the host society than those in group 1 (Kao et al. 1996).

Group 3 consists of the second-generation immigrant students, who were born in the USA with at least one foreign-born parent. This group of students is assumed to have almost no direct or substantive exposure to the school influences in their home society but still have exposure to the influences of the culture and/or schooling of their home country through their parents and/or family. However, they have substantially more direct exposure to the schooling, social, and cultural influences of the host society than both groups 1 and 2 (Kao and Tienda 1995).

Group 4 includes all students who were born in the USA with US-born parents. This group is presumably exposed directly or mainly to the influences of US school and culture. This group of students represents US non-immigrant students and is used as a control group to compare with the other three subgroups from each racial immigrant population to identify the similarities and differences in their mathematics performances.

The student questionnaire in PISA 2009 US dataset provided the background information about the age (ranging from age 1 to 16) at which the first-generation immigrant students migrated to the USA and the information about their racial background and immigration status. As a result, we grouped the 15-year-old students from each racial immigrant population in PISA 2009 US dataset into two groups and a non-immigrant reference group.

Group A includes the first-generation immigrant students who were foreign born with foreign-born parents. This group has relatively more exposure to the schooling, social,

and cultural influences in their home country while relatively less exposure to the schooling, social, and cultural influences in the host society (Hurh 1990; Lee 2001).

Group B consists of the second-generation immigrant students, who were born in the USA with at least one foreign-born parent. This group of students receives more direct exposure to the schooling, social, and cultural influences from the host society than those in groups A (Kao and Tienda 1995).

Group C includes all the students who were born in the USA with US-born parents. This group is presumably exposed directly and mainly to the influences of US school and culture. This group of students represents US non-immigrant students and is used to compare with the other two subgroups to identify similarities and differences in their mathematics performances. The sample sizes, data sources for each grade level and the age level of participants, and the immigration status of each subgroup within each racial population are presented in Table 1.

Data Analysis

Following the suggestions of the International Association for the Evaluation of Educational Achievement and Organization for Economic Cooperation and Development that developed TIMSS 2007 and PISA 2009, respectively (Hopstock and Pelczar 2011), we used the International Database (IDB) Analyzer (IEA 2009) along with IBM SPSS (IBM 2010) in conducting the data analyses for this study. We made this choice because TIMSS 2007 and PISA 2009 data were collected through a complex sampling design and IDB Analyzer automatically makes use of appropriate sampling weights and standard errors to produce accurate statistical results (Olson et al. 2008).

In order to answer the first research question, we first dummy coded groups 1, 2, 3, and 4 and used group 4 as a reference group in US fourth-grade and eighth-grade datasets of TIMSS 2007. Second, we conducted multiple linear regression approach of ANOVA to identify whether and to what extent any differences in participants' mathematics achievements identified between each subgroup (groups 1, 2, and 3) and the reference group (group 4) were statistically significant for each racial immigrant population in TIMSS 2007 US data. Finally, we dummy coded groups A, B, and C and used group C as the reference group in PISA 2009 US data and conducted multiple regression approach of ANOVA to identify whether and to what extent any differences in participants' mathematics achievements identified between each subgroup (groups A and B) and the control group (group C) were statistically significant. Due to its efficiency, multiple regression approach of ANOVA was used in place of simple *t* test in the above analyses.

In order to answer the second research question, we conducted the following analyses. We first conducted regression approach of *t* test to identify whether and to what extent any statistically significant differences could be identified in participants' mathematics achievement among groups 1, 2, and 3 of each racial population at the fourth- and eighth-grade level in TIMSS 2007 US data. Regression approach of *t* test was used in place of simple *t* test because IDB analyzer does not have the function of simple *t* test available but it does have the function of regression (Hopstock and Pelczar 2011). Then, we conducted regression approach of *t* test on PISA 2009 US data for the 15-year olds to identify whether and to what extent the differences in participants' mathematics achievement between groups A and B of each racial immigrant population was statistically significant. Lastly, we conducted simple

liner regression analysis using immigrant students' age of migration to predict their mathematics achievements in each racial immigrant population. We did this analysis because in PISA 2009 US dataset, immigrant students reported their age (ranging from 1 to16) at which they migrated to the USA. As both student-reported age and their mathematics achievements are continuous variables, the use of simple linear regression is appropriate to capture the statistical relationship between the two.

Limitations of the Study

This study has several limitations. First, the SES was not used in this study as a control variable. We chose to omit this variable because, first, no data was collected with consistent definition of the SES variable in both datasets. In addition, SES is often conflated with race and immigration status in the USA. As students' racial and immigration status is used in the analysis, it addressed this concern to some extent. Nevertheless, we acknowledge that SES may influence the mathematics performance of some racial groups and we would consider this variable when other appropriate datasets are available for such analyses in the future.

Second, although this study used the samples and data from two large-scale datasets, the sample sizes for some groups under comparison become relatively small when each racial was further divided into different groups with different immigration status. Therefore, caution should be exercised when generalizing the results of this study to the relevant larger populations.

Third, the existing approach to grouping immigrant students into White, African, Hispanic, and Asian immigrant students is still too broad to capture the differences among them in terms of the schooling and cultural influences in immigrants' home country. The lack of more detailed background information about the home countries from which US immigrant students come in both datasets limited our opportunity to conduct more useful categorization based on immigrant students' home countries. The country-based grouping is certainly better units for analysis as it suggests similar influences of schooling and culture on a particular immigrant group. In addition, neither dataset provides students' background information relevant to their refugee status. These limitations may in some degree constrain our analysis and compromise our results.

Last, the study is limited in the fact that the actual influences of schooling and culture in immigrants' home country is only indirectly examined and implied instead of being directly investigated. Further studies using carefully designed observations, interviews, and surveys as data sources with more qualitative or mixed research designs are needed in order to develop such an understanding about the direct influences of these cultural factors on immigrant students' learning in US schools.

Results

Performance Differences between Non-Immigrant and Immigrant Students Across Various Racial Populations

Results from our multiple regression approach of ANOVA analysis of the mathematics performance differences between immigrant students in each racial population and

the non-immigrant student group at the fourth, eighth grade, and 15-year-old age levels are shown in Table 2. Based on the table, we identified several results.

First, all Hispanic immigrant groups (groups 1, 2, 3, A, B) with different immigration status at two grade levels and one age level substantially underperformed their non-immigrant peers in groups 4 and C at the fourth-grade, eighth-grade, and 15-year old levels, all $ps<0.001$. Second, similar to their Hispanic counterparts, all but two groups of African immigrant students substantially underperformed their non-immigrant students in groups 4 and C at the fourth-grade, eighth-grade, and 15-year old levels ($ps<0.01$ for comparison between groups 1 and 4 at eighth-grade level, and between groups C and B at the 15-year old level, $ps<0.001$ for all other comparisons). The differences between the first generation African immigrant students in group 2, group A, and their non-immigrant peers at the eighth-grade level and the 15-year-old level were not statistically significant, $ps>0.05$.

Third, however, the mathematics achievement differences between all groups of White immigrant students and the non-immigrant students in groups 4 and C at the fourth-grade, eighth-grade, and 15-year-old levels were not statistically insignificant (all $ps>0.05$) except for two group contexts. The differences between group 3, group B, of the second-generation White immigrant students and their non-immigrant peers at the eighth-grade and 15-year-old levels were statistically significant, both $ps<0.05$.

Finally, the mathematics performance differences between all the groups of Asian immigrant students and groups 4 and C of non-immigrant students at the fourth-, eighth-grade, and 15-year-old levels were statistically significant ($ps<0.05$ for the comparison between groups 2 and 4 at eighth-grade level, and between groups B and C at the 15-year-old level, $ps<0.001$ for all others) except for three group contexts. The performance differences between Asian immigrant students in group 2 at the fourth-grade level, group 1 at the eighth grade level, group A at 15-year-old level, and their non-immigrant peers were not statistically significant, all $ps>0.05$.

Performance Differences among Various Immigrant Groups within Each Racial Population

Our analysis about the performance differences between various immigrant student groups at the fourth-, eighth-grade, and 15-year-old levels for each racial population using multiple regression approach of *t* test revealed several results as shown in Table 3.

First, for Hispanic immigrant students, the first generation in group 1 at the fourth-grade level and group 2 at the eighth-grade level substantially underperformed their second-generation immigrant peers in group 3 ($ps<0.001$ for the fourth-grade group comparison and $ps<0.01$ for the eighth-grade group comparison). However, the difference between Hispanic immigrant students in groups 1 and 2 at fourth- and eighth-grade levels and between groups A and B at the 15-year-old level were not statistically significant, all $ps>0.05$.

Second, for African immigrant students, the second-generation (group 3) significantly outperformed their first-generation peers who came to USA late (group 1) at the fourth-grade level, $p<0.05$. Similarly, the first-generation African immigrant students (group A) also significantly outperformed their second-generation peers (group B) at the 15-year-old level, $p<0.05$. However, no statistically significant differences were identified for all the other group comparisons at the two grade levels, all $ps>0.05$.

Third, the second-generation Asian immigrant students (group 3) outperformed their first-generation peers who came to the USA earlier at the fourth-grade level (group 2), $p < 0.05$, while no statistically significant differences can be identified for all the other group comparisons for Asian immigrant students at the two grade and one age levels, all $ps > 0.05$. Finally, no statistically significant differences were found among any White immigrant student groups at the fourth-, eighth-grade, and 15-year-old levels, all $ps > 0.05$.

Relationship between Age at Migration and Mathematics Performance of First-Generation 15-Year Olds

Results from the simple linear regression analyses about the relationship between the first-generation 15-year olds' reported age of migrating to the USA and their mathematics achievement are presented in Table 4. First, a statistically significant positive relationship is identified between 15-year-old White immigrant students' age of migration and their mathematics achievement, $p<0.05$, indicating the earlier they come to the USA, the lower their mathematics achievements will be. Second, no statistically significant relationship was found between students' age of migration and their mathematics performances for the 15-year-old Hispanic, African, and Asian immigrant students, all $ps>0.05$, indicating whether they came to the USA earlier does not necessarily lead them to better mathematics performance.

Discussion and Conclusion

As mentioned in the methodology section, this study is limited in its little attention to possible conflation between SES and race, smaller sample size for some groups, a lack of further differentiation among different racial groups, and a lack of direct observations and interviews about participants. In spite of these limitations, the results of this study did help us understand the two research questions in the following ways.

Firstly, while some racial groups of immigrant students with different immigrant statuses at different grade and age levels underperformed their non-immigrant peers, the results of the study also showed that other racial groups of immigrant students with different immigrant statuses at different grade and age levels nevertheless outperformed their non-immigrant peers or performed as well as their non-immigrant peers. For example, this study found that all Hispanic immigrant groups at the two grade level and one age level substantially underperformed their non-immigrant counterparts, which mirrors the result from other studies that Hispanic immigrant students often performed lower than US White students in mathematics (Aldous 2006; Kao et al. 1996; Kaufman et al. 1998; Suárez-Orozco and Suárez-Orozco 2001). Similar to Hispanic immigrant students, most African immigrant students at the two grade levels and one age level, except the first-generation African immigrant students at the 15-year-old level and those who came to the USA earlier at the fourth-grade level, also significantly underperformed their non-immigrant peers, which supports the findings in previous studies that found African immigrant students were not always poorer performers compared with non-immigrant African American students (Ogbu 1987, 1991). However, while a few White and Asian immigrant groups demonstrated similar mathematics performance compared with their non-immigrant peers, most White and Asian immigrant students at the different

grade and age levels actually significantly outperformed their non-immigrant peers. These include the second-generation White immigrant students at the eighth-grade and 15-year-old age level, the first-generation Asian immigrant students at the fourth-grade level who came to the USA late and at the eighth-grade level who came to the USA earlier, the second-generation Asian immigrant groups at the fourth-grade, eighth-grade, and the 15-year-old levels. Such result resonates with the existing studies on White and/or Asian immigrant students that no differences were found between immigrant and non-immigrant White and/or Asian students in their high school completion (Rong and Grant 1992) and school grades (Kao and Tienda 1995).

These results suggest that not all immigrant students came to the USA with inadequate cultural values and school education that ultimately prevent them from developing mathematics knowledge and skills that are equal to or better than their non-immigrant peers in US mainstream schools. Thus, these results pose a direct challenge to the deficit view that assumes immigrant students as consistently lower performers in US schools and thus, a problem for teachers and schools to overcome underlying the debates over the series of public and educational policies relevant to immigrant students (Smith-Davis 2004). They also indirectly question the biased view of the superiority of US culture, schools, and teaching over those in the home society of all immigrant groups (Bracey 1999). According to the results of this study, while US culture, schools, and teaching might be superior to those in the home societies of Hispanic immigrant students, they might not be necessarily better than those in the homes societies of White, African, and Asian immigrant students.

Secondly, the results showed that the second-generation Hispanic students at the fourth- and eighth-grade levels significantly outperformed their first-generation peers. Such results seem to suggest that Hispanic immigrant students improved their learning as they were more exposed to the US school influences while less exposed to the cultural and school influences in their home country, indicating again that US culture, family, and schools might be superior to those in the home countries of these Hispanic immigrants, which seems to support both the deficit view regarding immigrants' culture, family, and schooling, the straight-line assimilation assumption, and cultural capital theory.

However, such patterns disappeared in the comparison of the first-generation fourth-, eighth-grade, 15-year-old White, African, Asian immigrant students with their second-generation peers. As indicated in the results of the study, there were little differences identified between the first-generation fourth-, eighth-grade, 15-year-old White, African, Asian immigrant students, and their second-generation counterparts. In the case of African first-generation 15-year olds, their performance actually was better than their second-generation counterparts. Additionally, the result also shows that for the first-generation White immigrant students, the earlier they came to the USA, the lower their mathematics performance would be. These results indicate that US culture and schooling did not seem to help improve, as much as they did for Hispanic students, the mathematics performance of these White, African, and Asian immigrant students while being exposed more to US culture and schooling and less to the culture and schooling in their home society. Such results might challenge the deficit view of immigrant students' home culture and schooling, problematize the straight-line assimilation assumption, and cultural capital theory, while supporting the segmented assimilation assumption. Considering the assessment used for 15-year olds is in a context focusing on students' mathematics knowledge and skills that would be useful for the real-world problems and

in real-life contexts, such result becomes even more challenging for the deficit view of immigrant students and the biased view of US schools and teaching.

This study contributes importantly to the understanding of the theoretical assumptions about the relationship between immigrant student learning in the schools, culture, and the society of their home country, and their learning in the mainstream culture and schools in the host society in two ways. First, the study problematizes the straight-line assimilation assumption and the concept of cultural capital, which predicts that the new immigrant students often have the lowest school performance in the schools of the host society, and then their performances will be improved in the subsequent generations as they become more enculturalized into the cultural values, languages, and school norms in the host society (Bourdieu 1977, 1984; Gordon 1964; Park 1914). While such a prediction can explain why some groups of immigrants tend to perform gradually better due to the fact that the culture they bring with them is compatible with the dominate culture and thus they can identify with mainstream culture more easily, it cannot be confirmed and sustained consistently by the results of comparison among different racial groups or even the results of comparison among different grade levels and age subgroups within a single racial population in the study. While the two conceptual assumptions could be used to predict immigrant students' performance on language intensive subject areas (Crane et al. 2011), they might not be capable of explaining the variations found in the mathematics performance of students across different generations and racial groups except for Hispanic students. The reason for such variations could be explained by content area-related cultural capital instead of the traditional conceptualization of cultural capital as some cultures especially Asian culture value mathematics learning more than that of the host society, which might have contributed to the fact that some immigrant groups actually outperform the native student group. Thus, results from this study undermine the important conceptual bases that derive the deficit view of immigrant students and their cultural and school influences and the biased view of US school and teaching. This suggests that policymakers and practitioners need to recognize the mathematics related cultural capital some groups of immigrant students bring with them to the mainstream schools, provide differentiated instruction that is relevant to students' ability level in mathematics learning instead of using the level identified by using their language ability, in order to help these immigrant students achieve better in mathematics.

Second, the study seems to confirm indirectly the segmented assimilation assumption, which predicts that immigrants take a bumpy course in their assimilation into the host society (Sakamoto and Xie 2006). In this process, the more positive influences immigrant students are exposed to in the host society and they bring from their own native culture, the higher their school performances will be and vice versa (Gans 1992; Portes and Zhou 1993). Results of this study seem to support this assumption by showing that academic achievements of immigrant students will not only be different across different racial groups but also vary within a single racial group due to students' different immigration statuses and age levels. However, this study could not show directly the various processes in which each racial group and their subgroups negotiate the influences from the culture, family, and schools related to their home society and the host society, nor could this study show directly the consequences of these processes on their school performances. For a better and direct understanding about these process and consequences, we need both quantitative and qualitative data collected through systematic observations, in-depth interviews, and

careful documentations relevant to these processes and consequences, as well as complex triangulation among these sources of data.

To conclude, this study contributes to the understanding the US K-12 immigrant students' mathematics performance in the existing literature with a broader and more refined understanding about the mathematics performance differences among the various racial groups of first- and second-generation immigrant students at different age and grade levels. It also provides the necessary evidences to challenge and sustain the existing theories about immigrant students and their adaptation to US mainstream school and society. Thus, it helps build an important knowledge base for improving policymaking and practice that are related to mathematics education of immigrant students from various racial and ethnic backgrounds with different immigration status, and grade/age levels. Moreover, it helps inspire more research in this field with meaningful questions and better designs, which will lead to a better understanding and more reliable interpretation of the academic similarities and differences between immigrant students and students in mainstream society, as well as the factors and processes that influence these similarities and differences.

Appendix

Table 1 Immigration status, grouping information, sample size, and descriptive statistics

Grade level and data source	Race	Group	*n*	Mean	SD
4th Graders (TIMSS 2007)	White	Group 1	22	527.63	78.59
		Group 2	55	538.22	73.69
		Group 3	460	549.64	71.24
	African	Group 1	14	460.53	66.09
		Group 2	37	476.22	67.59
		Group 3	146	506.23	73.74
	Hispanic	Group 1	102	473.57	66.86
		Group 2	242	476.65	70.55
		Group 3	655	515.73	64.06
	Asian	Group 1	26	588.13	49.42
		Group 2	42	565.94	72.94
		Group 3	173	595.92	71.60
	All races	Group 4	4,575	543.70	67.87
8th Grader (TIMSS 2007)	White	Group 1	10	508.56	64.25
		Group 2	42	528.65	72.24
		Group 3	211	536.53	73.52
	African	Group 1	8	497.10	75.35
		Group 2	29	467.70	71.49
		Group 3	100	477.59	69.51
	Hispanic	Group 1	40	445.30	76.19
		Group 2	247	461.23	72.14
		Group 3	868	480.02	71.00

Table 1 (continued)

Grade level and data source	Race	Group	*n*	Mean	SD
	Asian	Group 1	9	576.91	61.29
		Group 2	45	555.05	70.66
		Group 3	151	548.72	65.90
	All races	Group 4	5,089	517.30	73.10
15-Year olds (PISA 2009)	White	Group A	41	498.91	91.67
		Group B	81	522.78	88.32
	African	Group A	30	486.42	91.70
		Group B	44	428.93	91.82
	Hispanic	Group A	175	456.21	80.34
		Group B	511	450.97	77.03
	Asian	Group A	59	528.21	89.64
		Group B	122	520.13	83.69
	All races	Group C	3,913	493.69	90.28

Table 2 Mathematics performance comparison between immigrant students and non-immigration students in TIMSS 2007 and PISA 2009

Race	Mean	SD	Mean	SD	*b*	SE	*t*
Fourth grade	Group 4		Group 1				
White	543.70	67.87	527.63	78.59	−16.08	20.78	−0.77
African			460.53	66.09	−83.17	20.64	−4.03***
Hispanic			473.57	66.86	−70.13	9.75	−7.19***
Asian			588.13	49.42	44.42	11.55	3.85***
	Group 4		Group 2				
White	543.70	67.87	538.22	73.69	−5.48	10.34	−0.53
African			476.22	67.59	−67.48	14.84	−4.55***
Hispanic			476.65	70.55	−67.05	7.34	−9.13***
Asian			565.94	72.94	22.24	15.34	1.45
	Group 4		Group 3				
White	543.70	67.87	549.64	71.24	5.94	4.45	1.34
African			506.23	73.74	−37.47	6.72	−5.58***
Hispanic			515.73	64.06	−27.97	3.17	−8.81***
Asian			595.92	71.60	52.22	10.57	4.94***
Eighth grade							
	Group 4		Group 1				
White	517.30	73.10	508.56	64.25	−8.74	21.41	−0.41
African			497.10	75.35	−49.60	15.41	−3.22**
Hispanic			445.30	76.19	−72.01	12.48	−5.77***
Asian			576.91	61.29	59.61	31.88	1.87
	Group 4		Group 2				
White	517.30	73.10	528.65	72.24	11.35	13.10	0.87

Table 2 (continued)

Race	Mean	SD	Mean	SD	*b*	SE	*t*
African			467.70	71.49	−20.20	30.35	−0.67
Hispanic			461.23	72.14	−56.07	6.92	−8.10***
Asian			555.05	70.66	37.75	15.01	2.52*
	Group 4		Group 3				
White	517.30	73.10	536.53	73.52	19.22	7.31	2.63*
African			477.59	69.51	−39.72	7.23	−5.50***
Hispanic			480.02	71.00	−37.28	5.46	−6.83***
Asian			548.72	65.90	31.42	6.36	4.94***
15-Year olds							
	Group C		Group A				
White	493.69	90.28	498.91	91.67	5.22	23.59	0.22
African			486.42	91.70	−7.27	18.80	−0.39
Hispanic			456.21	80.34	−37.47	9.01	−4.16***
Asian			528.21	89.64	34.52	18.10	1.91
	Group C		Group B				
White	493.69	90.28	522.78	88.32	29.09	11.99	2.43*
African			428.93	91.82	−64.76	16.86	−3.84**
Hispanic			450.97	77.03	−42.72	5.32	−8.03***
Asian			520.13	83.69	26.44	10.43	2.53*

*p<0.05; **p<0.01; ***p<0.001

Table 3 Mathematics performance comparison among different immigrant groups in TIMSS 2007 and PISA 2009

Race	Mean	SD	Mean	SD	*b*	SE	*t*
Fourth grade	Group 1		Group 2				
White	527.63	78.59	538.22	73.69	10.60	21.29	0.50
African	460.53	66.09	476.22	67.59	15.69	24.88	0.63
Hispanic	473.57	66.86	476.65	70.55	3.08	9.78	0.31
Asian	588.13	49.42	565.94	72.94	−22.19	15.54	−1.43
	Group 3		Group 1				
White	549.64	71.24	527.63	78.59	−22.02	21.03	−1.05
African	506.23	73.74	460.53	66.09	−45.70	21.50	−2.13*
Hispanic	515.73	64.06	473.57	66.86	−42.16	9.51	−4.43***
Asian	595.92	71.60	588.13	49.42	−7.80	11.65	−0.67
	Group 3		Group 2				
White	549.64	71.24	538.22	73.69	−11.42	10.33	−1.11

Table 3 (continued)

Race	Mean	SD	Mean	SD	*b*	SE	*t*
African	506.23	73.74	476.22	67.59	−30.01	16.02	−1.87
Hispanic	515.73	64.06	476.65	70.55	−39.08	6.55	−5.97***
Asian	595.92	71.60	565.94	72.94	−29.98	14.51	−2.07*
Eighth Grade							
	Group 1		Group 2				
White	508.56	64.25	528.65	72.24	20.09	24.39	0.82
African	497.10	75.35	467.70	71.49	−29.40	32.75	−0.90
Hispanic	445.30	76.19	461.23	72.14	15.94	12.55	1.27
Asian	576.91	61.29	555.05	70.66	−21.86	36.09	−0.61
	Group 3		Group 2				
White	536.53	73.52	528.65	72.24	−7.88	13.08	−0.60
African	477.59	69.51	467.70	71.49	−9.89	15.58	−0.63
Hispanic	480.02	71.00	461.23	72.14	−18.79	6.16	−3.05**
Asian	548.72	65.90	555.05	70.66	6.33	15.77	0.40
	Group 3		Group 1				
White	536.53	73.52	508.56	64.25	−27.96	22.80	−1.23
African	477.59	69.51	497.10	75.35	19.52	31.82	0.61
Hispanic	480.02	71.00	445.30	76.19	−34.72	11.27	−3.08**
Asian	548.72	65.90	576.91	61.29	28.19	31.06	0.91
15-Year olds							
	Group A		Group B				
White	498.91	91.67	522.78	88.32	23.87	27.68	0.86
African	486.42	91.70	428.93	91.82	−57.49	25.98	−2.21*
Hispanic	456.21	80.34	450.97	77.03	−5.24	8.88	−0.59
Asian	528.21	89.64	520.13	83.69	−8.08	18.25	−0.44

*$p<0.05$; **$p<0.01$; ***$p<0.001$

Table 4 Results of simple liner regression for group A of 15-year-old immigrant students in PISA 2009

Race	Independent variable	Dependent variable	*n*	Intercept	Coefficient	SE	*t*
White	Age of immigration	Math achievement	41	467.50	4.71	2.22	2.12*
African			30	474.22	1.93	4.42	0.44
Hispanic			172	474.40	−2.34	1.88	−1.25
Asian			59	554.25	−3.65	2.63	−1.39

*$p<0.05$

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