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Demographics and Equity of Dual Language Immersion Programs in Washington, DC

An analysis of the demographics of kindergarteners in DC public dual language immersion (DLI) schools as compared with non-DLI schools to move beyond anecdotal evidence and inform the debate on equity of access to and enrollment in DLI programs. The report highlights areas of concern and identifies policies and further research needed to allow the District's most vulnerable students equitable access to these opportunity-boosting programs.

Report jointly produced by the National Foreign Language Center, University of Maryland, and the DC Language Immersion Project

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DEMOGRAPHICS AND EQUITY OF DUAL LANGUAGE IMMERSION PROGRAMS IN WASHINGTON, DC

Introduction

Goals and Need for This Analysis

This report investigates the racial/ethnic and socioeconomic composition of dual language immersion (DLI) kindergarten populations as compared with other kindergarten populations in the District of Columbia's traditional public and public charter schools, using publicly available data, and makes recommendations for policies to expand access to DC's DLI programs for students from a range of backgrounds.[1]

Journalists, researchers, parents, and policymakers discuss the relationship between DLI programs and equity of access to high-demand academic programs (Todd, 2019; Williams, 2019), the role of parental preference (Cooperative Strategies, 21st Century School Fund, & Urban Institute, 2018), gentrification (Garcia, 2017; Stein, 2018), achievement (Alpert, 2015; Perry, 2019; Wilson, 2016), diversity (Williams & Brown, 2016), and integration (Orfield & Ee, 2017). These discussions rely on different degrees of empirical and anecdotal evidence and, in many cases, on data from individual schools. By directly comparing the demographics of DLI schools with other schools in the District in aggregate for the first time, this report establishes an empirical foundation for more substantive discussions on DLI schools and provides key evidence to inform policy decisions on

- whether and where to implement new DLI programs,
- how to promote equitable access to DLI programs, and
- how DLI programs may be used to promote diversity and integration in our public schools.

These goals are accomplished through two complementary analyses. First, we examine longitudinal demographic changes during the period of school years 2010–2011 through 2015–2016, with the goal of determining whether patterns of demographic shifts in DLI schools parallel those in non-DLI schools. Second, we present a one-year snapshot focusing on SY 2015–2016 that examines differences between the demographics of DLI and non-DLI programs in terms of racial/ethnic diversity, student socioeconomic status, and student special education status, while controlling for location and taking into account additional factors associated with school preference.[2]

The report concludes with policy recommendations stemming from the results of the analyses, as well as recommendations for further research.

Before we delve into the two analyses, below is background on the definitions, outcomes, integrating potential, and equity of dual language immersion programs, on the demographics of public schools in DC, and on the history, geography, demand, and accessibility of dual language programs in DC.

DUAL LANGUAGE IMMERSION (DLI) Programs where at least 50% of instruction is provided in a partner language through fifth grade or where programs are working toward that 50% goal and, for sixth grade onward, where bilingualism and biliteracy are the goal. Also called dual language or language immersion programs. These programs differ from foreign language classes in that dual language immersion programs provide instruction through the medium of the partner language and not as an add-on subject.

Dual language immersion programs are a type of bilingual education program but are distinct from other bilingual education programs such as transitional bilingual programs and heritage language programs.

1. We decided to focus the study on a single grade to ensure comparability in the ages of the population; comparing a single grade allows us to more closely track year-to-year changes in the schools' populations than if we were to look at a range of grades. Kindergarten was selected as the target grade for this study, as this is the first year of schooling in which enrollment is compulsory and the first in which DC residents have the right to attend their neighborhood school. See the Longitudinal Analysis section (p. 19) for more information.
2. Because this study uses publicly available data and not student-level data, we cannot look at the interaction of race/ethnicity and socioeconomic status. See the Conclusions and Recommendations section (p. 49) for further research recommendations.

Dual Language Immersion Programs: Definitions, Outcomes, Integrating Potential, and Equity

Dual language immersion programs are programs in which students learn academic content at least partially in a language other than English. They are reported to have beneficial outcomes for students and their broader communities and have been found to have the potential to integrate schools.

Definitions

For the purposes of this report, we define as DLI programs those elementary school programs where at least 50% of instruction is provided in a language other than English (a partner language) through fifth grade or where programs are working toward that 50% goal and, for sixth grade onward, where bilingualism and biliteracy are the goal. Because in DLI programs content is simply taught through a language other than English, a DLI program does not preclude other programmatic choices. In DC, there are DLI Montessori programs, DLI International Baccalaureate (IB) programs, a DLI arts integration program, and a DLI exploratory learning program with a sustainability curriculum.

There are a variety of DLI program models; some relate to the percentage of instructional time spent in the partner language (see definitions of 50/50 and 90/10 models), while some relate to the populations enrolled (see definitions of one-way and two-way programs).

ONE-WAY PROGRAM

Program in which the majority of students are native speakers of the dominant language (English in the United States) or program in which the majority of students are native speakers of the partner language. Normally, in the former type of one-way program, the instruction model is designed for non-native speakers of the partner language to learn that language while simultaneously learning grade-level content, whereas in the latter type of one-way program, the instruction model is designed primarily for English language learners (ELs) to access content faster and more easily while building English competence and retaining proficiency in their home language. Also called one-way immersion.

TWO-WAY PROGRAM

Programs in which the class population is approximately balanced between students who are native speakers of the partner language and students who are English native speakers. Normally, in a two-way program the instruction model is designed for students to learn with and from each other, with both groups of students advancing in English and the partner language while simultaneously gaining proficiency in grade-appropriate content areas. Also called two-way immersion.

Because DLI programs in DC use a variety of models for the percentage of instructional time across different grades, ranging from 50/50 to 90/10, we do not distinguish among these models for the purpose of this report.

The nine DLI programs included in the report include both two-way and one-way programs, with somewhat fluid demarcation lines between models as the populations of most of these programs do not fit squarely into one or the other model. In addition, it is not uncommon for schools to simultaneously implement different models in different grades due to different percentages of partner language speakers and different needs of the overall populations in each grade. Therefore, and also in light of the relatively small number of DLI schools that are the object of this study, we did not separate one-way and two-way programs in our analyses. See the Conclusions and Recommendations section (p. 53) for further research recommendations.

DLI programs can be offered to all students in a school (whole school program) or to only a subgroup of students (strand program). In DC, as of 2019, there are four remaining strand programs, while the rest of the programs are whole school programs. The analyses in the report exclude the schools with strand programs, since at the time of writing data were not available for individual strands within these schools.

Research comparing bilingual children or adults with their monolingual peers finds that bilinguals have many cognitive advantages, including in executive function and multitasking, selective attention, decision making ability, problem solving ability, general linguistic ability, and delay of age-related cognitive decline and dementia.

Most schools offer DLI programs in one partner language, while others offer DLI in two or more partner languages. In DC, there are only two DLI schools that offer programs in multiple partner languages: one school with French and Spanish, and a second with French, Spanish, and Mandarin. Most DLI programs in DC are offered in Spanish. The other available languages are French, Hebrew, and Mandarin. As of 2019, programs in additional languages (including Arabic and Russian) are in various stages of development.

50/50 & 90/10 MODELS

50/50 is a DLI model for percentage of instructional time, in which 50% of instruction takes place in English and 50% takes place in the partner language. This model is prevalent in two-way programs. These percentages can change as students progress to higher grades.

90/10 is a DLI model for percentage of instructional time in which instruction takes place mainly in the partner language, generally with the exception of specials like music, physical education, and art. This model is common in one-way programs, particularly in the early grades.

Outcomes

Cognitive, social, and economic benefits of bilingualism

Bilingualism has many well-established cognitive, social, and economic benefits. Research comparing bilingual children or adults with their monolingual peers finds that bilinguals have many cognitive advantages, including in executive function and multitasking (Bialystok, 2011), selective attention (Bialystok, 1992), decision making ability (Keysar et al., 2012), problem solving ability (Bamford & Mizokawa, 1991), general linguistic ability (Barac & Bialystok, 2012), and delay of age-related cognitive decline and dementia (Bialystok et al., 2012). In a study in Luxembourg examining relationships among bilingualism, poverty, and executive functioning, researchers found that poor bilingual children performed significantly better than monolingual students in selective attention and interference suppression, providing evidence that bilingual advantage is not limited by socioeconomic factors (de Abreu et al., 2012). For heritage language learners—that is, students learning a language that has been a native language for others in their family—higher levels of proficiency in the heritage language have been positively associated with the quality of parent-adolescent relationships and ethnic identity (Oh & Fuligni, 2009). Bilingual ability is also highly valued in the workplace, with many employers preferring bilingual or multilingual candidates (see, e.g., Damari et al., 2017; New American Economy, 2017; Porras, Ee, & Gándara, 2014). In the DC region specifically, the demand for multilingual employees more than doubled between 2010 and 2016 as indicated in a report by New American Economy (Liao, 2017). In some contexts, bilingual employees earn more money than their monolingual peers (Porras, Ee, & Gándara, 2014; Rumbaut, 2014), though more research is needed in this area. And finally, the recent report "Making Languages Our Business" finds that the demand for multilinguals is expected to grow, with 56% of survey respondents (US employers) projecting an increase in their foreign language demand over the next five years (American Council on the Teaching of Foreign Languages, 2019).

The Seal of Biliteracy,[3] an acknowledgment of a certain level of biliteracy that is reported in graduation transcripts, has been adopted by many states, including DC, as a way to signal to colleges and employers that the recipient of the seal has this valuable skill.[4] The Global Seal of Biliteracy[5] enables educators across the world to quickly validate their students' language skills to properly place them and award credit, and it allows employers to easily verify applicants' language skills and be confident that they bring the valuable interpersonal skills linked to bilingualism. These skills can translate into college credits and therefore reduce time and cost for a college education.

Benefits of a DLI education

For students in DLI programs specifically, emerging research shows that students from a variety of backgrounds achieve at or above the level of their peers on standardized assessments while also becoming proficient in another language. Students in DLI programs in Utah grew more in math from third to fourth grade (the grades investigated in the study) than students not in DLI programs, with no difference identified between students in one-way and two-way programs (Watzinger-Tharp et al., 2016). In Portland Public Schools (Oregon), students enrolled in DLI programs were seven months ahead of non-DLI students in English reading by fifth grade and nine months ahead of non-DLI students in English reading by eighth grade, with no detriment found in math or science; no significant difference was found between one-way and two-way programs (Steele et al., 2017).

In addition to the academic benefits, in a well-implemented DLI program, students benefit from the perspective that classroom diversity is an asset. Classroom-level integration is promoted through cross-cultural practices such as positioning students and families from diverse linguistic backgrounds as language and culture brokers for each other (DeMatthews, Izquierdo, & Knight, 2017) and through presenting a counter-narrative to dominant racial ideologies that disregard non-European cultures (Kotok & DeMatthews, 2018; Wiemelt & Welton, 2015).

Benefits of DLI for disadvantaged students

The academic advantages of a DLI education are found across demographic groups, but a related set of studies finds distinct benefits for otherwise disadvantaged groups. ELs frequently experience delays in English reading proficiency compared with their peers who are native English speakers. Students in Portland Public Schools who were non-native speakers of English had lower rates of classification as ELs by sixth grade if they were in a DLI program, even if they were learning a new language, that is, a third language after their native language and

3. https://sealofbiliteracy.org
4. Subtirelu et al. (2019) raise questions about equity of access to the Seal itself for language minority students, students of color, and students from low-income families.
5. https://theglobalseal.com

For students in DLI programs specifically, emerging research shows that students from a variety of backgrounds achieve at or above the level of their peers on standardized assessments while also becoming proficient in another language.

English (Steele et al., 2015). In another school district in Oregon, ELs in DLI programs nearly closed the English reading gap between third and seventh grade (Thomas & Collier, 2012). Umansky and Reardon (2014) found Spanish DLI programs to be more effective than other options leading to the reclassification of Latino ELs as English proficient by high school after a delay in reclassification in elementary school. Valentino and Reardon (2015) found Spanish DLI programs to be associated with the most improvement in English language arts scores for Latino ELs between kindergarten and seventh grade. Thomas and Collier (2012) also found closing or substantial reduction of achievement gaps for African American students, low socioeconomic status students, and special education students who are in DLI programs.

ENGLISH LANGUAGE LEARNER (EL)

Defined under the No Child Left Behind Act as students whose native language is not English and whose English language proficiency is at a low enough level that it may affect their academic assessment outcomes, classroom success, or ability to participate fully in English-language society. Sometimes also called English learners (ELs), limited English proficient (LEP), or emerging bilinguals (EBs).

While more research is needed in this area, the research currently available shows advantages for many groups of students enrolling in DLI programs, regardless of race/ethnicity, home language, cognitive or academic ability, or socioeconomic status.

Even with these significant positive outcomes of DLI programs, an analysis of yearly operating costs of DLI in DC (Levy, 2015) points to most DLI programs operating at or below the DCPS average. This finding is reinforced by the recent analysis of the operating costs of dual language programs in Portland, Oregon (Steele et al., 2018).

Integrating potential of DLI

In the context of highly segregated DC schools and high-demand/low-supply DLI programs, an opportunity exists to integrate schools through the strategic expansion of DLI programs, not only through two-way DLI programs but also through one-way DLI programs, as both have the potential to increase diversity in schools, in different ways.

Benefits of integration

Integration of schools along racial/ethnic and socioeconomic lines has been shown to be advantageous to multiple groups of students. As a general matter, racial/ethnic minority students in integrated schools can expect better academic outcomes than those in segregated schools, while their White classmates in integrated schools suffer no academic disadvantage compared with White students in segregated schools and in some situations also see improved academic outcomes (Braddock, 2009; Card & Rothstein, 2006; Hoschild & Scrovronick, 2004; Johnson, 2011; Reardon, Kalogrides, & Shores, 2017; Siegel-Hawley, 2012).[6]

Schools that are "doubly segregated by both race/ethnicity and poverty" are associated with many circumstances resulting in lower academic achievement (Orfield & Ee, 2017, p. 16). Factors associated with differences between higher SES schools and lower SES schools in student outcomes include teacher expectations, amount of homework assigned per week, availability of advanced courses, and students' feelings of being unsafe at school (Rumberger & Palardy,

6. However, Hoxby and Weingarth (2005) and others argue that students' initial achievement and their classmates' initial achievement are more useful predictors of their outcomes than the socioeconomic or racial composition of their classes.

2005, 2016). Even after controlling for test scores, students from highly segregated schools are less likely to be successful in college (Camburn, 1990).

In addition to the academic benefits associated with education in diverse schools, students in integrated schools seem to be less likely to accept stereotypes (Mickelson & Nkomo, 2012; Ready & Silander, 2011) and more able to make friends with students from different backgrounds (Killen, Crystal, & Ruck, 2007)—abilities that can have a positive impact on these students' lives and on society.

However, DC schools are highly segregated, not only among public schools but also among private schools and between public and private schools (Di Carlo & Wysienska-Di Carlo, 2017). According to Orfield and Ee (2017, p.11), "The schools are much more segregated than the city or the metro area. Residential segregation remains high in the city but isolation in schools is substantially greater." Previous research reveals inequities in commute time to school based on race and home ward (Blagg et al., 2018), which may contribute to school segregation.

WARD

Washington, DC, is divided into eight geographic wards for the purpose of politically representing approximately 75,000 residents each.

Integrating through both two-way and one-way DLI programs

DLI programs are often highlighted for their potential to increase school and classroom diversity and to integrate groups within a school (DeMatthews, Izquierdo, & Knight 2017; Kotok & DeMatthews, 2018).

A recent report recommends the use of DLI programs as a tool to desegregate DC schools specifically (Orfield & Ee, 2017). Decisions as to siting of new DLI programs are key to realizing the integrating potential of DLI programs. Some argue that clustering DLI programs in neighborhoods with high concentrations of EL, poor, or special needs students makes them less attractive to families who would have to come from other neighborhoods, therefore undermining desegregation efforts. This is not an issue with regard to EL students in the District, because even in the DC neighborhoods that have the highest concentrations of EL students, that concentration is only at approximately 30% of public school students. On the other hand, the high segregation by income could indeed undermine desegregation efforts if DLI programs were to be located in very low-income neighborhoods. However, the market forces at play in the District could lessen this argument as the very high demand for and low supply of DLI programs could overcome parental preferences for proximity and for wealthier student populations. We see particular promise for the desegregating potential of DLI programs in poor neighborhoods where there currently is some socioeconomic diversity. Currently that socioeconomic diversity is often not translated into the schools in those neighborhoods. With a highly desirable program in very low supply being implemented in poor neighborhoods, some of the socioeconomic diversity present in the neighborhood could be mirrored in the classrooms, while also bringing in additional socioeconomic diversity as families travel from

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Given the uneven distribution of racial/ethnic and linguistic groups around the city, it may not be possible to serve sufficient numbers of ELs and Black students in the same programs, or even in the same types of programs.

other neighborhoods for this high-demand program. In addition to location of DLI programs, lottery and enrollment policies can be designed to promote diversity, whether linguistic, racial/ethnic, or socioeconomic.

While most of the research around dual language and integration focuses on two-way programs, because of the geographic distribution of the population of the District, two-way DLI programs are not an option in the neighborhoods with high concentrations of Black students who are native English speakers but with no populations of partner language speakers living close by. The District does not have the option to ignore large swaths of the city when addressing the integrating potential of DLI programs. Given the uneven distribution of racial/ethnic and linguistic groups around the city, it may not be possible to serve sufficient numbers of ELs and Black students in the same programs, or even in the same types of programs.

PARTNER LANGUAGE
Language of a DLI program other than the typical language of instruction in that location (that is, other than English in the United States). Also called target language. DLI programs can offer one or multiple partner languages.

Anecdotal evidence from DC's two DLI programs recently opened in predominantly English-speaking, Black, and poor neighborhoods allows some interesting initial observations about the integrating potential of one-way DLI programs.

BY-RIGHT
Indicates the instances where students residing in the school's attendance boundary are guaranteed access to the school or program.

In SY 2016–17, Houston Elementary, a DC Public School, started a DLI program in PK3. Houston Elementary DCPS is located in the Deanwood neighborhood in Ward 7, where in SY 2016–17 only 26% of students enrolled in their by-right neighborhood schools, compared with 31% of students citywide (OSSE audited enrollment data reported by the Office of the Deputy Mayor for Education, 2019: https://edscape.dc.gov/node/1363781), with the majority of the families in the neighborhood, regardless of resources, opting to enroll their children elsewhere. The new DLI program enticed many local families to enroll their children and give their neighborhood school a chance. These families have remained at the school as the program grows by one grade each year. Families who live outside of the neighborhood have also enrolled their children. The DLI program is stabilizing enrollment in the school, which had a waitlist for kindergarten for the first time in a decade and is increasing the socioeconomic diversity of the school population.

Elsie Whitlow Stokes Public Charter School, which offers both a Spanish DLI program and a French DLI program, was the first DLI public charter school to open a campus east of the Anacostia River (Wards 7 and 8). Elsie Whitlow Stokes PCS, like Houston Elementary DCPS, provided Ward 7 families who would otherwise have enrolled their children in schools outside of the ward with a highly desirable DLI program in a school in their neighborhood. The school is attracting not only the neighborhood families who would normally have enrolled their children outside of their neighborhood but also families who live outside the neighborhood, providing anecdotal evidence that the desirability (and low supply) of DLI programs might trump proximity in parental preferences.

In both of these cases, the addition of DLI programs seems to be the most likely explanation for changes in parents' interest in enrolling their children in a school in these neighborhoods, though research is needed to clarify the extent of and reasons for these changes.

Equity in DLI programs

For decades, DLI programs have been considered for the most part remedial programs for EL students and therefore most appropriate for this population. Longitudinal research conducted over the last decade found that DLI programs are indeed one of the best types of programs for EL students to acquire English, helping to close the achievement gap while allowing EL students to retain their home language. However, some of that same research found that DLI programs benefit students regardless of language spoken at home. Therefore, while DLI programs are critical for EL students' academic success and significantly contribute to their sense of self, their ability to interact with their extended families and communities, and their academic achievement, the programs might be just as important for native English speakers. In particular, for underserved native English-speaking students who do not have the advantage of speaking or being familiar with another language, access to a DLI program might be one of the best ways to close achievement gaps and gain an increasingly valuable skill for their future job opportunities and to develop stronger cognitive and executive functioning skills and higher achievement in English reading.

AT-RISK

At-risk student is defined by the Code of the District of Columbia (2001, §38-2901) as a student who is "homeless; in the District's foster care system; qualifies for the Temporary Assistance for Needy Families program or the Supplemental Nutrition Assistance Program; or [is] a high school student that is one year older, or more, than the expected age for the grade in which the student is enrolled." At-risk status is the socioeconomic factor at focus in this report.

Therefore, for the purpose of this report, we define equity of access to DLI programs loosely as the ability of students representing a variety of demographic groups to gain entry to a DLI program via lottery and to actually attend a DLI program. While the report compares the demographics of DLI programs with the overall demographics of schools in the District, we do not express the view that students enrolled in individual DLI programs should reflect the overall population of the District. The policy recommendations in the conclusion focus on addressing the clearest inequities identified in the study. At a minimum, the percentage of at-risk students in DLI programs as a group should reflect the overall percentage of at-risk students in DC, but ideally all at-risk students would have privileged access to DLI programs due to the future opportunity benefits of these programs and the lack of opportunities to gain these benefits via language learning otherwise.

Demographics of Public Schools in DC

This report focuses on the kindergarten populations in SY 2010–11 to SY 2015–16. To better understand the demographic context during these years, this section describes the student population in the District of Columbia across sectors—traditional public, public charter, and private—and addresses composition in terms of race/ethnicity, at-risk populations, and EL populations. Because the District is divided into wards and because part of the analysis in this report controls for ward, where possible we describe populations by ward.

Over the last 20 years, the demographics of DC have changed dramatically due to immigration from foreign countries (Migration Policy Institute, 2019) and due to an influx of a wealthier middle class (Rabinowitz, 2017). Since 2010, the District has steadily grown in overall

Demographic groups are not evenly distributed across the city, whether by race/ethnicity, socioeconomic status, or home language; the District's eight wards have very different student populations in terms of these factors.

population from 600,000 to an estimated 700,000 in 2018 (U.S. Census Bureau, 2018), with a boom in the population of young children. According to data from the U.S. Census Bureau, as reported by the Office of the Deputy Mayor for Education of DC (2019), the population of children from the ages of 0 to 13 in the District has increased by nearly 25,000 between 2010 and 2017 (https://edscape.dc.gov/node/1385371).

During the same period of time, the District saw a change in the racial/ethnic composition of the population of under 18. Between 2010 and 2016, the percentage of non-Hispanic Black children in the District decreased from 65% to 56%, while the percentage of Hispanic/Latino children increased from 12% to 17%, and the percentage of non-Hispanic White children increased from 18% to 21% (U.S. Census Bureau data, as reported by the Annie E. Casey Foundation: https://datacenter.kidscount.org/data/tables/103-child-population-by-race?loc=10).[7]

Enrollment in public and private schools in DC

In SY 2010–2011, 74,996 students were enrolled in Grades PK3 through 12 in DC's public schools (both traditional public and public charter schools); in SY 2015–2016, this number was 87,344. The total population of school-aged children (PK3–12) in DC's public schools increased by 30% between 2008 and 2018 (OSSE Audited Enrollment Data, as reported by the Office of the Deputy Mayor for Education, 2019: https://edscape.dc.gov/node/1385261).

Of course, not all school-age children in DC attend public school. According to the estimates of the American Community Survey, from 2013 to 2017 14.5% to 16.7% of DC's kindergarten students attended private schools, a group unevenly distributed across the city. "The share of private school enrollment varies substantially by ward. Relying on the same five year American Community Survey estimates, between 41% and 49% of students in Ward 3 attended private school compared to between 3% to 6% of students in Ward 7" (Office of the Deputy Mayor for Education, 2019: https://edscape.dc.gov/node/1385301). According to a report based on 2011 data, "private schools, while serving only 15 percent of all D.C. students, enroll almost 60 percent of its White students" (Di Carlo & Wysienska-Di Carlo, 2017).

Differences in demographics by ward

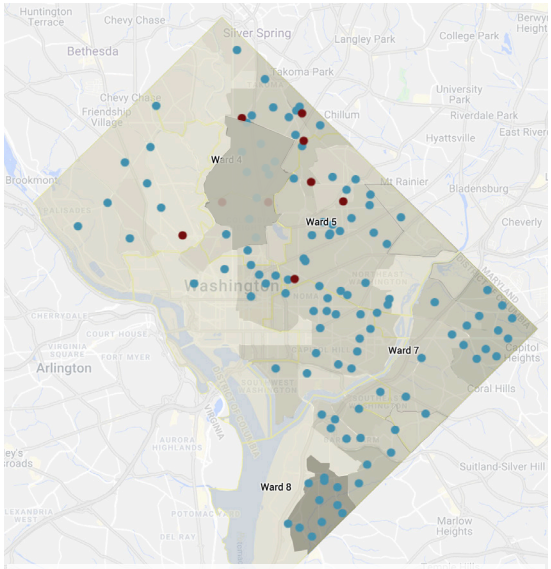
Demographic groups are not evenly distributed across the city, whether by race/ethnicity, socioeconomic status, or home language; the District's eight wards have very different student populations in terms of these factors. In SY 2015–16, out of all kindergarten to fifth grade students enrolled in public schools, 8,759 lived in Ward 8, 7,072 lived in Ward 7, and 5,771 lived in Ward 4. By comparison, only 750 kindergarten to fifth grade students enrolled in public schools lived in Ward 2 (OSSE Audited Enrollment Data, as reported by the Office of the Deputy Mayor for Education, 2019: https://edscape.dc.gov/node/1385281). These discrepancies are due both to differences in the number of school-age children in these wards and to the high proportion of Ward 2 residents attending private schools.

7. The racial/ethnic categories used here are from the U.S. Census Bureau. The categories used for the analyses detailed in this report come from the U.S. Department of Education; some of the category names are different, but the categories are parallel.

Racial/ethnic groups are not evenly distributed by ward. Ward 7 and Ward 8 are heavily Black, with over 90% of their under-18 populations identifying as Black throughout the years of the study. Wards 4 and 5, where many DLI schools are located, saw substantial changes in their racial/ethnic composition during the period of the study. Ward 4 began as majority Black but saw the proportions of Hispanic and White residents increase to over 25% each by the final year of the study, while Ward 5 went from over 90% Black to 71% Black, with proportions of Hispanic and White residents reaching the mid-teens by the final year of the study. During the years of the study, Ward 1 did not have a majority group but saw increasing proportions of White and Hispanic residents and a decreasing proportion of Black residents over the years of the study (U.S. Census Bureau data, as reported by the Annie E. Casey Foundation: https://datacenter.kidscount.org/data/tables/8874-race-ethnicity-of-child-population-by-ward).

At-risk students in DC's public schools

At-risk students are also concentrated in particular areas of the city, as seen in this map from SY 2015–16.



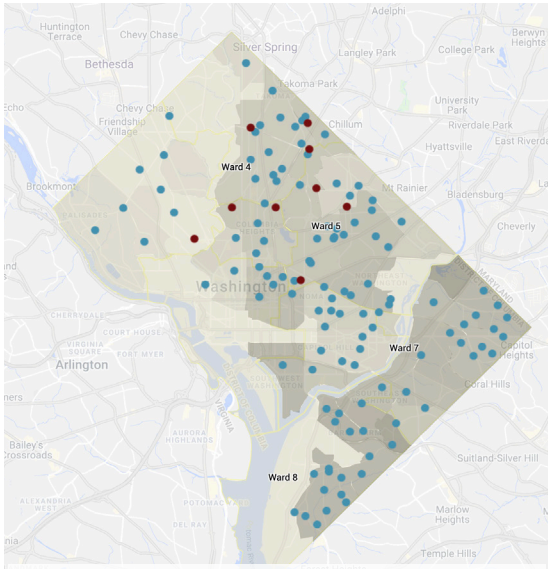


Figure 1: Number and share of at-risk students by neighborhood cluster for SY 2015–16
Source: OSSE Audited Enrollment Data, as reported by the Office of the Deputy Mayor for Education, 2019: https://edscape.dc.gov/page/pop-and-students-where-students-at-risk-live

English language learners in DC's public schools

In SY 2015–16, of the 6,119 EL students in DC,[8] 4,878 spoke Spanish or Castilian, 298 spoke Amharic, 168 spoke French, 89 spoke Chinese, and 52 spoke Vietnamese (U.S. Department of Education, 2016). While we do not have access to data on the percentage of ELs who are Hispanic or Latino, the data relating to language spoken at home seems to indicate that at least 80% of the District's ELs might be Hispanic or Latino. English learners are heavily concentrated in Ward 1 and Ward 4 (OSSE Audited Enrollment Data, as reported by the Office of the Deputy Mayor for Education, 2019: https://edscape.dc.gov/node/1385276).

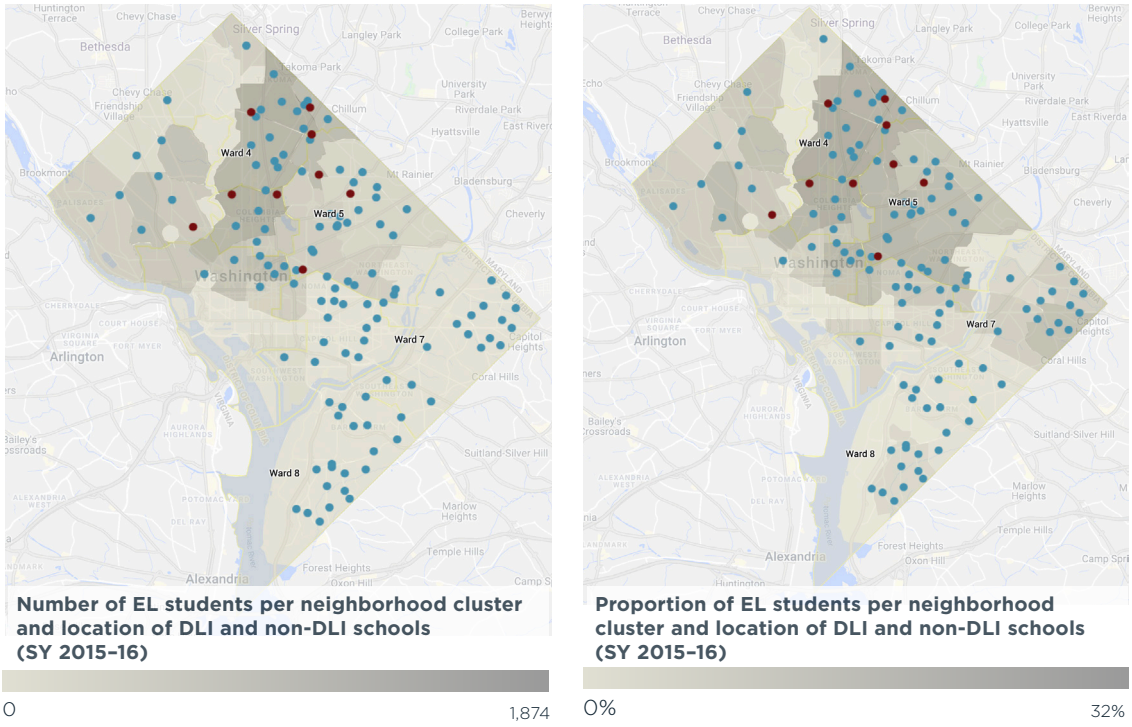


Figure 2: Number and share of student English learners by neighborhood cluster for SY 2015–16 Source: OSSE Audited Enrollment Data, as reported by the Office of the Deputy Mayor for Education, 2019: https://edscape.dc.gov/node/1385276

8. In contrast to the 5,847 LEP number reported by OSSE to the U.S. Department of Education (U.S. Department of Education, 2016), EdScape reports 7,855 LEP students in SY 2015–2016, for which the stated source is the OSSE Audited Enrollment for the same year (Office of the Deputy Mayor for Education, 2019: https://edscape.dc.gov/node/1363636).

Demographics of traditional public versus charter public sectors

Enrollment in the charter sector has grown steadily since 1997. In SY 2015–16, public elementary school students were enrolled in traditional public (in-boundary and out-of-boundary) and public charter sectors at the following rates (OSSE Audited Enrollment Data, as reported by the Office of the Deputy Mayor for Education, 2019: https://dataviz1.dc.gov/t/OCTO/views/EnrollmentPatterns-Choice_15585430296170/ESStudentsPK3-5embed):

- 29% in DCPS in-boundary school
- 24% in DCPS out of boundary (through the lottery)
- 2% in DCPS citywide (through the lottery)[9]
- 43% in public charter schools (through the lottery)

These groups were unevenly distributed across the city, with higher rates of students in the western part of the city attending their in-boundary schools and higher rates of students in the eastern part of the city attending public charter schools.[10] There are also notable differences between the races and special populations served by each sector. In SY 2015–16, the charter sector enrolled roughly half of non-Hispanic Black kindergarteners enrolled in DC's public schools but only enrolled roughly one-fourth of Hispanic, White, and Asian kindergarteners. In the same year, the charter sector enrolled only 39% of the at-risk kindergarteners enrolled in DC's public schools and only 29% of the EL kindergarteners in DC's public schools (U.S. Department of Education, 2017).

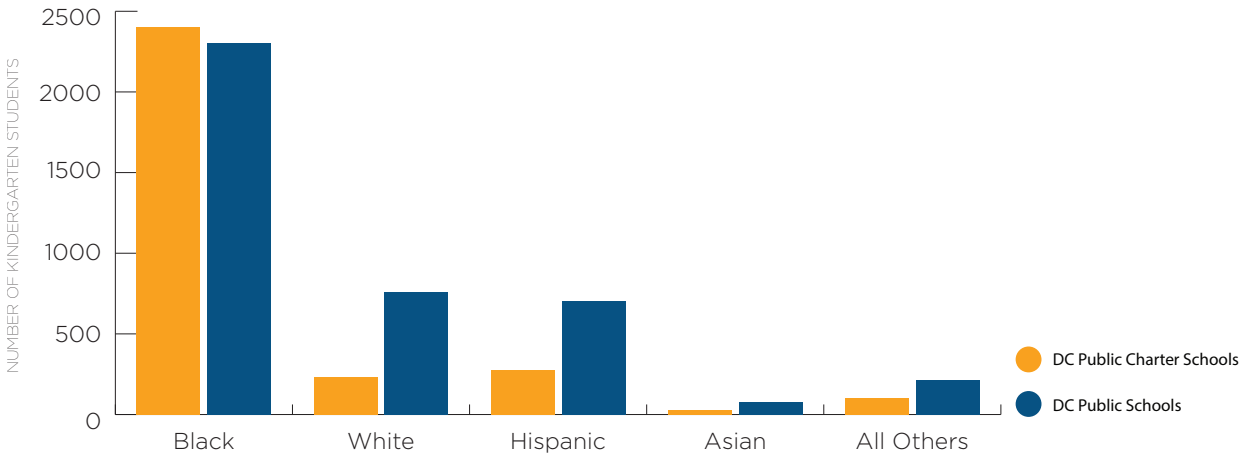


Figure 3: Kindergarten enrollment by race/ethnicity, broken down by sector SY 2015–16 Source: U.S. Department of Education, 2017

9. "A citywide school is a DCPS school that does not have a boundary and therefore cannot be claimed as an in-boundary school" (https://www.myschooldc.org/faq/faqs).
10. Ibid.

State of DLI in DC: History, Geography, Demand, and Accessibility

The District of Columbia was an early adopter of DLI, is host to some of the most innovative DLI programs in the country, and compared with other states, has a relatively high number of DLI programs given the population of the city. Yet, the DLI programs are not evenly distributed geographically and are insufficient to meet the growing demand from families.

History (across education sectors)

The District has had DLI programs for over 40 years, beginning with the founding of a DLI program at J.F. Oyster Elementary (now Oyster Adams Bilingual) in 1971. Over the last 20 years the number of public DLI schools in the District has grown to include 23 programs (as of SY 2019–20). Historically, DLI programs were mostly Spanish-language elementary programs, opened in neighborhoods densely populated by Latino families. Over the years, the District added middle and high school DLI programs, and now most students enrolled in DLI programs have a right to continue in a DLI program from PK3 through twelfth grade, though schools are not always geographically convenient to where students live, and there may not always be enough seats in the DLI middle and high schools for all students completing elementary DLI programs. Of the current 23 DLI programs, 16 are elementary, 4 are middle, and 3 are high school programs.

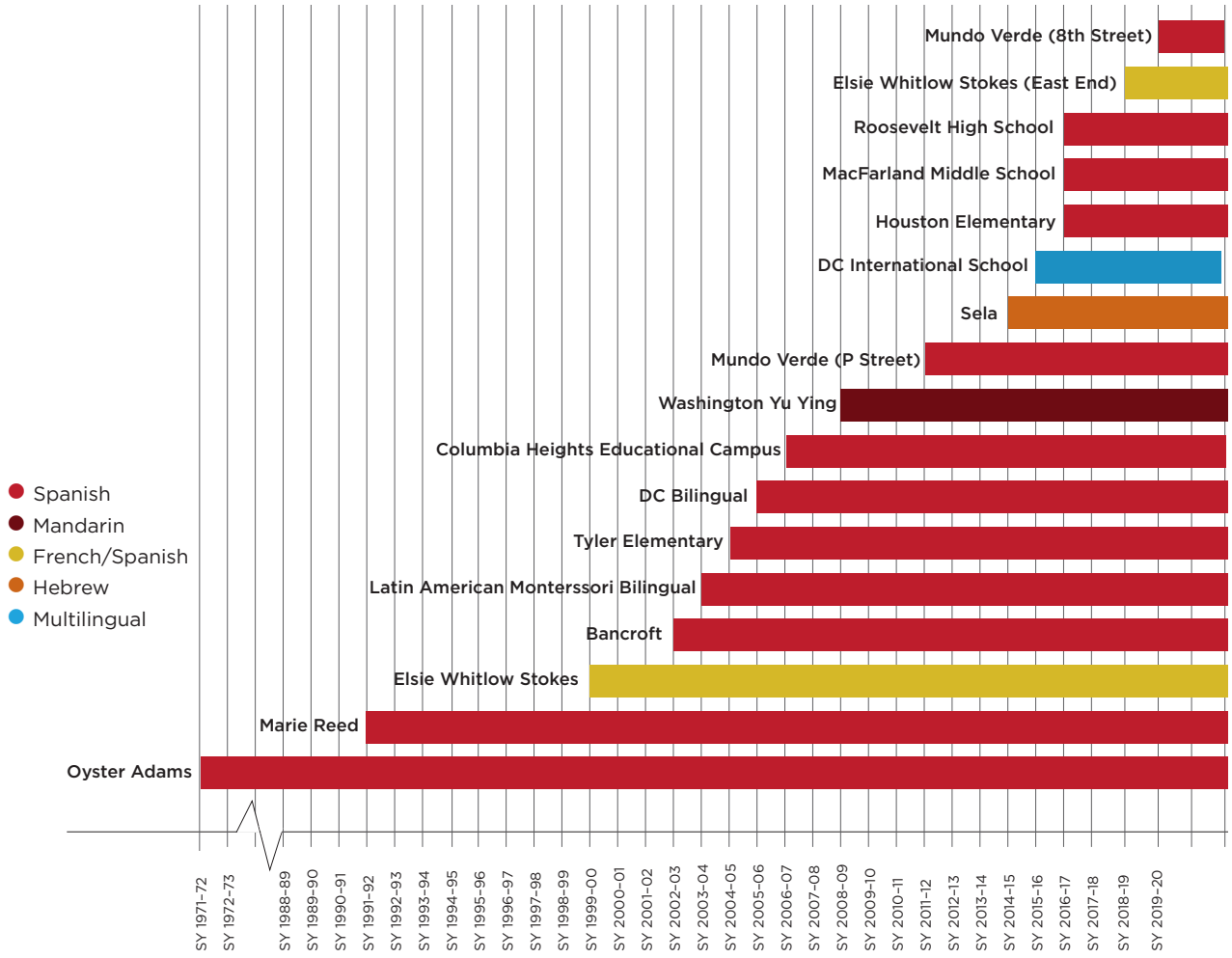


Figure 4: Time frame of implementation of DLI programs in DC

DC Language Immersion Project, 2019

Both the number of DLI programs and the number of students in DLI are roughly evenly split between DCPS and public charter schools. While all DLI programs in DCPS are in Spanish, public charter schools offer DLI programs in Spanish, French, Mandarin Chinese and Hebrew. Both sectors have a combination of elementary, middle, and high school DLI programs. All of the public charter school DLI programs are whole school programs, while four of the DCPS DLI programs are still strands, where approximately half of the school population is enrolled in the DLI program and the other half is enrolled in an English-only program.[11]

Table 1: DLI programs by grades served, sector, and language (as of 2019)
Source: DC Language Immersion Project

ELEMENTARY SCHOOLS (PK3–5)	SECTOR	WHOLE/STRAND	LANGUAGE
Bancroft	DCPS	W	Spanish
Bruce-Monroe @ Park View	DCPS	W	Spanish
Cleveland	DCPS	S	Spanish
DC Bilingual	DCPCS	W	Spanish
Elsie Whitlow Stokes (Brookland)	DCPCS	W	Spanish, French
Elsie Whitlow Stokes (East End)	DCPCS	W	Spanish, French
Houston	DCPS	W	Spanish
Latin American Montessori Bilingual (Missouri)	DCPCS	W	Spanish
Latin American Montessori Bilingual (Aspen)	DCPCS	W	Spanish
Latin American Montessori Bilingual (Perry)	DCPCS	W	Spanish
Marie Reed	DCPS	S	Spanish
Mary McLeod Bethune (16th)	DCPCS	W	Spanish
Mary McLeod Bethune (Jackson)	DCPCS	W	Spanish
Mundo Verde (P St)	DCPCS	W	Spanish
Mundo Verde (8th St)	DCPCS	W	Spanish
Oyster-Adams (Oyster)	DCPS	W	Spanish
Powell	DCPS	W	Spanish
Sela	DCPCS	W	Hebrew
Tyler	DCPS	S	Spanish
Washington Yu Ying	DCPCS	W	Mandarin

MIDDLE SCHOOLS (6–8)	SECTOR	WHOLE/STRAND	LANGUAGE
District of Columbia International	DCPCS	W	Spanish, French, Mandarin
Lincoln Multicultural (CHEC)	DCPS	W	Spanish
Oyster Adams (Adams)	DCPS	W	Spanish
MacFarland	DCPS	S	Spanish

HIGH SCHOOLS (9–12)	SECTOR	WHOLE/STRAND	LANGUAGE
Bell Multicultural (CHEC)	DCPS	S	Spanish
District of Columbia International	DCPCS	W	Spanish, French, Mandarin
Roosevelt	DCPS	S	Spanish

11. These strand programs are Tyler Elementary DCPS, Marie Reed Elementary DCPS, Cleveland Elementary DCPS, and Powell Elementary DCPS (though Powell is currently in the process of shifting to a whole school model). As mentioned earlier, these programs are excluded from the present study because student data were not available by strand.

Geography

The majority of DLI programs are still centered around the historically heavily Latino 16th Street corridor in the northwest quadrant of the city and in Ward 5 in the northeast quadrant. As of SY 2019–20, there are two nascent programs in Ward 7: Elsie Whitlow Stokes PCS East End campus in its second year and Houston Elementary DCPS in its fourth (neither of these is included in this study because they were not operating DLI programs until after SY 2015–16). Out of the eight wards of the District, Ward 2 and Ward 8 have no DLI programs, and Ward 6 and Ward 3 only have one DLI program each.

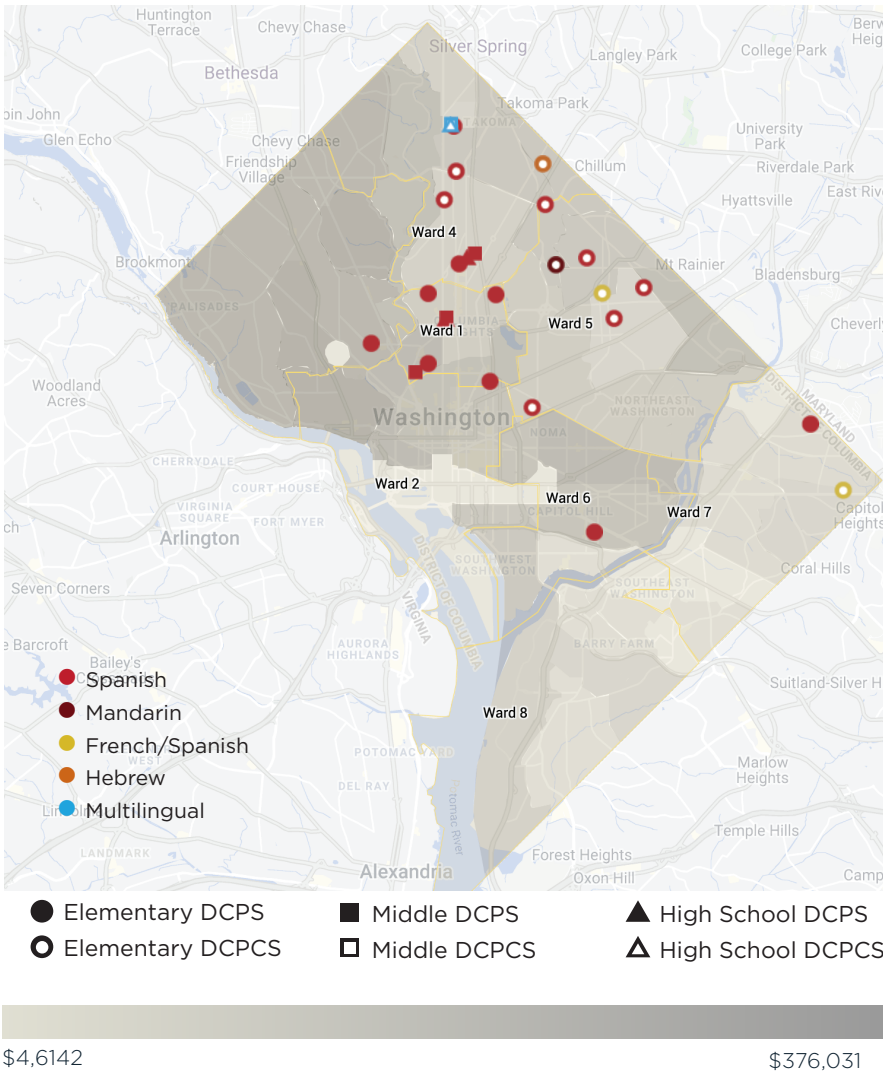


Figure 5: Map of DLI programs and income (as of 2019)
Source: DC Language Immersion Project

DLI programs are not evenly distributed geographically, and this potentially has implications for equitable access by racial/ethnic group and by socioeconomic status, since DLI programs are clustered relatively far from neighborhoods with concentrated Black and low-income populations and generally closer to neighborhoods with concentrated Hispanic/Latino populations. As DC relies primarily on walking, public transportation[12] and family involvement to get students to school, and since this is particularly so in the case of elementary school students,

12. The School Transit Subsidy Program has only been free to students since the fall of 2016 and is therefore not relevant for the purposes of this study.

geographic proximity is a considerable factor in any study looking at kindergarten populations (Urban Institute Student Transportation Working Group, 2018). We return to the topic of geographic proximity in the discussion of the results of the studies.

The 2018 Master Facilities Plan study (MFP) (Office of the Deputy Mayor for Education, 2018) examined the distribution of specialized programs in DCPS and public charter schools, as defined uniformly by both sectors and included in the My School DC school finder. According to the MFP, although DLI programs were the most prevalent among specialized programs, representing 21% of all specialized programs offered, only 19% of elementary school students live within a half mile, which is considered to be walking access, from a DLI program.

MY SCHOOL DC

"The My School DC common lottery is a single, random lottery that determines placement for new students at all participating schools. Student-school matches are based on the number of available spaces at each school; sibling, proximity, and other lottery preferences; how each student ranked his or her school choices; and each student's random lottery number." (My School DC: https://www.myschooldc.org/about/about-my-school-dc/)

Demand

Although a thorough analysis of the demand for DLI programs has yet to be conducted[13] and waitlists are an imperfect approximation of demand, DLI programs on the whole have had quite long waitlists (averaging 274 students in SY 2015–2016), significantly longer than those for non-DLI programs (averaging 62 students in SY 2015–2016), as shown in the Single-Year Snapshot Analysis (p. 35) section. For every year of the common lottery so far, 5 or 6 out of the top 10 longest waitlists for charter schools have been for DLI schools, despite the fact that, during the years of the study, DLI schools made up only 5–8 out of over 50 public charter elementary schools accessible by lottery (counting multiple campuses of the same school as separate lottery options). Waitlists for DLI programs across both DCPS and public charter schools have grown substantially over the last six years. Conservative estimates show there are on average 10 students on a waitlist for every available seat in a DCPS DLI program.

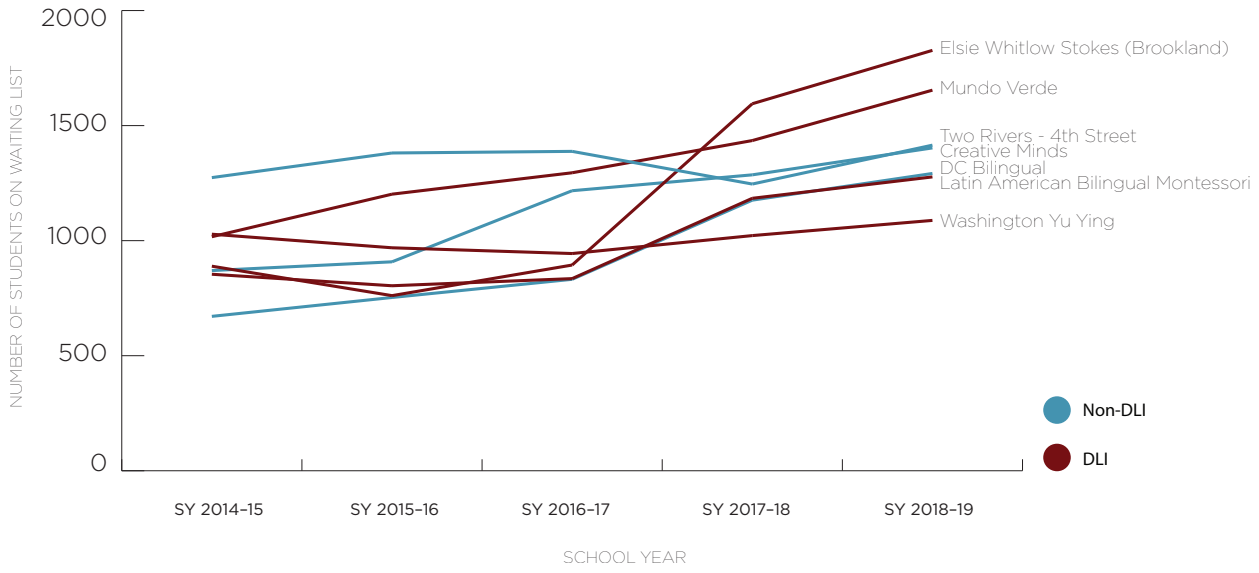


Figure 6: Evolution of highest waitlists for elementary public charter schools, PK–5th grade, SY 2014–15 to SY 2018–19 Source: Waitlists published by the DC Public Charter School Board (no longer available online).

Looking at which schools lottery applicants list as their first choice gives further insight into demand for DLI programs. A recent DC Auditor report analyzes My School DC lottery stu-

13. Data requests to the Common Lottery Board submitted by the authors of this report in 2016 and 2018 have been denied.

dent-level data, finding that, of the eight elementary schools most frequently listed by applicants as their first choice, four are DLI schools (Cooperative Strategies, 21st Century School Fund, & Urban Institute for the Office of the District of Columbia Auditor, 2018).

We discuss the role of demand further in the Single-Year Snapshot Analysis section (p. 35), with a focus on SY 2015–16.

Accessibility

The history, geographic distribution, and demand for DLI programs have an impact on the ability of all students to access DLI programs. Another important factor in determining the accessibility to DLI programs is whether these programs are accessible by-right or by lottery. Which students participate in the common school lottery, which students are aware of the existence of different schools and programs (and their selling points), and the policies setting aside lottery seats for some populations impact access to DLI programs.

By-right DLI programs

In SY 2015–16, only three of the District's DLI programs guaranteed by-right access *to the DLI program* to the students living within the school's boundary.[14] Despite all DCPS DLI programs being in schools that are by-right schools, strand schools only guarantee by-right access to the English-only strand and not to the DLI strand. Therefore a large majority of the DLI programs in the District and six out of the nine DLI programs in the study do not guarantee by-right access.

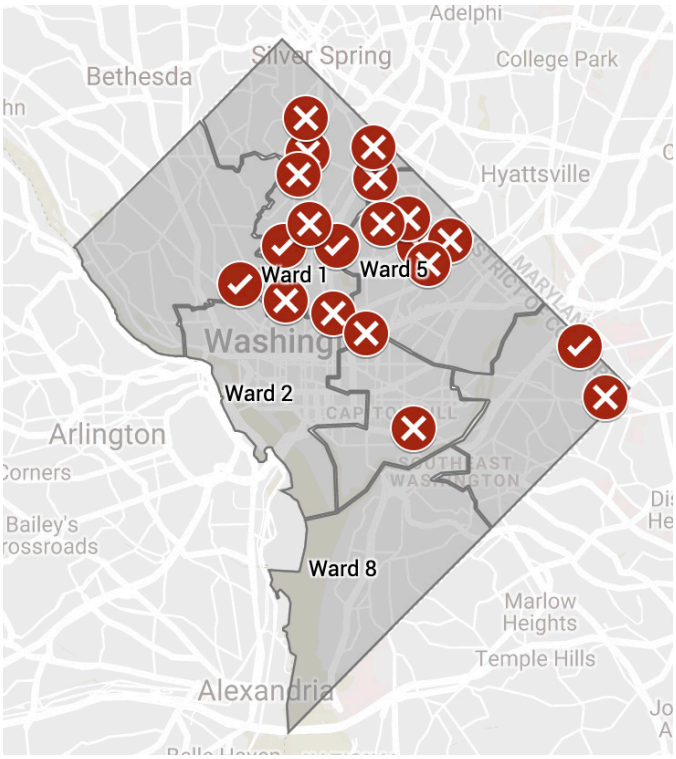


Figure 7: DLI Programs by-right and non-by-right as of SY 2019–20 Source: DC Language Immersion Project

14 .These are Oyster Adams Bilingual DCPS, Bancroft DCPS, and Bruce Monroe DCPS. At the time of writing this report there are four by-right DLI programs, as Houston Elementary DCPS, which had its inaugural DLI kindergarten class only in SY 2018–19, is also a by-right DLI program.

DLI programs accessible through the common school lottery

In preparation for SY 2014–15, the Office of the Deputy Mayor of Education established a common school lottery to create a single centralized system for school choice, enabling students to apply to up to 12 schools though a single form. The common lottery standardized the process for admission of students, with placement decisions made by a computer algorithm following a publicly established process—including public lottery preferences such as sibling preference—rather than leaving decisions up to individual school administrators. Additionally, the common lottery standardized the process of applying to schools, minimizing requirements like standing in line and applying in person. The less standardized nature of earlier lotteries, run by the individual schools before the advent of the common lottery, skewed high-demand schools toward higher socioeconomic populations. As explained by Catherine Peretti, the executive director of My School DC, "It was inequity in process. We had all these different systems and applications that tended to favor those with the time and resources to navigate them" (Austermuhle, 2019). The common lottery is expected to democratize the school selection process and theoretically lead to more diverse and representative student populations.

In the first year of the common lottery, 193 schools participated, including all DCPS schools and nearly all charter schools. As part of the lottery process, My School DC, which administers the lottery, began providing a standard set of information about each school on a public website (http://myschooldc.org), making certain parameters more equitably accessible, including whether a school had a DLI program. In the common lottery for SY 2014–15, six out of nine DLI schools included in this study participated in the common lottery. By the next year (the final year of this study), all but one DLI school participated in the common lottery.

Because the common lottery was in operation only for the last two years of the longitudinal analysis, any effects of the new lottery requirements on equity of access may not be discernible either in terms of socioeconomic equity or racial/ethnic equity. Lower attrition rates of high-demand programs such as DLI mean that fewer seats are available to the general population of lottery applicants each year than in schools with higher attrition rates. Sibling preference further decreases the number of seats available. When parents have less reason to move their students out of in-demand schools, any democratizing effects of the common lottery would be expected to be observed more slowly in high-demand schools such as DLI schools.

Regardless of whether the common school lottery impacted the population of schools in the study, there are three main factors that could limit the effects of the common school lottery on equity of access to DLI programs. These are unequal participation in the common school lottery and lack of awareness about specialized programs (see the Single-Year Snapshot Analysis section, p. 35); the dominant language lottery preference (see the Longitudinal Analysis section, p. 19); and the sibling lottery preference in the context of high-in-demand programs. Of the many lottery preferences,[15] sibling preference significantly prolongs the legacy of pre–common lottery enrollment patterns and therefore decreases breadth of accessibility to DLI programs. Because of sibling preference, high-demand schools such as DLI schools have fewer seats available to the general population of lottery applicants.

15. Lottery preferences include: children of staff, in-boundary, in-boundary with "sibling attending" preference, in-boundary with "sibling offered" preference, proximity preference, sibling attending preference, sibling offered preference, transfer preference, twin offered preference (My School DC: https://www.myschooldc.org/faq/key-terms).

Longitudinal Analysis

In this section we examine patterns of racial/ethnic change in the kindergarten student population attending DC public schools over a six-year period from SY 2010–11 to SY 2015–16 and how similar or different these changes are between DLI and non-DLI schools. This analysis relies on two sets of measures: the respective proportions of students who are Black, Hispanic, and White[16] and the entropy indexes of each individual school. Using these measures, we conduct a year-by-year analysis followed by a longitudinal analysis that looks at patterns of change.

This section comprises

- two main research questions and methods used to address each question,
- explanation of which schools are included in the study,
- introduction of the measures on which the analysis relies (four proportions and entropy index),
- results, and
- summary and discussion.

ENTROPY INDEX

Measure of diversity that describes the extent to which a single school's distribution of racial/ethnic groups reflects the District's distribution of racial/ethnic groups. An entropy index of 0 indicates that the school reflects the overall population distribution; an etropy index below zero indicates that the school is more evenly distributed than the overall population, or "hyper-integrated" (Reardon & O'Sullivan, 2004); and an entropy index above 0 indicates that the school is more homogenous than the overall population. In this study, the entropy index refers to the kindergarten populations of each school in the study. Also called Theil's information index or the information theory index.

Research Questions and Methods

1. Do DLI schools have different racial/ethnic populations than non-DLI schools?

This research question is first addressed through an exploratory analysis of three proportion variables (proportion Black students, proportion Hispanic students, proportion White students) and the entropy index. The differences between DLI and non-DLI schools are explored for each year of the study using independent-samples t-tests for each of the four proportions and for the entropy index. Significant differences are noted.

2. Are DLI and non-DLI schools changing demographically in the same ways?

This question expands on the above findings, asking whether there any patterns of change in DLI or non-DLI schools in the four proportions or in the entropy index and, if so, whether there are any significant differences between the patterns of change of DLI and non-DLI schools.

Calculation

In the case of this study, a longitudinal multilevel model was used to contrast changes in demographics between DLI and non-DLI schools. DLI status (*DLI*, in formula below) was used as a dichotomous predictor of slope, so its significance was used to indicate differences in rates of demographic change. The models fit account for variance between schools in the demographic measures and in the rates of change in the demographic measures through the inclusion of random effects (r_0 and r_1): these reflect the differences between schools at the start of the study and account for the fact that demographic change does not occur uniformly across geographic areas.

Combined Multilevel Model

$$D_t = \beta_{00} + \beta_{01}*DLI + \beta_{10}*YEAR_t + \beta_{11}*DLI*YEAR_t + r_0 + r_1*YEAR_t + e_t$$

Further information regarding the linear multilevel longitudinal models used is detailed in Appendix 4.

16. We considered the proportion of Asian students for analysis but did not present the results in this report, as the topic of Asian students in DC demographics is not a common topic of interest and the proportions of Asian students in District schools are extremely small. Results are given in Appendices 3 and 4: no differences were found between DLI and non-DLI schools in any individual year of the study, and the full multilevel model fit was not improved significantly beyond the fit of the null model.

Schools Included in Longitudinal Analysis

The general population of schools included in the study was defined as all schools that had kindergarten classes enrolled between SY 2010–11 and SY 2015–16. We decided to focus the study on a single grade to ensure comparability in the ages of the population; comparing a single grade allows us to more closely track year-to-year changes in the schools' populations than if we were to look at a range of grades. Kindergarten was selected as the target grade for this analysis as this is the first year of schooling in which enrollment is compulsory (Compulsory School Attendance Amendment 8-247, 1990) and the first in which DC residents have the right to attend their neighborhood school (District of Columbia Public Schools, n.d.). The number of schools that enrolled kindergarten classes varied between 130 and 133 during the years of the study, as shown in Table 2, which also distinguishes between DLI and non-DLI schools. All schools with kindergarten classes were used in the calculation of the entropy indices in order to capture the population of the entire kindergarten population.

DCPS
District of Columbia traditional public schools, as opposed to DC Public Charter Schools.

DC public schools
When not capitalized, this refers to all DC public schools whether traditional (DC Public Schools) or charter (DC public charter schools).

DC PUBLIC CHARTER SCHOOL
An independent local education agency (LEA) funded by taxpayer money through a per-pupil formula. The DC Public Charter School Board has chartering authority over DC public charter schools.

Several schools that enroll kindergarteners were excluded for two reasons: differences in motivation for enrollment and missing data. Schools excluded for differences in motivation for enrollment include academic programs provided by DCPS in residential facilities and special education-only schools, which parents or guardians would enroll their children in for reasons other than those typically considered to influence school choice. Four DCPS DLI schools (Cleveland ES, Marie Reed ES, Powell ES, and Tyler ES) were excluded from the analysis due to missing data. These four schools have a DLI program strand next to a traditional English language program, and demographic data were not differentiated by program in the years of the study.

Table 2: Numbers of DLI and non-DLI schools included in and excluded from analysis

Year	DLI	Non-DLI	Total
2010	12	119	131
Excluded	5	5	10
Included	7	114	121
2011	13	120	133
Excluded	5	5	10
Included	8	115	123
2012	13	118	131
Excluded	5	1	6
Included	8	117	125
2013	14	116	130
Excluded	5	2	7
Included	9	114	123
2014	14	118	132
Excluded	5	3	8
Included	9	115	124
2015	14	119	133
Excluded	5	3	8
Included	9	116	125

Measures

Three proportions

The proportion of students in a school who were Black, Hispanic, and White, respectively, were defined by and obtained from the U.S. Department of Education's Common Core of Data (CCD) database (U.S. Department of Education, 2017). The CCD database summarizes organizational characteristics, demographic data, and financial data for all public schools and districts annually. For this study, data came from SY 2010–11 through SY 2015–16. In this federally compiled data set, race/ethnicity is divided into seven mutually exclusive groups so that students are counted as belonging to one and only one group. For the purposes of this study, three groups out of the seven—Black or African American, Hispanic/Latino (of any race), and White—were selected as groups of interest, as these are the three largest groups in the District of Columbia and are often discussed in the context of school diversity, as described above. Each proportion is calculated as the number of students in the racial/ethnic group in the school's kindergarten population divided by the total number of students in the school's kindergarten population. No data were missing.[17]

Entropy index

There are different ways to measure diversity in schools or other contexts. The measure we selected to represent contextualized diversity in this study is an **entropy index**, which allows us to understand the degree to which the distribution of groups in individual schools' populations reflects or differs from the distribution across the District's population.[18]

The entropy index was selected due to its ability to summarize both the distribution of racial/ethnic groups and put this distribution into a localized context.[19] For these reasons, it was chosen over a binary criterion ("diverse" or "not diverse" as defined by some cut score) and over a diversity score that does not take into account local context.

Calculation

In the case of this study, an entropy index (H_i) is calculated for the kindergarten population of each individual school (i). As seen in Figure 8, this entropy index (H_i) reflects the difference between each school's distributions of racial/ethnic groups (known as entropy E_i) and the distribution of students in these groups across the population of all kindergarteners in the District (known as entropy E). This difference is standardized by dividing by the entropy index of the population of all kindergarteners in the District (E). Doing this allows us to compare individual schools in terms of how the distribution of groups in each school's kindergarten population relates to the District's population of kindergarteners.[20]

$$H_i = \frac{E - E_i}{E}$$

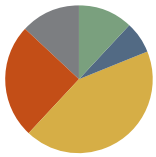
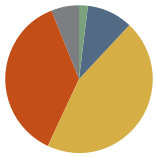
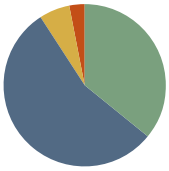
Further information regarding the entropy index calculation is detailed in Appendix 2.

17. Throughout this report, in the interest of brevity, we sometimes refer to an average school's proportion of a given racial/ethnic group, or an average school's entropy index. This is simply shorthand for referring to the measures for the school's kindergarten population..
18. While we recognize that each ward, zip code, and neighborhood cluster has its own distinct balance of racial/ethnic groups, for this study we calculate entropy indices based on the overall measure of diversity in the District, since each school in the study is available to students beyond the limits of ward, zip code, and neighborhood cluster.
19. An entropy index was also the measure chosen by the Office of the Deputy Mayor of Education in one analysis to describe the impact of moving school borders (Office of the Deputy Mayor of Education, 2014).
20. Full documentation of sources and calculation of the entropy indices may be found in Appendix 2.

Entropy index interpretation

Entropy index (H_i) values reflect comparisons of school kindergarten populations to the District's kindergarten population rather than a straightforward reflection of the individual school's diversity. Thus all values must be interpreted with reference to their comparison to 0 (equal to the District's entropy) and 1 (completely homogenous).[21] The upper limit of the entropy index is 1, but entropy indices can fall below zero.

The sample images below illustrate five values from five schools in a recent school year. The corresponding pie charts illustrate the proportions of racial/ethnic groups within each respective school's kindergarten population. The respective racial/ethnic groups represented in the pie charts are not identified, as the images are for explanatory purposes only, though they do represent real schools in the study.

<table>
<tr><td rowspan="2">Entropy indices below 0
When a school's entropy value is negative, there is hyper-integration, meaning that the individual school's racial/ethnic composition is more evenly distributed among racial/ethnic groups than in the District as a whole.</td><td>$H_i = -.395$</td><td>  </td></tr>
<tr><td>$H_i = -.203$</td><td>  </td></tr>
<tr><td>Entropy indices of 0
An entropy index value of 0 would indicate that there was no difference between a school's distribution of racial/ethnic groups in their kindergarten population and the distribution of racial/ethnic groups in the kindergarten population District-wide. This example shows a school with an entropy index very close to 0, illustrating a school whose population distribution nearly exactly mirrors that of the District as a whole. No school exactly reflected the District's distribution of races/ethnic groups.</td><td>$H_i = .034$</td><td>  </td></tr>
<tr><td rowspan="2">Entropy indices above 0
An entropy index value above 0 indicates that the school's distribution of racial/ethnic groups in kindergarten is less evenly distributed than the whole kindergarten population of the District.

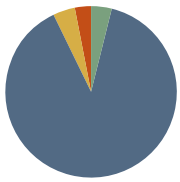
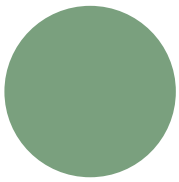
A value of 1 indicates there is only one racial/ethnic group in the individual school's kindergarten population.</td><td>$H_i = .530$</td><td>  </td></tr>
<tr><td>$H_i = 1$</td><td>  </td></tr>
</table>

Figure 8. Entropy indices and potential proportions of racial/ethnic groups

The unweighted average school entropy indices across the years of the study ranged between 0.54 (2010) and

21. The largest value of H_i goes to 1, but it does not necessarily mean the values have a ceiling of 1. The data are not truncated or censored, and values become smaller or equal to 1 naturally. There is no concern about insufficient range of measurement, floor, or ceiling effects.

0.45 (2015) across all schools in the sample. These values above zero indicate that the distribution of racial/ethnic groups in a typical school within the study is less evenly distributed than in the District as a whole. This is not an unexpected finding, as regional differences are well-documented within the District (see, e.g. Coffin, 2018; Orfield & Ee, 2017).

Entropy index caveat: Equal but nonidentical proportions of groups in school populations

A limitation to entropy index calculation is the fact that entropy indices represent the degree to which schools' populations reflect the distribution of groups across the District's kindergarten population as a whole, but this value is strictly with respect to the numerical proportions of racial/ethnic groups and is indifferent to the actual racial/ethnic groups that make up the proportions.

As seen in Figure 9 below, the entropy indices of these two hypothetical schools are identical. However, the schools' populations of the racial/ethnic groups represented by colored pie chart sections are transposed. This illustrates a limitation of the entropy index measure in that it does not take into account the size order of the groups.

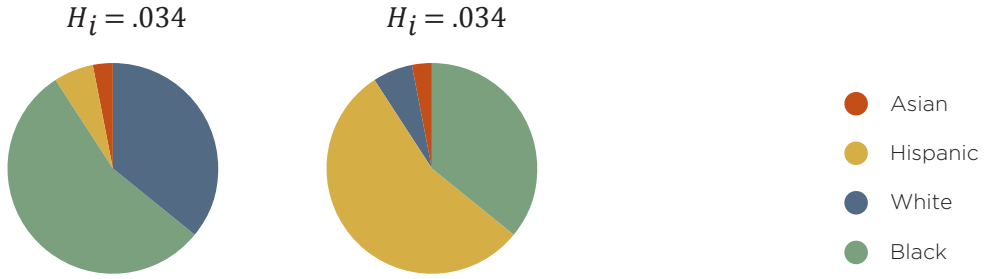


Figure 9. Identical values but different racial/ethnic compositions (hypothetical schools)

We chose to accept this limitation of entropy indices because the size order of proportions of racial/ethnic groups in the schools in the study was most often reflective of the size order of proportion of racial/ethnic groups of the District population[22] and because there is no measure that takes into account the size order of all groups. Finally, our treatment of the proportions of individual racial/ethnic groups provides complementary information to further flesh out the picture of demographic diversity and representativeness in these schools.

Results

Overall racial/ethnic profile of kindergarten populations of included schools

The largest group District-wide across the years of the study was consistently Black students. The second and third largest groups changed during the period of the study. From 2010–2014, the second largest group was Hispanic students and the third largest group was White students, while in 2015, the final year of the study, White students comprised the second-largest group and Hispanic students the third-largest group. It should be noted that these values are

22. Indicating that the H_i values for individual schools communicated well the distributions of individual schools' racial/ethnic populations relative to the District's distribution.

very close and could be a matter of a nonsignificant fluctuation that is due to just a few students. Together these three groups made up over 95% of the kindergarten population for the years of the study, with the remaining segment of the population comprising students from four much smaller groups (Asian, Pacific Islander, Multiracial, and Native American). Count values and percentages for all seven groups can be found in Appendix 3.

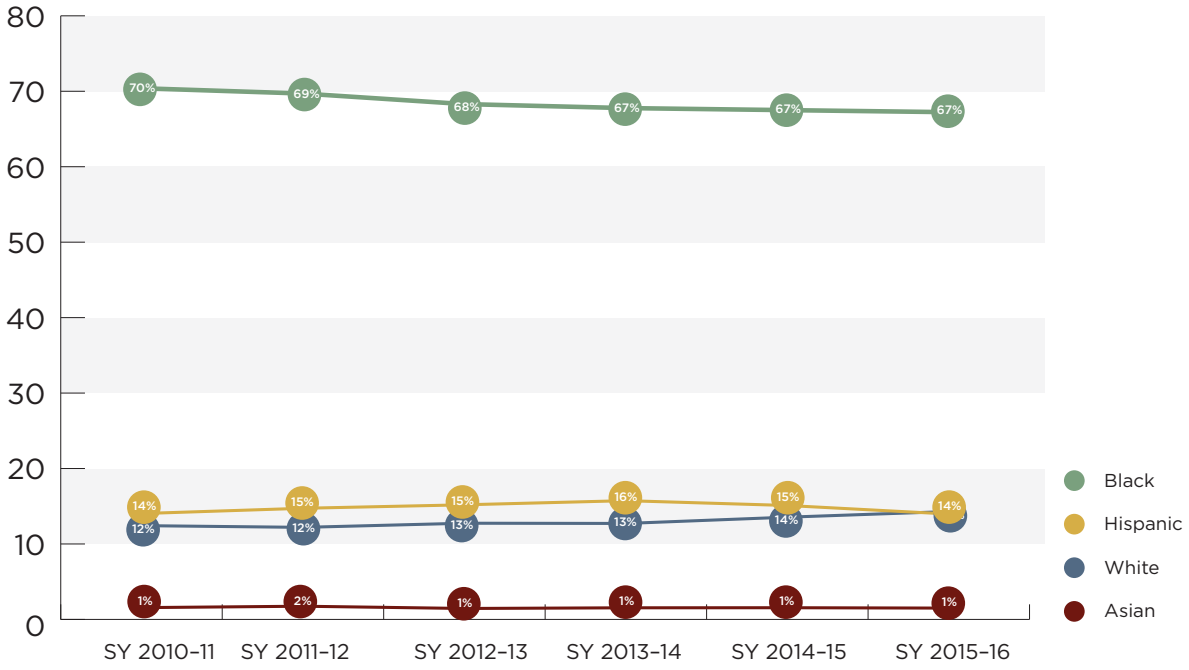


Figure 10. District-wide kindergarten racial/ethnic composition from SY 2010–11 to SY 2015–16, inclusive

The unweighted average school entropy indices across the years of the study ranged between 0.54 (2010) and 0.45 (2015) across all schools in the sample. These values above zero indicate that the distribution of racial/ethnic groups in a typical school within the study is less evenly distributed than in the District as a whole. This is not an unexpected finding, as regional differences are well-documented within the District (see, e.g. Coffin, 2018; Orfield & Ee, 2017).

Proportion Black

Year-by-year analysis

Visual examination of the boxplot in Figure 11 reveals that individual schools' proportions of Black students appear to be consistently and significantly higher in non-DLI schools compared with DLI schools within each individual school year.[23] This is corroborated by a series of tests (Appendix 7).[24] First, significant differences were found in the proportions of Black students among all schools in each school year from 2010 through 2015. Furthermore, significant differences were found between DLI schools and non-DLI schools for each year of the study. This indicates that DLI schools and non-DLI schools may be expected to have different proportions of Black students in their populations, with DLI schools having lower proportions of Black students each year.

23. This boxplot represents the spread of proportion Black students for DLI and non-DLI schools in each school year from 2010 to 2015, inclusive. In each category, 50% of the schools for each year lie within the colored bars, while 25% of schools lie within each of the lines above and below the bars. Dots outside the bars represent outliers.
24. See Appendix 7 (Methods of Comparison of Proportions) for two-test methodology.

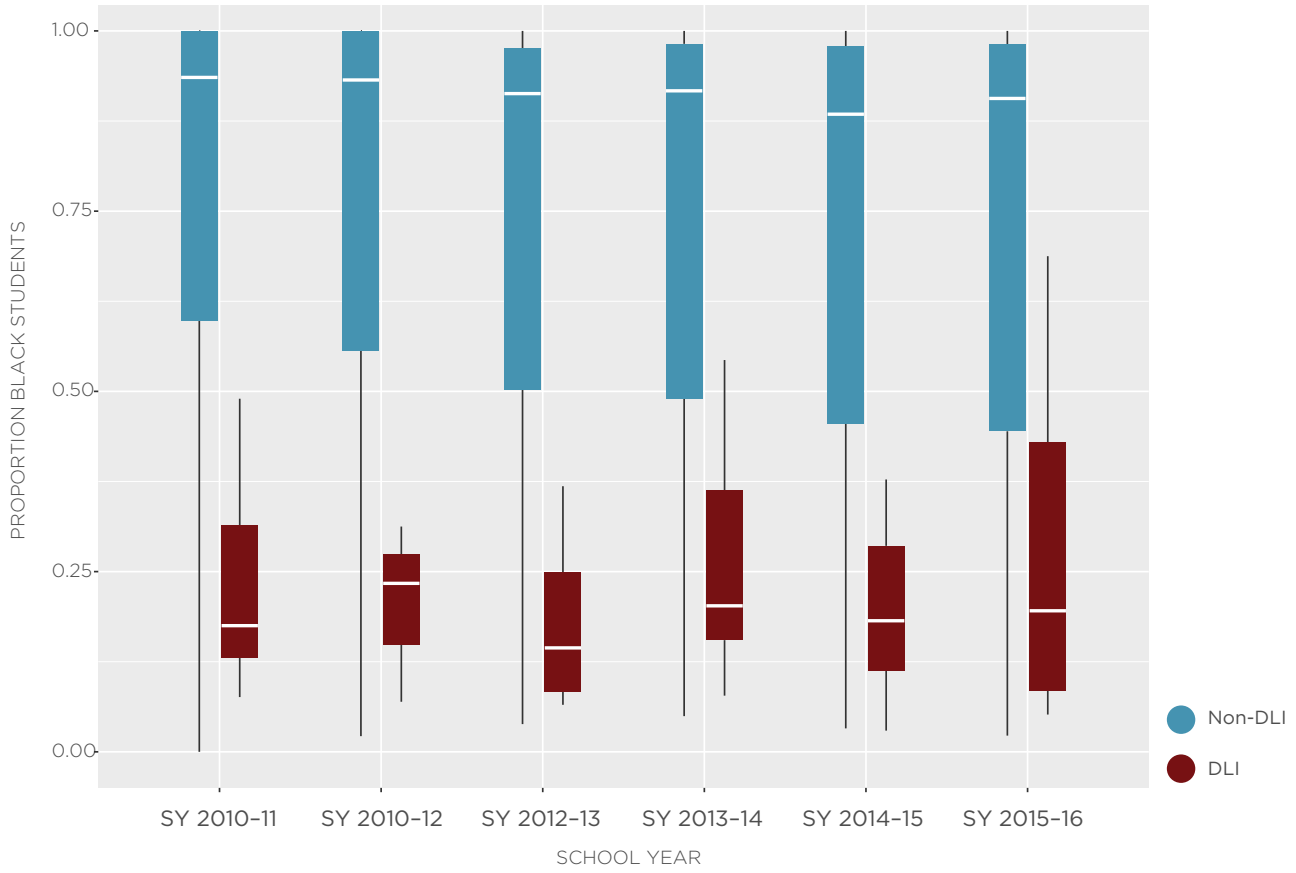


Figure 11. Proportion Black students, DLI and non-DLI demographics grouped by year
Source: CCD

Longitudinal model

Visual observation of the unweighted average proportion of Black students across schools (Figure 12) does not reveal distinct longitudinal patterns in either non-DLI or DLI schools, but very slight decreases in the proportions of Black students in non-DLI schools can be observed. A multilevel model confirmed that the average proportion of Black students in non-DLI schools decreased in each year of the study at a rate of -.006, or -.64%, each year.[25] This decrease was statistically significant (p = .012). The rate at which the proportion of Black students in DLI schools changed was not significantly different from the rate of change in non-DLI schools (-.006, -.63%, p = .98). The rates of change do vary significantly (p < .001), indicating that there is significant variance in the rates of change in Black populations across all schools in the sample. Significant variance was also found in the initial proportions of Black students in schools (p < .001).

STATISTICALLY SIGNIFICANT

When results are described as "significant" or "statistically significant," the evidence strongly indicates that there are some differences between the groups on the outcome measures and that these differences are unlikely to be due to random chance.

Mathematically, this occurs when the model's coefficient of interest is statistically different from zero and is rejected at the 95% level of confidence. Throughout this report, a .05 level of significance is used (α=.05).

25. The fully specified model exhibited significantly better fit than the null model (Δ-2LL=90.761, df=5, p≤.001). Full multilevel model building reporting tables are found in Appendix 4.

As the average school's kindergarten population across the years of the study had 52 students (SD = 23.44), an annual expected decrease of .6% in the proportion of Black students in schools would indicate an expected loss of one Black kindergarten student per school approximately every three years, in both DLI and non-DLI school populations, with all other factors, including class size, held constant. This should be interpreted as a general pattern only: the significant variance in slopes indicates that some schools are expected to lose Black students more quickly and others more slowly than the average rate, and it does not rule out individual schools' proportions of Black students increasing.

VARIANCE
Statistical measure of the degree to which cases of a measure are spread around their average: the greater the variance, the more spread out the data are. It is calculated by squaring the standard deviation of a measure.

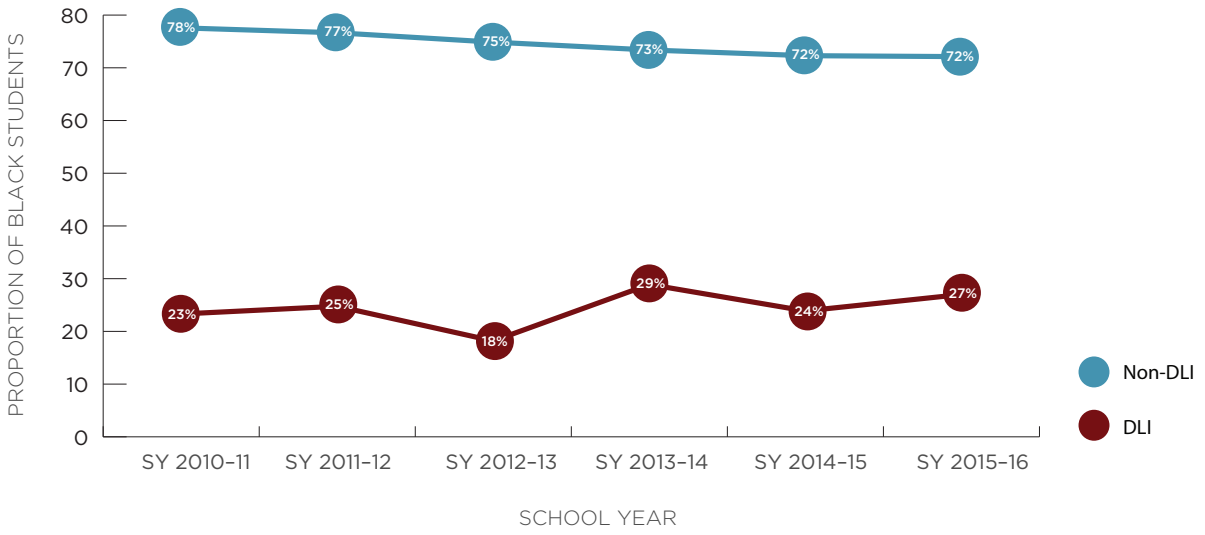


Figure 12. Unweighted average proportion of Black students in school kindergarten populations from SY 2010–11 to SY 2015–16

Proportion Hispanic

Year-by-year analysis

Visual examination of the boxplot in Figure 13 reveals that individual schools' proportions of Hispanic students in their kindergarten populations appear to be higher in DLI schools compared with non-DLI schools within each individual school year. This is corroborated by a series of tests (Appendix 7).[26] First, significant differences were found in the proportions of Hispanic students among all schools in each school year from 2010 through 2015. Furthermore, significant differences were found between DLI schools and non-DLI schools for each year of the study. This indicates that DLI schools and non-DLI schools may be expected to have different proportions of Hispanic students in their populations, with DLI schools having higher proportions of Hispanic students each year.

26. See Appendix 7 (Methods of Comparison of Proportions) for two-test methodology.

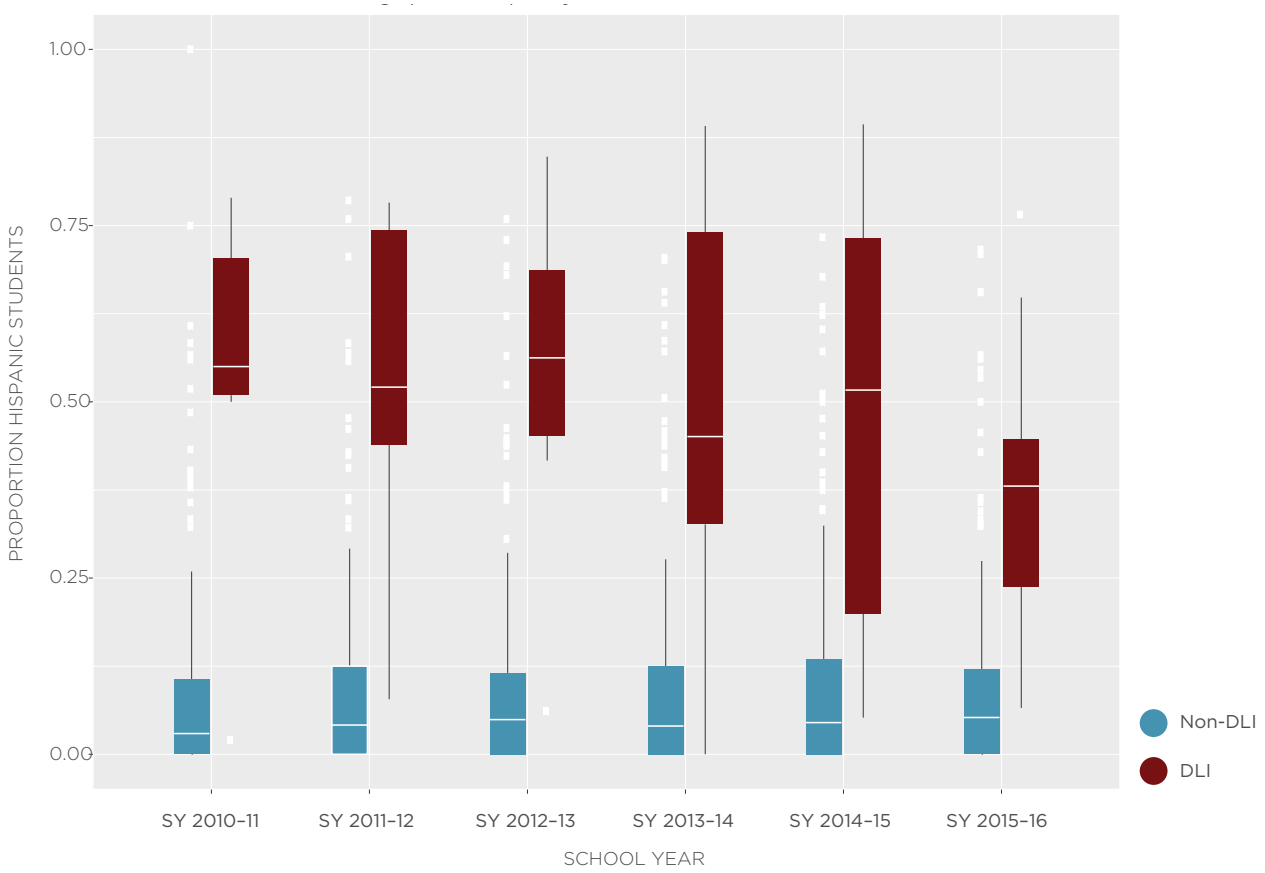


Figure 13. Proportion Hispanic students, DLI and non-DLI demographics grouped by year Source: CCD

Longitudinal model

Visual observation of the unweighted average proportion of Hispanic students across schools (Figure 14) illustrates a decrease in the average proportion of Hispanic students in DLI schools over the years of the study, but no longitudinal patterns can be observed in non-DLI schools. A multilevel model confirmed that the average proportion of Hispanic students in non-DLI schools decreased in each year of the study at a rate of .002, or .17%, each year,[27, 28] but this decrease was not statistically significant ($p = .443$). The rate at which the proportion of Hispanic students in DLI schools changed was significantly different from the rate of change in DLI schools, with an expected rate of change of -.018, or -1.76%, per year ($p = .005$). The rates of change vary significantly across all the schools in the sample ($p < .001$), indicating that there is significant variance in the rates of change in Hispanic populations among schools. Significant variance was also found in the initial proportions of Hispanic students in schools ($p < .001$).

This indicates that the proportion of Hispanic students in DLI schools is decreasing at a faster rate than in non-DLI schools, which were not found to have significant changes in proportions of Hispanic students. As the average DLI kindergarten population across the years of the study had 61 students (SD = 17.66), an annual expected decrease of 1.76% in the proportion of Hispanic students in DLI schools would indicate an expected drop of one Hispanic student approximately every year from the average DLI school's kindergarten population, with all other factors, including class size, held constant. This should be interpreted as a general pattern only; the significant variance in slopes indicates that some DLI schools are expected to lose

27. The fully specified model exhibited significantly better fit than the null model (Δ-2LL=73.158, df=5, $p \leq .001$). Full multilevel model building reporting tables are found in Appendix 4.
28. Numbers in proportions and percents differ due to rounding.

Hispanic students more quickly and others more slowly than the average rate and does not rule out individual schools' proportions of Hispanic students increasing.

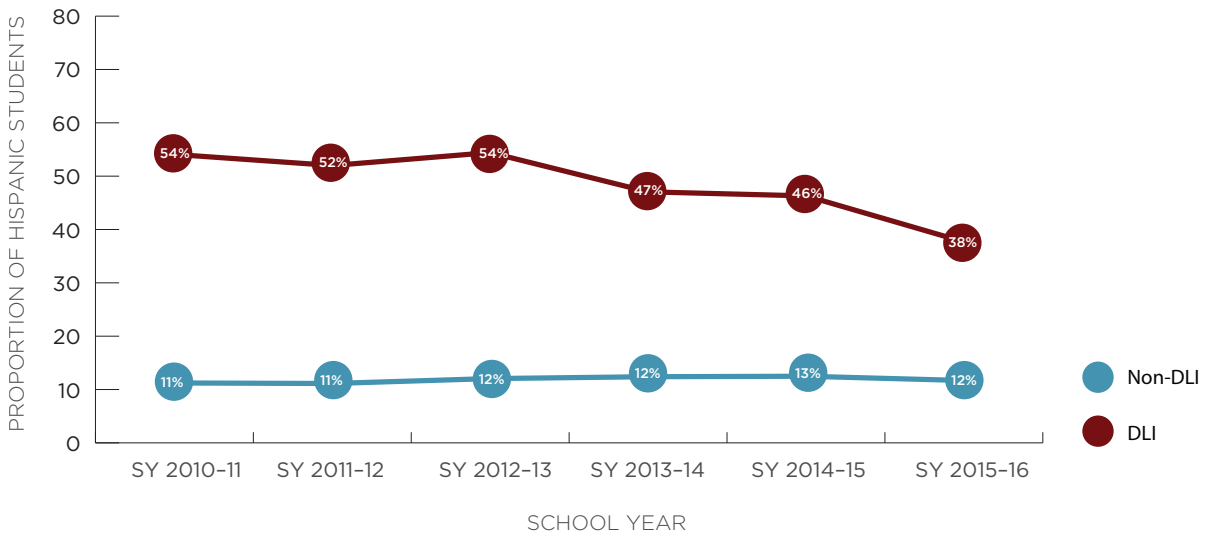


Figure 14. Unweighted average proportion of Hispanic students in school kindergarten populations from SY 2010–11 to SY 2015–16

Proportion White

Year-by-year analysis

Visual examination of the boxplot in Figure 14 reveals some differences in the average proportions of White students in DLI schools versus non-DLI schools, as the proportion of White students in DLI schools appears to be slightly higher but with overlap in distributions between DLI and non-DLI schools within each individual school year. This is corroborated by a series of tests (Appendix 7).[29] Significant differences were found in the proportions of White students among all schools in each respective school year from 2010 through 2015. However, significant differences were not found between DLI schools and non-DLI schools for each year of the study. This indicates that DLI schools and non-DLI schools may be expected to have similar proportions of White students in their populations.

Longitudinal model

Visual observation of the unweighted average proportion of White students across schools (Figure 16) shows slight increases in the average proportion of White students in DLI schools over the years of the study and a possible slight increase in the proportion of White students in non-DLI schools. A multilevel model confirmed that the average proportion of White students in non-DLI schools increased in each year of the study at a rate of .002, or .24%, each year.[30] This increase was not statistically significant ($p = .120$). The rate at which the proportion of White students in DLI schools changed was significantly different from the rate of change in non-DLI schools, with the proportion of White students in DLI schools increasing at a rate of .014, or 1.38% per year ($p = .002$). The rates of change in schools vary significantly, indicating that, in addition to the trends observed across the two groups of schools, individual schools changed at significantly different rates ($p < .001$). Significant variance was also found in the initial proportions of White students in schools ($p < .001$).

29. See Appendix 7 (Methods of Comparison of Proportions) for two-test methodology.
30. The fully-specified model exhibited significantly better fit than the null model (Δ-2LL=48.839, $df=5$, $p \leq .001$). Full multilevel model building reporting tables are found in Appendix 4.

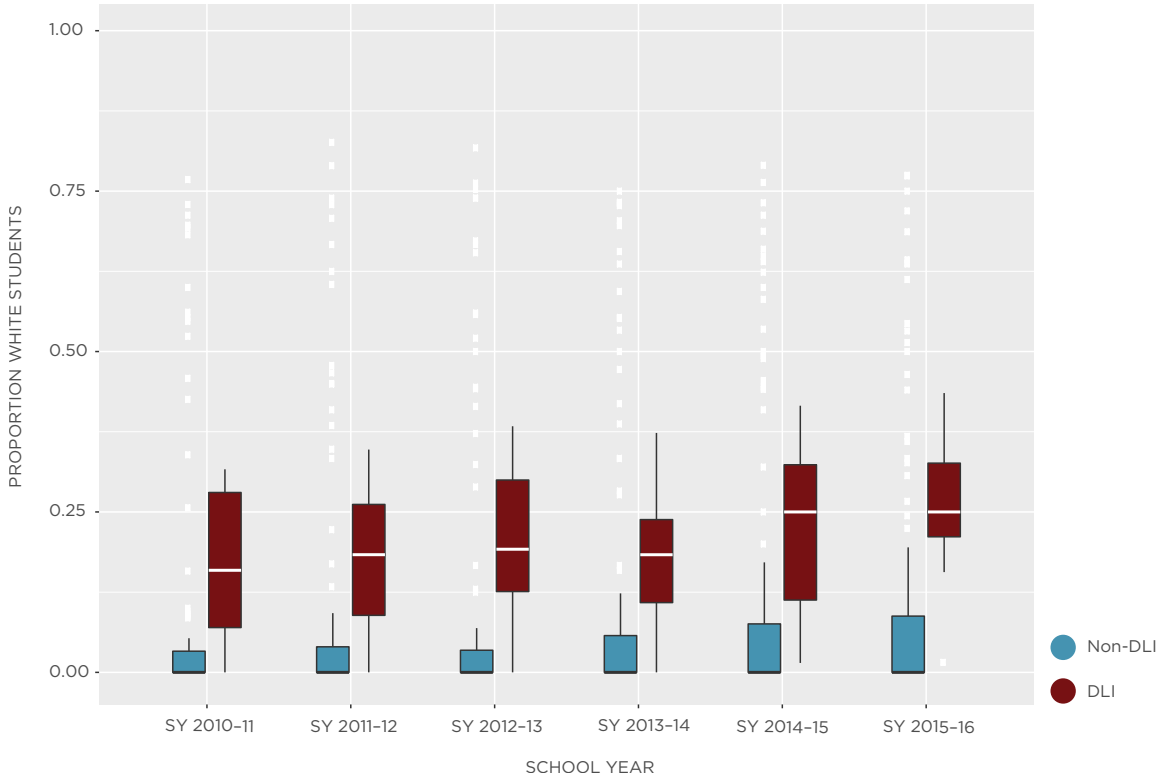


Figure 15. Proportion White students, DLI and non-DLI demographics grouped by year
Source: CCD

These findings indicate that the proportions of White students attending non-DLI schools did not change significantly, while the proportions of White students in DLI programs increased significantly in comparison over the course of the study. The average DLI kindergarten population across the years of the study had 61 students (SD = 17.66); thus an annual expected increase of 1.38% in the proportion of White students in schools would indicate the addition of one White student approximately every one to two years to the average DLI school's kindergarten population, with all other factors, including class size, held constant. This should be interpreted as a general pattern only; the significant variance in slopes indicates that some DLI schools are expected to gain White students more quickly and others more slowly than the average rate and does not rule out individual schools' proportions of White students decreasing.

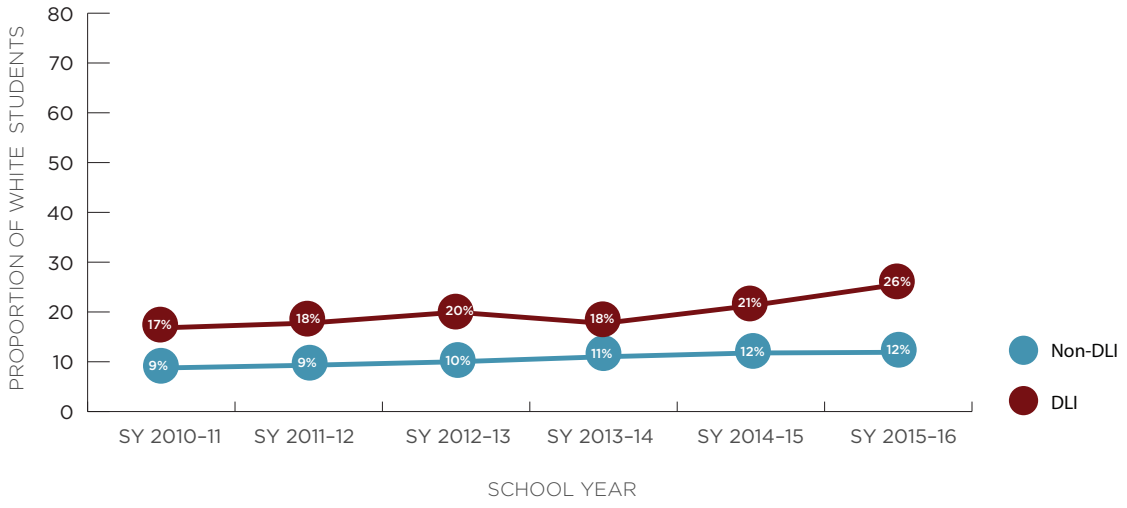


Figure 16. Unweighted average proportion of White students in school kindergarten populations from SY 2010–11 to SY 2015–16

Entropy index

Year-by-year analysis

Visual examination of the boxplot in Figure 17 reveals that individual schools' entropy indices appear to be higher in non-DLI schools compared with DLI schools within individual school years. The unweighted average of the DLI schools' entropy indices was close to zero for each year studied, ranging between -0.131 (2015) and 0.052 (2013), indicating a distribution of racial/ethnic groups similar to that of the District as a whole. The unweighted average individual non-DLI schools' entropy indices were higher, indicating less even distribution of racial/ethnic groups than in the District as a whole. This is corroborated by a series of independent samples t-tests: a significant difference in mean entropy indices is found between DLI schools and non-DLI schools for each school year from 2010 through 2015, inclusively.[31] DLI schools are found to have a significantly smaller entropy index each year. This indicates that DLI schools in this sample have more evenly distributed compositions of racial/ethnic groups than non-DLI schools in this sample.

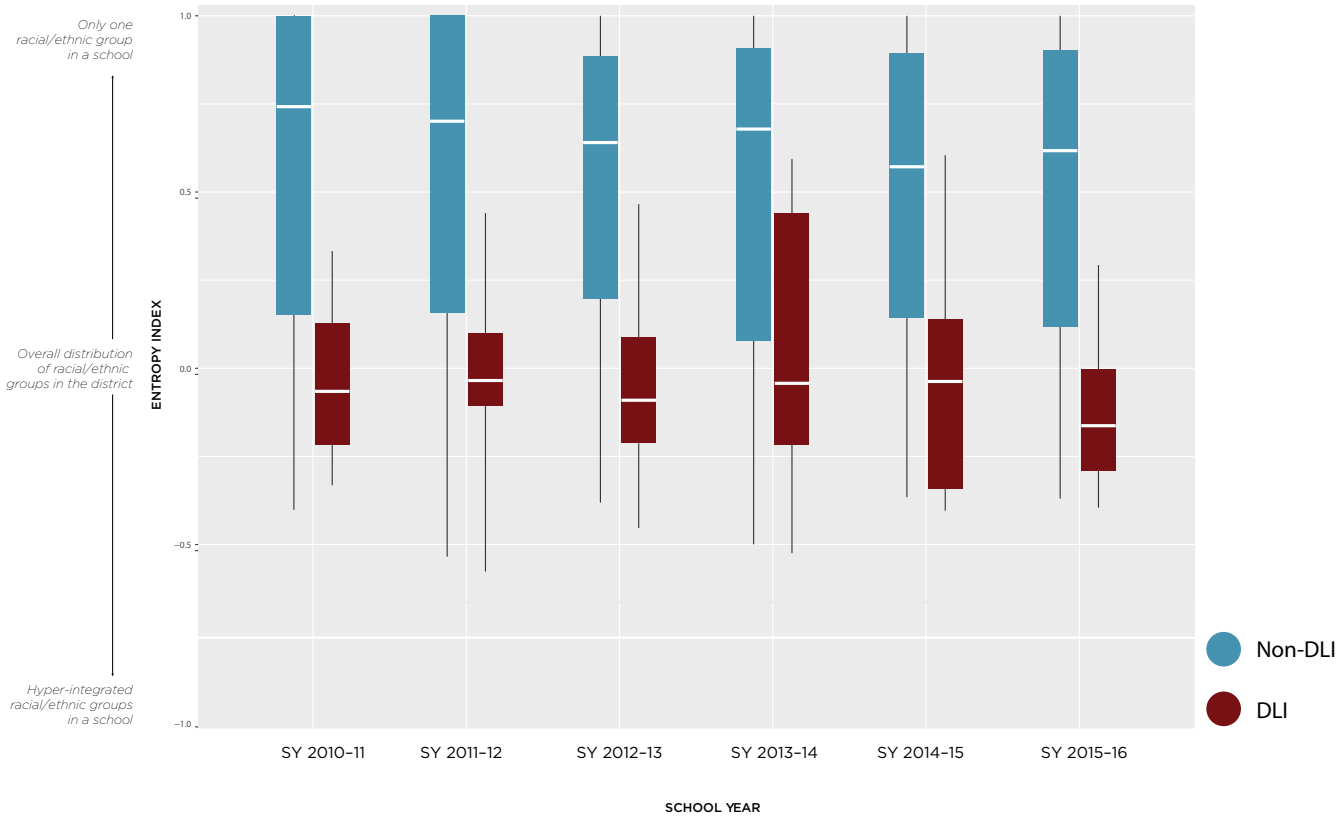


Figure 17. DLI and Non-DLI demographics grouped by year

31. Detailed descriptive statistics can be found in Appendix 3.

Longitudinal model

Visual observation of the unweighted average entropy index across schools (Figure 19) reveals that the average entropy index of non-DLI schools in the study appears to decrease each year while the average entropy index of DLI schools appears to vary slightly above and below the District entropy index of 0. A multilevel model[32] confirmed that the average entropy index did decrease in non-DLI schools in each year of the study at a rate of -.009 each year. This decrease was statistically significant (p = .020). This indicates that the average non-DLI school's distribution of racial/ethnic groups became more similar to the overall distribution of racial/ethnic groups in the District's kindergarten population each year. The rate at which DLI schools changed was not significantly different from the rate of change of non-DLI schools (-.018, p = .33). This indicates that the degree to which DLI schools reflect the District is changing at a similar rate and in a similar direction as the non-DLI schools. The model fit also finds that the rates of change across all the schools in the sample vary significantly (p = .002), with significant variance in the initial entropy indices of schools in the first year of the study (p < .001). Over the years of the study, the entropy index of the typical DLI school became more negative, moving further below zero, indicating that DLI schools are becoming slightly more evenly distributed in racial/ethnic group composition than the District as a whole (hyper-integrated).

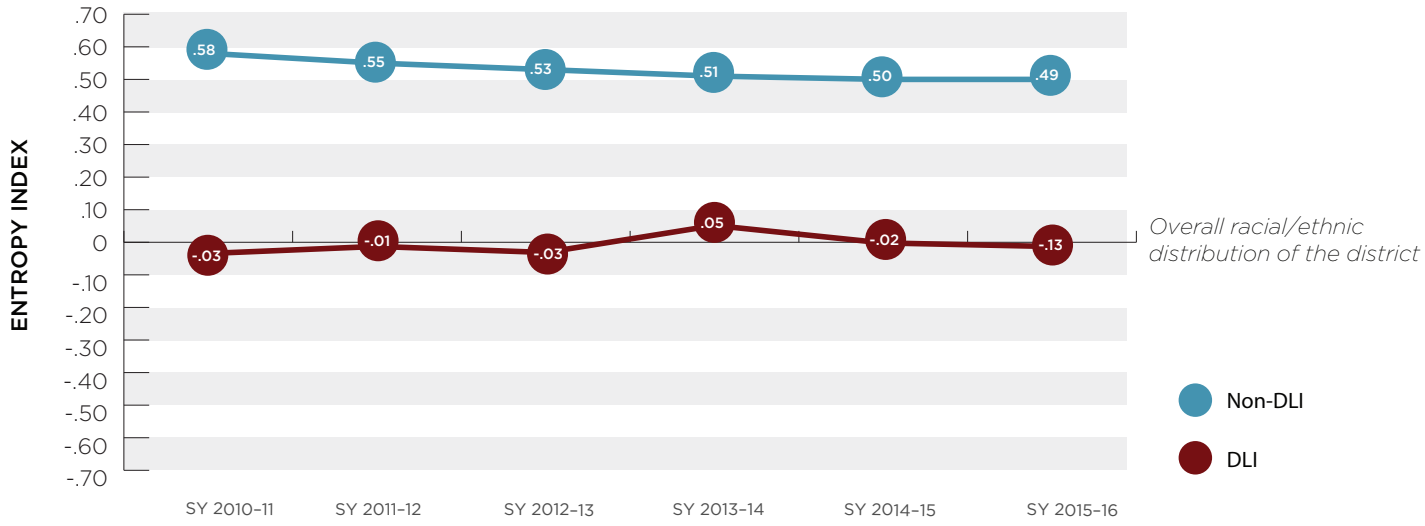


Figure 18. Average school entropy indices from 2010 to 2015

32. The fully specified model exhibited significantly better fit than the null model (Δ-2LL=32.279, df=5, $p \leq .001$). Full multilevel model building reporting tables are found in Appendix 4.

Summary of Results

In each year of the study, DLI schools had

- **smaller proportions of Black students than non-DLI schools;**
- **larger proportions of Hispanic students than non-DLI schools;**
- **no statistically significant difference in the proportion of White students compared with non-DLI schools; and**
- **a more even distribution of racial/ethnic groups than non-DLI schools, more closely mirroring the distribution of racial/ethnic groups across the District.**

In terms of change over time, we found

- no statistically significant difference in the rate of change in the proportions of Black students in DLI compared with non-DLI schools; both groups of schools saw small but statistically significant decreases in the proportions of Black students over time, corresponding to approximately one less Black student expected every three years in an average kindergarten population of about 52 students;
- DLI programs had a decrease in the proportion of Hispanic students, corresponding to approximately one less Hispanic student per year expected in an average DLI kindergarten population of about 61 students (the proportion of Hispanic students in non-DLI also decreased, but the decrease was not statistically significant);
- DLI programs had an increase in the proportion of White students, corresponding to an additional one to two White students expected per year in an average DLI kindergarten population of about 61 students (the proportion of White students in non-DLI schools also increased, but the increase was not statistically significant); and
- both groups of schools were becoming more evenly distributed in their compositions of racial/ethnic groups over time, with no statistically significant difference in the rate of change between the two groups.

Discussion

The difference in the Hispanic populations between DLI and non-DLI schools is likely associated with the locations of the Spanish DLI schools close to neighborhoods with historically high rates of Spanish speakers (especially in Ward 1 and Ward 4), as well as lottery requirements of the three DCPS DLI schools in the sample. In SY 2015–16, all three DCPS DLI schools in the sample required lottery applicants to identify themselves as "Spanish dominant" or "non-Spanish dominant" in order "to create linguistically balanced classrooms"; these students could then be tested to ensure that their language skills were accurately reported (District of Columbia Public Schools, 2015, p. 15).[33]

It is reasonable to assume that most of the students identified as Spanish dominant would also self-identify as Hispanic. According to the Pew Research Center, in 2015 82% of Hispanics age five and older in the DC metro area spoke Spanish at home (Krogstad & Lopez, 2017), and in 2011 93% of U.S. residents who spoke Spanish at home identified themselves as Hispanic (Gonzalez-Barrera & Lopez, 2013). If we understand "linguistically balanced" as approaching a 50/50 balance of Spanish dominant and non-Spanish dominant students,[34] we see how the lottery requirements of DCPS DLI schools could contribute to the higher average rates of Hispanic students in DLI schools (37.7%) as compared with non-DLI schools (11.8%). It is important to

33. Though we could not find documentation of this policy for school years prior to 2015–2016, it seems likely that a similar policy was in place prior to 2015–2016, even if it was not a publicly stated policy. Public charter schools are not permitted to limit enrollment based on student characteristics, including language spoken (DC Public Charter School Board, 2013).
34. A definition by DCPS of "linguistically balanced" was not found.

note that "Spanish dominant" does not mean "English language learner," as only 81.7% of ELs in DC's public schools were Spanish speakers in SY 2014–2015 (U.S. Department of Education, 2014–2015), and not all students who speak Spanish at home are identified as ELs.

The faster decline in the proportion of Hispanic students in DLI schools as compared with non-DLI schools over the course of the period of the study can be partially explained by which schools are included in the study. Sela PCS, a Hebrew-language DLI school, opened in SY 2013–14. Since it is not a Spanish-language program, it is unsurprising that it has a smaller proportion of Hispanic students than Spanish-language programs. With the small number of DLI schools in the sample, the addition of a single school with a lower proportion of Hispanic students can have a large impact on the average proportion of Hispanic students across all the DLI schools. Further research should be done to address this question.

One relevant factor in understanding the difference in the proportion of Black students between DLI and non-DLI schools is likely to be the distance between Wards 7 and 8, with their high concentration of Black residents, and the DLI schools included in the study, which are mostly concentrated in Ward 1, Ward 4, and a small area of Ward 5 (Ward 5 did have a Black majority throughout the period of the study). We discuss later, in the Single-Year Snapshot Analysis section (p. 35), the roles of distance and commute length for Ward 7 and 8 residents in awareness of and enrollment in DLI schools. However, DLI schools were not found to be losing Black students faster than non-DLI schools, despite the fact that, over the years of the study, the Black population in Wards 1 and 5, which were home to a total of six out of the nine DLI schools in the study, declined notably (U.S. Census Bureau data, as reported by the Annie E. Casey Foundation: https://datacenter.kidscount.org/data/tables/8873-race-ethnicity-of-young-child-population-by-ward).

Moving beyond geographic explanations, previous research has examined the lower rates of enrollment in language programs by Black students as compared with other demographic groups, though most commonly these studies focus on the university level. Possible explanations given for these lower enrollment rates include

- low numbers of Black world language instructors who can serve as role models to Black students learning world languages (Guillaume, 1994; Moore, 2005; Pratt, 2012);
- potential threats to cultural identity; Clowney and Legge (1978) reported that 57% of Black students in their study (who were studying world languages at Historically Black Colleges and Universities, HBCUs) thought that their cultural identity would be threatened by "a wholehearted commitment" to studying a foreign language and culture (p. 270). In contrast, however, Davis and Markham (1991) report that 84% of Black students in their study (all studying at HBCUs) did not feel that studying a foreign language was a threat to their cultural identity;
- relatively low exposure to languages and travel, and a view among African Americans that "foreign language [is] a rote exercise to be tolerated, one that is far removed from their concept of reality" (Lassiter, 2003, p. 6, as cited in Watterson, 2011);
- insufficient parental support for Black students to study world languages, Spanish in particular (Pratt, 2012); and
- advice given to Black students by teachers and school counselors to pursue courses of study perceived as practical, such as business, engineering, or education at the ex-

pense of liberal arts including language (Watterson, 2011), or to avoid courses of study (including world languages) deemed "too academic" or "too hard" (Garibaldi, 1992; Hall & Post-Kramer, 1987; Moore, 2005).

Some of these possible explanations for lower rates of Black student enrollment in language programs are speculative, and many are based on studies conducted in a single high school or university; there does not seem to be much research that is generalizable to a larger population of Black students or parents and certainly none about the relevant views of Black students or families in DC. More research is needed in this area.

One possible explanation for the faster increase in White students in DLI schools is the rapid growth of the White student population in Ward 5 over the time period of the study. Four of the nine DLI schools in the study were located in Ward 5, where the percentage of White children under the age of five nearly doubled from 8.8% of the under-five population in 2010 to 17.5% in 2015. The presence of an increasing number of White students in Ward 5 could mean that these students' families are exposed to more information about DLI schools than families in other wards and are more likely to apply to and enroll in these schools because they are convenient.

The difference in entropy index between DLI and non-DLI schools is likely at least partially explained by the significant differences in Black and Hispanic student populations between DLI and non-DLI schools. The proportions of individual racial/ethnic groups are used to calculate the entropy index, and DLI schools have smaller proportions of Black students in their kindergartens than non-DLI schools, while they have larger proportions of Hispanic students than non-DLI schools.

Single-Year Snapshot Analysis

While the previous section provided information regarding patterns of demographic change in the District over a six-year period, this section focuses on a single year and examines differences between the populations of DLI and non-DLI schools in terms of three outcome variables: racial/ethnic diversity (entropy index), socioeconomic status (at-risk status), and special education. If all schools were located randomly around the District, any significant differences would be attributable primarily to the DLI status of the schools, but since schools are not located randomly, we include a location variable (ward) to take into account the role of location and reduce the possibility that these differences could be due to population differences between wards of the District. Variables that may be related to DLI status will be examined post hoc in supplemental analyses to determine potential sources of significant differences.

This section comprises

- three research questions and the methods used to address each question,
- school characteristics,
- results, and
- discussion.

Research Questions and Methods

In a recent single school year, were the demographic profiles of DLI schools significantly different from non-DLI schools?

We used a linear regression model to measure the difference between DLI and non-DLI schools on the three outcome variables (entropy index, proportion of at-risk students, and proportion of special education students). The DLI status of individual schools is treated as a dichotomous predictor in the model; determination of DLI status is documented in Appendix 1. Significance of the DLI predictor will indicate a difference in demographic profiles between DLI and non-DLI schools. Geographic differences in these variables across the different parts of the city are accounted for through weighted effect-coded predictors representing the eight wards in the District. Effect sizes of the model and DLI status predictor are obtained from the omnibus R^2 and squared part correlation coefficient, respectively.

WEIGHTED EFFECT-CODED

Method that allows for the use of categorical variables as predictors in regression models while allowing for the proportion of cases represented by each code to vary and be represented equally. Weighted effect codes were used to represent ward in the snapshot analysis's regression model, as the number of schools in wards varies greatly.

If the demographics of DLI and non-DLI schools were significantly different, in what ways were they different?

The direction and value of any significant DLI coefficient found in the linear regression models described above will be used to determine the relationship and degree of difference between DLI and non-DLI schools on the outcome of interest.

What factors may explain these potential differences?

Factors that may explain possible sources of differences are explored post hoc. These factors were selected because previous research has shown them to be associated with caregivers' preferences for particular schools but were not included in the models because they are not independent of the other factors being examined. Differences between these factors are explored via t-tests, z-tests, or chi-squared tests, depending on the nature of the data being analyzed. Information regarding the chi-squared methodology is available in Appendix 7.

Schools Included in Snapshot Analysis

As in the longitudinal analysis, the population of schools included in the study was defined as all schools with a kindergarten class enrolled in SY 2015–16, which amounted to 141 schools. We again excluded several schools, either due to differences in program type or missing data.[35]

35 See p. 20 in the previous section (Longitudinal Analysis) and Appendix 1 for more information about schools included.

School Characteristics

DLI status, ward, and sector

The schools included in the study were not evenly distributed by ward, reflecting both the uneven distribution of all schools by ward throughout Washington, DC, and the uneven distribution of DLI programs (DC Language Immersion Project, n.d.). The average number of schools in a ward that were included in the study was 15.89 (SD = 8.40). The wards with the largest numbers of elementary schools included in the study were Wards 5, 8, and 4, while the wards with the fewest were Wards 1, 2, and 3.[36] The majority of the schools included in the study (118) were non-DLI schools, while nine DLI schools were included in the study.[37] Among schools included in the study, the average number of DLI programs in a ward was 1.125 (SD = 1.36). DLI schools included in the study were located in Wards 1, 3, 4, and 5. Ward is used in the linear regression models to account for regional differences, since school location has previously been associated with school choice in DC (Glazerman & Dotter, 2016) and elsewhere (Harris & Larsen, 2015; Hastings, Kane, & Staiger, 2006).[38] In the linear regression model, Ward 2 is used as the reference ward, as it is the ward with the fewest schools and with no DLI programs.

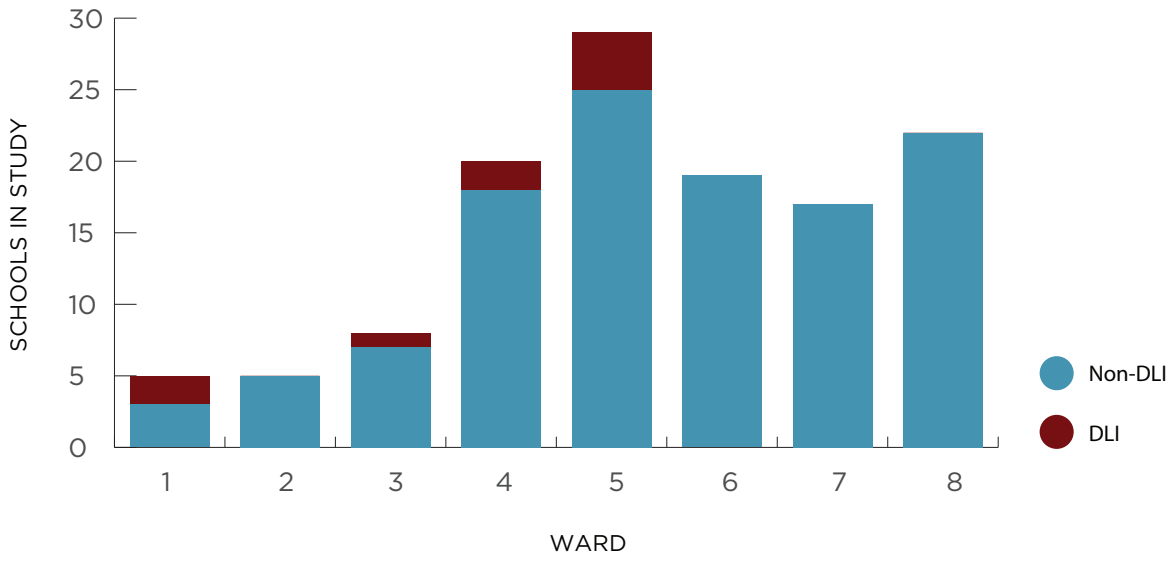


Figure 19. Schools included in study by ward

In the study, 54 schools were public charter schools, while 73 were traditional public schools (DCPS). Of the nine DLI programs in the study, six of these were charter schools, while three were DCPS. (See Appendix 1 for a full list of schools, wards, and educational sector.)

Three outcome variables and post-hoc explanatory factors

The three outcome variables are highlighted in the boxes below. In some cases the explanatory factors provide additional information about schools or their student population in SY 2015–16. In other cases the explanatory factors are considered possible drivers of school choice, in which case they are measured in the latest year that would have been available to families making decisions regarding enrollment for SY 2015–16. In each case we specify the

36. Each school was coded with the ward it was located in during SY 2015–16.
37. Houston ES was included in the study as a non-immersion school. It converted to an immersion school in SY 2016–17, after the year examined in this study.
38. Other measures of location were considered, including zip code and census tract. However, there are too few schools per zip code and per census tract to facilitate an informative analysis, so ward was selected as the most useful representative of location.

year for which the variable was measured. Due to the varied sources of these variables, data were not available for all variables for all schools.
Significant differences between DLI and non-DLI schools are noted in this section for all post-hoc explanatory factors, unweighted by school population. Significant differences for the three outcome factors are described in the following section (Results).

Student factors

The numbers of students of each race/ethnicity in District schools were obtained from the U.S. Department of Education's Common Core of Data (CCD) database for SY 2015–16 (U.S. Department of Education, 2017). In the CCD data, race/ethnicity is divided into seven mutually exclusive groups, so that students are counted as belonging to one and only one group (U.S. Department of Education, 2008). For the purposes of this study, as for the longitudinal analysis above, three groups out of the seven—Black or African American, Hispanic/Latino (of any race), and White—were selected as groups of interest.[39] Only students in kindergarten were included in this measure.

The proportions of students belonging to each of the four largest groups are shown in Table 3 below. Significant differences were found between schools on the proportions of Asian, Black, Hispanic, and White students in each respective school across the study. This indicates that schools vary between each other on their proportions of each respective ethic group ($p < .001$). For example, significant differences were found between schools on the proportions of Asian students. Following confirmation of these differences, the data were examined to determine whether the differences were related to DLI and non-DLI school statuses.[40] While DLI schools had a higher proportion of Asian students (.03) than non-DLI schools (.01), this difference was not found to be significant ($p = .69$). Similarly, DLI schools had a higher proportion of White students (.27) than non-DLI schools (.13), but this difference was also not found to be significant ($p = .25$). Significant differences were found, however, between the proportions of Black students in DLI schools (.23) versus non-DLI schools (.71); the proportion of Black students in non-DLI schools was found to be significantly larger ($p = .002$). Similarly, significant differences were found between the proportions of Hispanic students in DLI schools (.27) versus non-DLI schools (.13); the proportion of Hispanic students in DLI schools was found to be significantly larger ($p = .02$).

Table 3. Means of proportions of races/ethnicities in schools

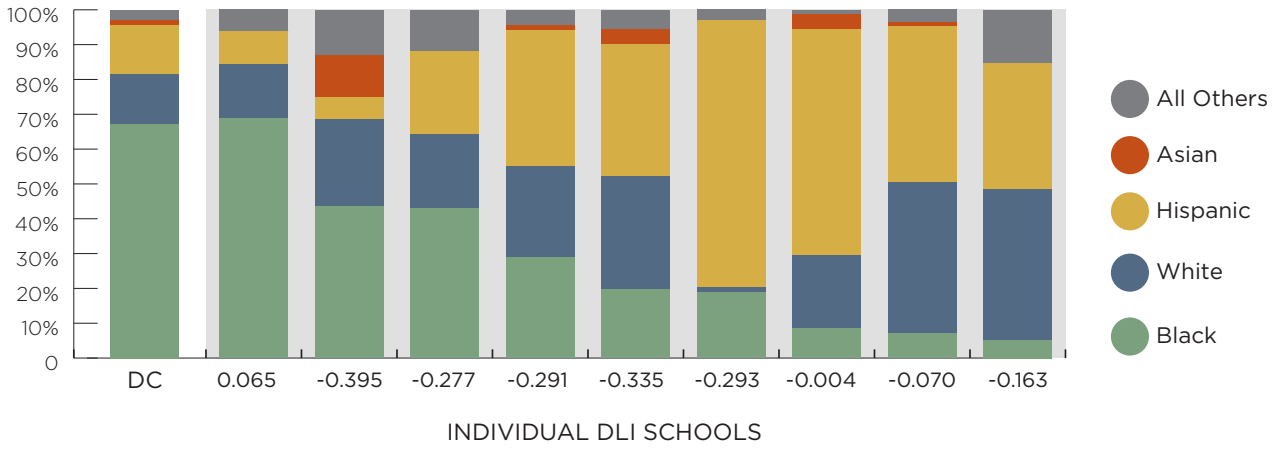
Year	Differences Among Schools				Differences Between DLI and non-DLI schools			
	Proportion	χ^2	df	p	DLI Proportion	Non-DLI Proportion	χ^2	p
Asian	0.02	467.35	124	<0.001	0.03	0.01	0.16	0.69
Black	0.67	3931.09	124	<0.001	0.23	0.71	8.71	0.002
Hispanic	0.14	1728.56	124	<0.001	0.40	0.12	5.47	0.02
White	0.14	2924.65	124	<0.001	0.27	0.13	1.34	0.25

39. Students who reported Hispanic/Latino, either alone or in combination with any other race, were categorized as Hispanic/Latino.
40. See Appendix 7 (Methods of Comparison of Proportions) for two-test methodology.

Ethnic Diversity Outcome Variable (Entropy Index)

The entropy index was measured in SY 2015–16 and was calculated for the kindergarten population of each individual school using race/ethnicity figures obtained from the CCD database. The average entropy index across the kindergarten populations of all individual schools in the sample was .54 (SD = .47). As this value is above zero, it indicates that the kindergarten population of the typical school is more racially homogenous than the District's overall kindergarten population. Entropy indices of the kindergarten populations of individual schools ranged from a minimum of -.40 to a maximum of 1 (the maximum possible entropy index measure, indicating a completely homogenous school). Average entropy at non-DLI schools was .50 (SD = .45), again indicating an average more homogeneous than the District as a whole. Entropy indices of individual non-DLI schools ranged from a minimum of -.37 to a maximum of 1. The average entropy at DLI schools was -.138 (SD = .22), with this value below zero indicating that in the average DLI school, the population of kindergarteners is more evenly distributed between racial/ethnic groups than the District as a whole. Entropy indices of individual DLI schools had a smaller range, from a minimum of -.40 to a maximum of .29.

The relationship between DLI status and entropy index is discussed in the Results section below.



Bars represent kindergarten populations of the schools included in the study. Schools are labeled with their entropy index; see page 22 for explanation of entropy index.

Figure 20. Racial/ethnic composition of DLI schools, as compared with districtwide population (SY 2015–16)

EL status data were collected due to EL status's possible association with school preference relating to DLI programs and its association with race/ethnicity among DC students.[41] Schools' proportions of ELs were measured in the SY 2015–16 enrollment audit. This measure is calculated using a whole school's population and is not available by grade. In the studied population, 9.4% of the students were ELs. Significant differences were found between individual schools' proportions of EL students ($\chi 2=4685648054, df=124, p<.001$). Of the non-DLI students in the studied population, 7.9.0% were ELs; 29.3% of the DLI students in the studied population were ELs. The difference between the proportions of EL students in DLI versus non-DLI schools is not significant but does approach significance ($\chi 2=3.531, df=1, p=.060$).[42]

41. Students who are identified as ELs can enroll—and succeed—in DLI programs, regardless of whether the language of instruction matches their native languages. On enrollment, see My School DC: https://www.myschooldc.org/faq/faqs. On success of ELs in programs that match and do not match their first languages, see, e.g., Lindholm-Leary & Block, 2010; Steele et al., 2017; Umansky & Reardon, 2014; Valentino & Reardon, 2015.
42. Data for 125 schools were available.

The proportion of the population of students who were eligible for free or reduced lunch (FARMs) was calculated by dividing the number of free or reduced lunch eligible students in a school by the total number enrolled at the school.[43] The number of FARMs students was reported in SY 2015–16. This measure was calculated using a whole school's population and is not available by grade. In the studied population, 74.1% of the students were eligible for free or reduced lunch. Significant differences were found between individual schools' proportions of students who were FARMs eligible ($\chi 2=32737.137, df=124, p<.001$). In non-DLI schools, 77.0% of students were eligible for FARMs; 42.6% of the DLI students in the studied population were eligible for FARMs.[44] The difference between the proportions of FARMs-eligible students in DLI versus non-DLI schools is significant ($\chi 2=5.147, df=1, p=.023$).[45] FARMs has limited utility for fully understanding the socioeconomic profile of a school, since schools determined to be among the "highest poverty schools" may apply to provide free breakfast and lunch to all their students, without the need for families to submit individual applications. Thus, in schools that report having all students eligible for free meals, 100% of their students may be individually eligible for free or reduced meals, or the percentage may be lower; percentages of individually qualifying students are not available for schools adopting this practice.[46]

Socioeconomic Outcome Variable (At-Risk)

The proportion of at-risk students was measured in the SY 2015–16 enrollment audit. This measure was calculated using a whole school's population and is not available by grade. The average proportion of students who were at-risk in schools was .485, or 48.5% of the school populations (SD = .25). The proportion of students identified as at-risk in individual schools ranged from a minimum of .015 (1.5%) to a maximum of .907 (90.7%). The average proportion of students who were at-risk in non-DLI schools was .505, or 50.5% (SD = .25). The proportion of students identified as at-risk in individual non-DLI schools ranged from a minimum of .015 (1.5%) to a maximum of .907 (90.7%). The average proportion of students who were at-risk in DLI schools was .228, or 22.8% (SD = .17). The proportion of students identified as at-risk in individual DLI schools had a smaller range, from a minimum of .033 (3.3%) to a maximum of .521 (52.1%).

The significance of the relationship between DLI status and at-risk status is discussed in the Results section below.

43. Data from U.S. Department of Education (2017).
44. Percentages reported here are out of studied population: unweighted school proportions are in Appendix 5 for reference.
45. Data for 125 schools were available.
46. On the Community Eligibility Provision, which allows qualifying schools to provide free meals to all enrolled students, see Office of the State Superintendent of Education (n.d.).

Special Education Status Outcome Variable

This figure was measured in the SY 2015–16 enrollment audit. This measure was calculated using a whole school's population and is not available by grade. The average proportion of students who were enrolled as special education students across schools in the sample was .114, or 11.4% of the school populations (SD = .06). The proportion of students identified as special education students in individual schools ranged from a minimum of .005 (0.5%) to a maximum of .300 (30.0%). The average proportion of students who were enrolled as special education students in non-DLI schools was .116, or 11.6% (SD = .06). The proportion of students identified as special education students in individual non-DLI schools ranged from a minimum of .005 (0.5%) to a maximum of .300 (30.0%). The average proportion of students who were enrolled as special education students in DLI schools was .085, or 8.5% (SD = .03). The proportion of students identified as special education students in individual DLI schools had a smaller range, from a minimum of .045 (4.5%) to a maximum of .124 (12.4%).
The significance of the relationship between DLI status and special education status is discussed in the Results section below.

Attendance and suspension rates

In-seat attendance was defined as the total number of students' days present divided by the total number of students' days enrolled in the school.[47] This measure used figures from SY 2013–14, as this was considered to be a variable potentially influencing school preference, and this would be the most recent available data for parents enrolling their children for SY 2015–16. This measure was calculated using a whole school's population and was not available by grade. The average in-seat attendance rate was 93.2 (SD = 2.5). Average in-seat attendance at non-DLI schools was 93.0 (SD = 2.54), while average in-seat attendance at DLI schools was 95.2 (SD = 1.39). The difference between these figures was significant.[48]

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Defined by the Office of the State Superintendent of Education (OSSE) as students between the ages of 3 and 21 who are eligible to receive special education services.

School suspension rates are calculated by dividing the number of students with out-of-school suspensions of one or more full days by the total number enrolled.[49] This measure was retrieved from the annual OSSE school equity reports. Suspension rates used in this study were measured in SY 2013–14, as this measure was considered to be a potential influence on school preference, and this would be the most recent available data for parents enrolling their children in SY 2015–16. The suspension rate was calculated using a whole school's population and was not available by grade. Of the students in the studied population, 6.0% had been suspended for one or more days.[50] Significant differences were found among individual schools' proportions of students who had been suspended ($\chi 2=891118886.5, df=115, p<.001$). Of the non-DLI students in the studied population, 6.3% had been suspended; 2.3% of the DLI students in the studied population had been suspended. The difference between the proportions of students who had been suspended in DLI versus non-DLI schools was not significant ($\chi 2=0.251503, df=1, p=0.616$).[51]

47. Definition from equity reports (Office of the State Superintendent of Education, 2014).
48. Data for 116 schools were available.
49 . Definition from equity reports.
50. Unweighted school suspension rate proportions are given in Appendix 5.
51. Data for 116 schools were available.

Pupil-teacher ratio and transportation routes

Schools' pupil-teacher ratios are calculated by dividing the total number of students enrolled by the number of full time teachers.[52] This measure was retrieved from the CCD database. The pupil-teacher ratio was measured in SY 2013–14 and was considered to be a potential influence on school preference. This measure was calculated using a whole school's population and is not available by grade. The average pupil-teacher ratio across all schools in the sample was 13.24 (SD =2.29). The average pupil-teacher ratio at non-DLI schools was 13.3 (SD = 2.12), while the average pupil-teacher ratio at DLI schools was 10.65 (SD = 1.15). The difference between these figures was significant ($t= 1.985, df = 111, p = .050$).[53]

The convenience of the school location (shown in previous research to be associated with school choice) was partially captured by the combined numbers of bus and metro lines accessible to the school. The District provides free transportation to school and school activities via the Metrorail (the public subway) and the Metrobus and DC Circulator (public bus systems) for all students enrolled in traditional public and public charter schools (District Department of Transportation, n.d.). This measure was retrieved from the My School DC School Finder database for schools participating in the lottery in SY 2015–16. This information is available to parents on the My School DC lottery page prior to lottery deadlines in order to aid in school selection. Data on accessibility by public transportation for schools not participating in the lottery were found on the individual schools' websites or parent guides. The combined number of public transportation lines accessible to a school has limited utility for fully understanding accessibility, since a school that is accessible from many methods of public transportation not be conveniently located to where students live and because different bus lines may run on nearly identical routes, inflating this measure. However, this was the most accurate method of measuring convenience that was available to us. The average number of combined bus and metro lines serving a school was 8.26 (SD = 4.86). The average number of bus and metro lines serving non-DLI schools was 8.28 (SD = 4.94), while the average number serving DLI schools was 8.00 (SD = 3.84). The difference between these figures was not significant ($t = .163, df=123, p = .870$).[54]

Results

We have provided information about all of these measures to demonstrate similarities and differences between DLI and non-DLI schools on a variety of factors. However, as mentioned earlier, the main areas of focus for the one-year snapshot analysis are whether the DLI status of a school can predict its racial/ethnic diversity, its proportion of at-risk students, or its proportion of special education students, when controlling for the ward the school is located in. We now present the results of those analyses.

Diversity (entropy index)

The first analysis considered whether a significant difference existed between DLI and non-DLI schools in the schools' entropy indices. A linear regression model was used, with the predictors DLI status and weighted-effect coded variables to control for region. No violations of the assumptions of linearity, independence, normality, and homoscedasticity of residuals were detected.

52. Definition from Public Elementary/Secondary School Universe Survey Data survey (U.S. Department of Education, n.d.), data downloaded from ElSi (U.S. Department of Education, 2017).
53. Data for 113 schools were available.
54. Data for 125 schools were available.

The model was significant ($F(8,116) = 20.804$, $p \leq .001$) and found a significant effect of DLI status ($t(116) = -4.256$, $p \leq .001$). The predictors that were included (that is, DLI status and ward) accounted for 56.10% of the variance in the entropy indices of the population of schools in the study.

This finding indicates that a randomly-selected DLI school in SY 2015–16 could be expected to have an entropy index .485 lower than a randomly-selected non-DLI school, showing that the racial/ethnic groups in a DLI school are expected to be substantially more evenly distributed than in a non-DLI school. A 95% confidence interval of -.710 to -.259 supports this finding and furthermore indicates that DLI schools are expected to have a substantially more even distribution of racial/ethnic groups than the District as a whole. The DLI status of a school accounts for 6.40% of the variance in the entropy indices of the populations of schools in the study above and beyond the variance explained by location (ward).

At-risk

This analysis considered whether there was a significant difference between DLI and non-DLI schools in their proportions of at-risk students. A linear regression model was used, with predictors of DLI status and weighted-effect coded[55] ward variables to control for region. No violations of the assumptions of linearity, independence, normality, and homoscedasticity of residuals were detected.

The model was significant ($F(8,116) = 22.325$ $p \leq .001$) and found a significant effect of DLI status ($t(118) = -3.401$, $p = .001$). The predictors included accounted for 57.9% of the variance in the proportions of at-risk students in the populations of schools in the study.

This model indicates that a randomly-selected DLI school in SY 2015–16 could be expected to have 20.8% fewer at-risk students than a randomly-selected non-DLI school. A 95% confidence interval of -32.8% to -8.7% supports this finding. The DLI status of a school accounts for 3.92% of the variance in proportion of at-risk students among the populations of schools in the study above and beyond the variance explained by location (ward).

Special education

This analysis considered whether a significant difference existed between DLI and non-DLI schools in the proportions of students who were classified as special education students. A linear regression model was used, with predictors of DLI status and weighted-effect coded variables to control for region. The model was not significant ($F(8,116) = 1.399$, $p = .204$). This indicates that we cannot state whether or not a difference between DLI and non-DLI schools exists on this measure.

Discussion

The results of these analyses address the first two research questions by showing two ways that the demographic profiles of DLI and non-DLI programs are in fact significantly different and how they are different. The following section addresses the third research question, which asks what factors may explain these differences. In this section we focus on the role of school location and other factors associated with families' school preference to explain the differences. We also recognize the possibility that these differences may be partially explained by school-side factors in recruitment, enrollment, and retention, though we do not address those here.

55. See index of terms.

Entropy index: Correspondence of findings to explanatory variables

The entropy index was found to have a significant relationship to DLI status. As seen above, across all schools, the ward a school is located in accounted for a large proportion of the variation in entropy index. This is consistent with previous research showing that wards vary greatly in terms of their levels of school diversity (Coffin, 2018). However, even after controlling for ward, kindergarten populations in DLI schools are still expected to have a substantially more even distribution of racial/ethnic groups than kindergarten populations in non-DLI schools and a distribution that is also more evenly distributed than in the District-wide kindergarten population in SY 2015–2016. To better understand this finding, we examine some related factors.

As discussed on page 30 in the previous section, the difference in entropy index is likely associated with the significant differences in Black and Hispanic student populations between DLI and non-DLI schools. We address possible reasons for these differences in that section. An additional factor likely related to differences in the Hispanic student population, and therefore to the entropy index, is EL status; the difference in the proportions of EL students enrolled in DLI and non-DLI programs approaches significance.

An additional question is whether sector plays a role; that is, is a school's status as a traditional public or public charter school associated with its entropy index? Earlier studies have found that traditional public schools in DC are more racially diverse than public charter schools (Coffin, 2018, p. 17; Orfield & Ee, 2017, p. 55). We ran a two-way ANOVA to understand the roles of DLI status, sector, and the interaction between the two as they relate to a school's entropy index. A significant main effect was found in entropy index between DLI and non-DLI schools ($F_{DL}=14.09, df=1,121, p\leq.00\ 1$), but no main effect of sector was found in entropy index between charter schools and traditional public schools ($F_{Sector}=.236, df=1,121, p=.628$), and no significant interaction effect was found between DLI status and sector ($F_{interaction}=2.122, df=1,121, p=.148$).[56] These results did not find any link between sector (traditional public vs. public charter) and differences in entropy index between DLI and non-DLI programs.

At-risk: Correspondence of findings to explanatory variables

The proportion of students who were classified as at-risk was also found to have a significant relationship with DLI status. As seen above, the ward a school is located in accounted for a large proportion of the variation across all schools in proportion of students classified as at-risk. However, even after controlling for ward, DLI schools are expected to have fewer at-risk students than non-DLI schools. To shed more light on these findings, we examine the role of other relevant factors for at-risk students.

We again ran a two-way ANOVA, in this case to understand the roles of DLI status, sector (traditional public vs. public charter), and the interaction between the two as they relate to a school's predicted proportion of at-risk students. Orfield and Ee (2017) found that, in SY 2012–2013, DC charter schools had higher proportions of low-income students (72.5% of charter school students) compared with traditional public schools (52.6% of traditional public school students).[57] For the present data, in a similar finding to the ANOVA reported above, a significant main effect was found in proportion of at-risk students between DLI and non-DLI

56. Assumptions of independence, homoscedasticity, and normality of residuals were examined. The assumptions of independence and homoscedasticity were accepted; the assumption of normality was presumed to hold, due to its robustness to violations, and was accepted.
57. Note that "low-income" is a different designation than "at-risk," though both are associated with poverty.

schools (F_{DL}=7.814, df=1,123, p=.006), with DLI schools serving lower rates of at-risk students than non-DLI schools, but no main effect of sector was found in proportion of at-risk students between charter schools and traditional public schools (F_{Sector}=.887, df=1,123, p=.348), and no significant interaction effect was found between DLI status and sector ($F_{interaction}$=.524, df=1,123, p=.470).[58] These results did not find any link between sector (traditional public vs. public charter) and differences in proportions of at-risk students between DLI and non-DLI programs.

Differences in the proportion of at-risk students between DLI and non-DLI schools are likely related to the significant differences between the proportion of Black and Hispanic students in DLI and non-DLI schools. According to U.S. Census Bureau data reported by the DC Fiscal Policy Institute, in 2016 the poverty rate for Black District residents was 27.9% and for "Latinx" residents was 17.8%, compared with 7.9% for White residents (Naveed, 2017).[59] Since DLI schools have significantly smaller proportions of Black students and larger proportions of Hispanic students in their kindergartens than non-DLI schools, the finding of the relationship between DLI status and proportion of students classified as at-risk is likely related to the differences in proportion of Black students and Hispanic students.

Another factor likely contributing to the difference between DLI and non-DLI schools in the proportion of at-risk students is the fact that families of at-risk students are less likely to enter the lottery, defaulting to their neighborhood school rather than seeking enrollment in a different school. Since six out of the nine DLI schools included in the study could only be accessed through the lottery, lottery participation may play a role in the composition of the student population of these DLI schools. Prior research shows that at-risk students are generally underrepresented in the common DC lottery. Peretti and Parrott (2018) report that, in SY 2016–17, 7,432 out of 21,208 lottery applicants (that is, 35% of lottery applicants) were identified as at-risk, a smaller proportion than the 43.7% of all enrolled students in SY 2016–17 who were identified as at-risk (Office of the State Superintendent of Education, 2017a). Similarly, Glazerman and Dotter (2016, p. 10) found a small but statistically significant difference between the proportion of "direct certified"[60] students in the DC common lottery for SY 2014–15 and the proportion enrolled in schools; the proportion of direct certified students in the lottery was lower than among total enrolled students.

Relatedly, some at-risk students are homeless. In SY 2016–17, 4,634 students in DC's public schools ages 5–17 experienced homelessness during the school year (Office of the State Superintendent of Education, 2016). By law, the school district may place a homeless student in a school that is deemed to be in the student's "best interest," meaning that a portion of at-risk students may not have a choice in which school they enroll in (District of Columbia Public Schools, 2017). There is some anecdotal evidence that the city does not view DLI programs as a good fit for homeless students since, due to the students' transient status, they may not be

58. Assumptions of independence, homoscedasticity, and normality of residuals were examined. The assumptions of independence and homoscedasticity were accepted; the assumption of normality was presumed to hold, due to its robustness to violations, and was accepted.
59. Data on differences in at-risk status across racial/ethnic lines among DC students were not publicly available. At the kindergarten level, the majority of factors used to determine at-risk status are related to poverty.
60. A student is "direct certified" if they are eligible for free meals by virtue of being homeless, in foster care, or qualifying for public assistance programs. The factors used to identify students as "direct certified" overlap substantially with the factors used to determine at-risk status.

able to complete a full program. Lower rates of overall lottery participation by at-risk students—whether homeless or not—may contribute to the difference in the proportion of at-risk students in DLI as compared with non-DLI schools.

Among those who do enter the lottery, at-risk families may not use the same information as not at-risk families to identify schools to apply to. Glazerman and Dotter (2016) found that, among lottery participants applying to middle schools in DC, low-income choosers were more likely to choose schools based on information that was directly observable on the lottery website (in their study, specifically math and reading proficiency rates), while higher income choosers were more likely to rank schools based on information not directly available on the lottery website (in their study, school accountability ratings). Schools' DLI status is on the lottery website, but the advantages of DLI for students are not described there, and information about the advantages of DLI for students may not be equally accessible to all families. Fond et al. (2017) show a number of gaps between what experts know about early bilingualism and the general public's beliefs about early bilingualism, including regarding the benefits of early bilingualism and the mechanisms of language learning. Therefore it is possible to speculate that additional research on DLI might be required on the part of parents and guardians in order for them to become aware of its benefits. Higher income lottery entrants may be more likely to seek out information on the benefits of DLI programs and apply to them, compared with lower income families.

Among the other factors that lottery entrants might consider in their choice of school, several that are associated with differences between DLI and non-DLI schools are also not reported directly on the lottery website. DLI schools have significantly higher attendance rates than non-DLI schools, and although the suspension rates between DLI and non-DLI schools were not significantly different, DLI schools do have a lower average suspension rate. Both of these factors could increase the appeal of DLI schools to higher income lottery entrants, who may be more likely to look for them.

The difference in proportion of at-risk students may also be related to the accessibility of the DLI schools to at-risk students. We found no significant difference in the number of bus and train lines accessible for DLI and non-DLI schools. However, this is only one measure of convenience. To fully measure the convenience of DLI and non-DLI schools would require calculating the travel distance or travel time required for each individual student based on their home address, information that was not available to us at the time of this study. A report from the Office of the Deputy Mayor of Education (2018) shows that, in SY 2017–18, 19% of District students were within 0.5 mile walking distance of a DLI program, higher than for most specialized programs.[61] An additional 67% of students had transit access to a DLI program, leaving only 14% of District students without either walking or transit access to a DLI program, a similar percentage to other specialized programs (Office of the Deputy Mayor for Education, 2018, p. 2-47).

61. "Older students are often more independent and rely on public transit and/or the Kids Ride Free program to get to school. However, for elementary school students, walking is an important factor when considering program accessibility." (https://dme.dc.gov/sites/default/files/dc/sites/dme/publication/attachments/DC%20Public%20Education%20Master%20Facilities%20Plan%202018.pdf, p. 2-45).

However, when we look at wards with high concentrations of at-risk students, accessibility of DLI schools looks different. Controlling for ward in the model above accounts for the demographic composition of each ward, but it might not fully capture the extent to which the geographic distance of many at-risk families from DLI programs may affect those families' awareness of and interest in enrolling in DLI programs, as well as their willingness to enroll in DLI programs, given the long commute. "Many families don't even know what school options are available, they generally just know what they see around them. They go to a particular charter school or their neighborhood school because they don't realize other options." says Faith Gibson Hubbard, chief student advocate at the State Board of Education, quoted in a news story (Austermuhle, 2019).

Wards 7 and 8 have much higher concentrations of children living in poverty than DC's other wards. (At-risk data were not available by ward of residence, so here we use poverty rates as a proxy.) In 2015, 39.9% of children (under the age of 18) living in Ward 7 and 49.6% of children living in Ward 8 were living below 100% of the federal poverty level, while the rates in other wards ranged from 2.9% to 23.7% (U.S. Census Bureau, 2015 ACS 5-Year Estimates, as reported by the Annie E. Casey Foundation: https://datacenter.kidscount.org/data/customreports/1852,1853,1854,1855,1856,1857,1858,1859/6748). The DLI schools included in the study—while served by as many bus and train lines as non-DLI schools—are relatively difficult to reach by public transportation coming from Wards 7 and 8. A commute by public transportation from the Anacostia Metro station on the Green Line in Ward 8 to each of the DLI schools would take between 28 and 44 minutes; a commute by public transportation from the Benning Road Metro station on the Blue/Silver Line in Ward 7 would take between 41 and 62 minutes; and a commute by public transportation from the Minnesota Avenue Metro station on the Orange Line in Ward 7 would take between 39 and 68 minutes.[62] These are the closest-in metro stations in each ward; commutes from anywhere else in the ward would take longer.

Other factors

Of course, a school's academic characteristics are known to be an important factor in school preference. Glazerman and Dotter (2016) found that a school's proficiency rate (the percentage of students testing as "proficient" on a standardized assessment) was one of the factors driving school preference. Our study does not examine differences in proficiency rate between DLI and non-DLI schools for a number of reasons. One reason was missing and limited data; some schools did not have students who were old enough to take the assessments, and other schools had such small numbers of students in each category that publicly available data were hidden for those groups. Another reason is the possibility of circular logic. Choosers may prefer some DLI schools because they have higher proficiency rates, and schools may have higher proficiency rates because they have a DLI program. For these reasons, we decided not to consider the role of a school's academics in this study, though we recognize that it plays a substantial role in school preference.

A number of other factors are associated with differences between DLI and non-DLI programs in DC, which have also been shown in previous research to be associated with race/ethnicity and/or socioeconomic status. DLI schools have significantly lower proportions of students

62. Using Google Maps' public transportation option, planned arrival time of 8:30 a.m.

enrolled in the FARMs program than non-DLI schools. Although District student-level data were not available to confirm this, Hispanic and Black students are overrepresented among students enrolled in FARMs nationally (U.S. Department of Education, 2019a). Black students are underrepresented in DLI schools, which is in line with this finding. However, Hispanic students are overrepresented in DLI schools. DLI schools have higher attendance rates and lower suspension rates than non-DLI schools. Attendance rates have been found to be associated with race, with Black and Hispanic students experiencing higher rates of chronic absenteeism (U.S. Department of Education, 2019b). Suspension rates have been found to be associated with race, with Black students overrepresented in suspensions (Office of the State Superintendent of Education, 2017b; U.S. Government Accountability Office, 2018). The associations between a school's DLI status and its entropy index and racial/ethnic makeup, on the one hand, and these other factors, on the other hand, appear concurrently. The differences by race/ethnicity in FARMs enrollment, attendance rates, and suspension rates have been identified elsewhere, and further research could explore the complex interactions among all of these factors and how they might play a role in the demographic composition of DLI schools as compared with non-DLI schools.

Conclusions and Recommendations

The studies found notable similarities and differences between DLI and non-DLI schools of the District of Columbia in both the racial/ethnic and socioeconomic composition of kindergarten populations from SY 2010–11 to SY 2015–16.

Main Findings

Racially/ethnically more diverse

DLI schools were racially/ethnically more diverse (had a more even distribution of racial/ethnic groups on average, as calculated using an entropy index) than non-DLI schools located in the same wards, regardless of sector. DLI schools had smaller proportions of Black students and larger proportions of Hispanic students, on average, than non-DLI schools, probably due in part to the locations of the schools and their different degrees of accessibility for different groups of students, as well as a lottery requirement among DCPS DLI schools that reserves seats for Spanish-dominant students. DLI schools and non-DLI schools had similar proportions of White students.

Fewer at-risk students

Socioeconomically, DLI schools differed significantly from non-DLI schools; on average, DLI schools were expected to have about 21% fewer at-risk students than non-DLI schools regardless of sector. Because less than 4% of the variance is explained by the DLI status of the school, while a notable amount is explained by the wards the schools are in, this presents an opportunity to address equity of access through policies focusing on the locations of new DLI programs and on the lottery preferences that can counterbalance the effects of existing school locations.

Populations of DLI schools and non-DLI schools changed in the same direction but at different rates

Racial/ethnic proportions in DLI and non-DLI schools over the years of the study changed in the same directions (decreases in proportions of Black and Hispanic students and an increase in proportion of White students); statistically significant differences of less than 2 percent were found in the rates of change between DLI and non-DLI schools.

Limitations

Several limitations should be borne in mind when interpreting the studies presented here. First and perhaps most importantly, four DCPS DLI schools (out of a total of 13 DLI elementary schools across the District during the period of the study) had to be excluded from both the longitudinal analysis and the one-year snapshot because each of these schools has both a DLI and a non-DLI strand, and historically they have not tagged students' data by strand. Thus demographic data for a substantial proportion of students enrolled in DLI programs were not available for this study, limiting the breadth of the analysis. In SY 2015–16, these schools began tagging students' data by strand, however these data were not publicly available at the time of

writing.

When possible, we used data from kindergarten for the sake of consistency, but as noted in the Single-Year Snapshot Analysis section, for some variables only whole-school data were available.

The analyses here are also limited by missing data. Not all data were available for all schools. Footnotes throughout the report identify the number of schools that data were available for. In some cases, publicly available data showed an approximate value rather than an exact value on a certain measure for certain schools. In these cases, we replaced values like "<4%" and "<2%" with 3.5% and 1.5%, respectively.

The one-year snapshot has some additional limitations. First, geographic control using ward is a rough measure; ward boundaries are political boundaries, not related to education. Ward boundaries can only give us a general sense of the role of region in demographic differences. Additionally, while at-risk is one of the more useful measures of poverty among DC students (compared, for example, with eligibility for free and reduced meals or the status "economically disadvantaged," which is based on eligibility for free and reduced meals), none of these measures gives us a complete understanding of the full range of socioeconomic status of DC students.

Numerous schools included in the study closed, opened, or moved locations during the range of years included in the study. These closings and openings often force student population shifts and present a limitation to our discussion of the role of school locations in demographic changes over time. The analysis performed here is limited in generalizability to only the schools and years included in the analysis. Results are meant to be descriptive of demographic changes in this period and are not meant to be applied to other contexts or to predict future changes.

Policy Recommendations

This report sheds light on the racial/ethnic diversity of DLI programs and on the significant inequities in participation and access to DLI programs particularly by at-risk students. Deliberate action on the part of DC's decision makers can help harness the integrating potential of DLI programs and address the underrepresentation of certain groups in programs that have been shown to be academically advantageous to students across many different demographics. We note that these policy recommendations are tailored specifically to the DC context and may not be appropriate for other states or school districts.

Any policies concerning DLI programs should be part of a coordinated set of policies to address critical inequities in the education and future opportunity of the District's at-risk communities. This is because of the increased economic opportunity that DLI programs bring to students and to the District as a whole, the economic drivers that underpin education policy such as housing policy, the many constituents touched by these policies (Black, Latino, recent immigrants, EL, at-risk, teachers), and the potential corollary effects of these policies (integration/segregation, displacement).

DLI programs should be added in neighborhoods with high densities of at-risk students, and investments should be made in targeted outreach to families of at-risk students

The DC Public Education Master Facilities Plan (MFP) 2018 recommends, "Unique program offerings should be geographically distributed and easily accessible . . . to promote equity and access across Washington, DC, . . . and promote improved utilization of underutilized facilities. The MFP advocates for cross-sector coordination in planning for unique program distribution across the city" (Office of the Deputy Mayor for Education, 2018). Delaware deliberately and successfully adopted a policy to implement DLI programs in under-enrolled schools with high percentages of at-risk students. The District can do the same.

In order for additional DLI programs to be implemented in under-enrolled and under-resourced schools and in neighborhoods where students face significant additional challenges, the District could incentivize the planning and implementation of DLI programs in these neighborhoods (whether in new schools, new programs in existing schools, or replication of current DLI programs), provide systemic support to the planning and implementation of these programs, or both. Systemic support could include funding targeted programs to increase DLI teacher preparation; adjusting certification requirements to allow for limited licensure; incentivizing grow-your-own teacher programs; and funding professional development for administrators, educators, and staff currently not working in DLI programs to increase awareness and willingness to plan and implement DLI programs in the schools they currently work in. More equitably distributing DLI programs must include more equitably distributing DLI elementary, middle, and high schools for students to reap the full benefits of DLI programs.

Because the underrepresentation of at-risk students in DLI programs could be linked to inequitable access to information about the existence, location, and benefits of DLI programs by parents and caregivers of at-risk students, the District should invest in targeted outreach on these topics to the parents and caregivers of at-risk students. This could be done through the Office of the State Superintendent of Education in partnership with organizations that specialize in community outreach. Outreach should target specific populations, for example, by having outreach sessions and informational content in the languages spoken by the parents and guardians of ELs, by holding sessions in the communities where at-risk students live, and by providing content that is relevant to them (Fond et al., 2017), such as the benefits of DLI programs specific to those populations or any lottery preference available to them. Any reticence toward DLI programs by at-risk communities should be further researched and understood to ensure outreach is conducted in a way that will enable families of at-risk students to make informed decisions, whether or not they ultimately choose DLI programs. (See the Future Research Recommendations section, p. 53, for more information.)

DLI programs should have at-risk and EL lottery preferences, and these should replace dominant language lottery preference

Currently, all DCPS DLI programs utilize a dominant language lottery preference to try and maintain a "balanced" population of dominant English speakers and dominant Spanish speakers. This lottery preference is problematic for several reasons. First, it does not apply across sectors to all of DC's DLI programs, making it inherently inequitable. Second, it is premised on an assumption about the superiority of the two-way immersion model, which leverages the

two linguistic groups, over the one-way model. While two-way immersion models have been shown to be extremely effective for ELs who are native speakers of the partner language and for the English speakers who learn with them, two-way programs cannot serve the majority of at-risk students and the majority of Black students in DC because of where the populations who are dominant in Spanish and in English live and because there are too few dominant language speakers of languages other than English. Third, the dominant language lottery preference might be eroding the by-right access available to any student that lives in the school's boundary of the three DCPS DLI programs that are accessible by-right without the upside of guaranteeing that spots go to at-risk students or ELs. This is problematic in cases where DLI schools are located in neighborhoods with high concentrations of at-risk or EL students who are not dominant in the partner language. In these situations, these groups have access to approximately 50% of the seats in any DLI program that uses the current dominant language preference, limiting access for at-risk or EL students. The dominant language lottery preference could even further erode access for these students if English-dominant, better-informed parents and caregivers apply in greater numbers for the half of the seats reserved for students who do not speak the partner language. This might result in in-boundary students not having access to DLI programs. These issues may be exacerbated by the fact that sibling preference comes before in-boundary preference for DCPS DLI programs, leaving fewer seats open for enrollment through the lottery. Conversely, students who are dominant in the partner language are also limited to approximately half of the seats in a program with this preference, even in neighborhoods with high concentrations of speakers of the partner language. This creates the potential for a situation in which a high number of partner-language speakers compete for a small number of partner language seats.

Thus we recommend replacing the dominant language lottery preference with a preference for at-risk students and a preference for ELs. The District is currently contemplating adding an at-risk preference for all schools in the lottery (Peretti & Parrott, 2018). Given the lower participation of at-risk students in high-in-demand programs that have been shown to be academically advantageous to students, if an at-risk preference is not added to the entire lottery process, the at-risk preference should be applied to DLI programs across both sectors and regardless of language dominance in one language.

Given that proficiency in English is critical in increasing overall achievement for EL students and that DLI programs are an extremely effective way to foster English proficiency in ELs regardless of their home language, the District should consider adding a preference for EL students applying for DLI programs across both sectors. This policy would need to go hand in hand with a policy expanding DLI programs as, even if all the existing seats in current DLI programs were occupied by ELs, there would not be enough seats for all of the 10,423 ELs who currently live in the District. It is critical that the implementation of an EL preference be in conjunction with both an expansion in DLI programs and the implementation of an at-risk preference to prevent reducing access for at-risk students who are not classified as ELs.[63]

63. In order for a DLI program to be most effective in closing the opportunity gap for an EL student, the language spoken at home by the student should match the partner language in the DLI program. Therefore, the EL preference would have to take language spoken at home into consideration. This raises an important equity consideration for the EL students who speak languages other than those currently implemented in the District's existing DLI programs (Spanish, French, Mandarin, and Hebrew). The District should consider conducting feasibility studies for DLI programs in the other languages most spoken by the District's EL students. At the very least, the District should conduct a feasibility study for a DLI program in Amharic, given that it is the second-most widely spoken language among EL students living in the District.

Strand DLI programs should be accessible to in-boundary students by-right in high at-risk neighborhoods

Although this report does not analyze the differences in demographics and access to schools where there are DLI and English-only strands, the current policy that reserves the English-only strand as the by-right strand for in-boundary students could lead to underrepresentation of certain populations in the DLI strand, particularly if compounded by the dominant language preference and the sibling preference, and especially where a high percentage of at-risk students live in-boundary. Therefore, to increase access to the DLI strand for at-risk students, in-boundary preference should apply to both programs, not only to the English-only strand as is currently the case in the remaining four strand programs.

It is our hope that, in the near future, these four remaining DLI strands will transition to DLI whole school programs to increase access to DLI programs and to begin to undo the in-school segregation that the different lottery treatment of each strand and other implementation mishaps have created (for other advantages of a whole-school model over a strand model, see DC Immersion, 2017).

Future Research Recommendations

Increasing accuracy and widening scope of this study

The accuracy of these findings would be improved through the use of fine-grained student-level data that were unavailable for this study. Student-level data will allow for a more accurate analysis than performed in this study, including examination of multiple student characteristics together in the same models and measuring interactions of such characteristics as race/ethnicity and at-risk status on enrollment in DLI programs rather than comparison of school characteristics.

Furthermore, analysis using individual student commute data will allow for examination of the impact of distance on DLI enrollment in a more accurate manner than controlling for school ward. Analyzing this will help explain the relative roles in enrollment differences between DLI and non-DLI played by geographical distance and other student characteristics, such as race/ethnicity, at-risk status, special education status, or EL status.

By-strand data for schools that have independent DLI and non-DLI programs should be examined to compare DLI and non-DLI students in populations that attend the same school but are separated by program. Such data were not available for this study, as students within these schools were not tracked by their participation in DLI programs until recent years, despite strands' distinct curricula and independent lotteries. This comparison will control for both location and school, providing a useful analysis of the impact of DLI programs on student populations.

The impact of DLI programs on student enrollment should also be explored through longitudinal analysis of changes in student populations within individual schools in the initial years following the foundation of a DLI program. For example, analysis of differences in the Houston ES population prior to and following the start of the school's DLI program in SY 2016–17 will provide direct insight into the impact of DLI programs on student populations.

Finally, future research should expand the scope of the study to include recent years of data (that were unavailable at the start of this study) and additional grades to extend the understanding of longitudinal demographic changes in the district and in DLI schools, especially as more DLI programs have been added and grown, and as the common lottery has had more time to have an impact.

Impact of the lottery

As described above, the My School DC common lottery has been expected to have a democratizing effect on school enrollment. Whether this holds true, and in what ways the implementation of a common lottery affected the populations entering DLI programs, should be examined. This should be performed using longitudinal models examining the respective years in which individual schools began to participate in the lottery and whether differences can be observed before and after. Close analysis using student-level data should also be performed to look at only those incoming students who fill open seats, excluding those who are prioritized for acceptance in the lottery though sibling preference. This will isolate and highlight the effect of the lottery on incoming cohorts' populations.

Populations that apply for DLI programs

This proposed research must be contextualized by an understanding of the rates of application for DLI programs. This will involve investigation into the motivations of students and families that apply for DLI enrollment and, equally importantly, the motivations of students and families that do not apply for DLI enrollment. Understanding the factors driving lottery applicants' views of DLI programs will enable stakeholders to better inform parents and students about DLI programs and their potential benefits for students. The DC Public Education Master Facilities Plan 2018 recommends specifically "that student demand data be further studied to understand programmatic interests" and to inform equitable distribution of specialized programs across the District (Office of the Deputy Mayor for Education, 2018, p. 4-5), a recommendation we endorse.

In 2016, the authors of this report submitted a data request for an IRB approved research project to better understand demand for specialized programs. The Common Lottery Board denied this data request. It is puzzling to the authors of this report that data that must be provided by the public in order to access public education may not be used for research that may help formulate better policies for public education.

A first step in this research should be to analyze student-level data in the waitlists for DLI and non-DLI schools. The rates at which students from different racial/ethnic and socioeconomic populations apply to DLI programs and the priority at which they rank DLI schools in their lottery choices should be examined for between-group differences. These analyses should include measures of the distances that students live from the schools they apply to, in order to determine whether students are willing to travel additional distance to attend DLI programs and whether differences in this willingness exist between groups of students. Any differences found through quantitative analysis of lottery applications should be explored qualitatively to find out why different types of students might apply at different rates to DLI programs. What factors make DLI programs more or less appealing to different types of students? Any insights gained through this research could be used to guide policymakers and school administrators in future choices regarding community outreach and DLI program locations.

These analyses should be repeated using accepted-student data and second-round waitlist data to determine whether any differences in enrolled students originate in the difference between who is accepted into DLI programs from the lottery and who enrolls. Differences found at this point in the enrollment process may indicate, for example, that parents may apply to the lottery prioritizing schools of one type for their child but that once an acceptance is sent out, they may realize that logistical difficulties prevent attendance. Or, upon researching DLI curricula, parents may determine that it is not what they want for their child. These findings should also be explored qualitatively. Implications would include the demand for DLI programs in additional locations, if logistic barriers to attendance are found, or more extensive and targeted outreach to parents.

Impact of DLI on enrolled students

The scope of this study should be expanded to include the impact of DLI programs on student achievement and the interactions of these impacts with school preference. While DLI programs have been shown to impact student outcomes, narrowing achievement gaps for several populations, research must be performed to explore whether this occurs in DLI programs in Washington, DC, and whether the narrowing of the achievement gap can be attributed to the DLI program itself, independent of school preference. Whether the impact and direction of impact of DLI instruction on standardized assessment scores varies between populations should be explored, as well as the influence of school assessment scores on school preference in lottery selections and enrollment and the interaction of assessment scores and DLI status on school preference. These findings would indicate the value of DLI curriculum not only in its influence on school preference but also its perceived value within a larger context of student achievement.

Contributions of the Study

This report presents an analysis describing demographics in DLI schools to compare them with non-DLI schools, highlights areas of inequity in the programs, and identifies ways to mitigate them. Prior to the publication of this report, public debate regarding DLI demographics was largely informed by anecdotal evidence, frequently based on individual schools, without reference to data representing the larger group of DLI and non-DLI schools in the city. This study contributes empirical evidence to inform debate regarding access to and enrollment in these programs in the District. Furthermore, the findings presented will give policy makers, educational specialists, and parents important information to make decisions regarding the establishment of DLI programs and equity of access for students in the District.

GLOSSARY

TERM	DEFINITION
50/50 MODEL	DLI model for percentage of instructional time, in which 50% of instruction takes place in English and 50% takes place in the partner language. This model is prevalent in two-way programs (see below). These percentages can change as students progress to higher grades.
90/10 MODEL	DLI model for percentage of instructional time in which instruction takes place mainly in the partner language, generally with the exception of specials like music, physical education, and art. This model is common in one-way programs (see below), particularly in the early grades.
AT-RISK STUDENT	At-risk student is defined by the Code of the District of Columbia (2001, §38-2901) as a student who is "homeless; in the District's foster care system; qualifies for the Temporary Assistance for Needy Families program or the Supplemental Nutrition Assistance Program; or [is] a high school student that is one year older, or more, than the expected age for the grade in which the student is enrolled." At-risk status is the socioeconomic factor at focus in this report.
BY-RIGHT ACCESS	Indicates the instances where students residing in the school's attendance boundary are guaranteed access to the school or program.
DC PUBLIC CHARTER SCHOOL	An independent local education agency (LEA) funded by taxpayer money through a per-pupil formula. The DC Public Charter School Board has chartering authority over DC public charter schools.
DC PUBLIC SCHOOLS	When not capitalized, this refers to all DC public schools whether traditional (DC Public Schools) or charter (DC public charter schools).
DC PUBLIC SCHOOLS (DCPS)	District of Columbia traditional public schools, as opposed to DC public charter schools.
DUAL LANGUAGE IMMERSION (DLI)	Programs where at least 50% of instruction is provided in a partner language through fifth grade or where programs are working toward that 50% goal and, for sixth grade onward, where bilingualism and biliteracy are the goal. Also called dual language or language immersion programs. These programs differ from foreign language classes in that dual language immersion programs provide instruction through the medium of the partner language and not as an add-on subject. Dual language immersion programs are a type of bilingual education program but are distinct from other bilingual education programs such as transitional bilingual programs and heritage language programs.
ENGLISH LEARNERS (ELS)	Defined under the No Child Left Behind Act as students whose native language is not English and whose English language proficiency is at a low enough level that it may affect their academic assessment outcomes, classroom success, or ability to participate fully in English-language society. Sometimes also called English language learners (ELs), limited English proficient (LEP), or emerging bilinguals (EBs).

ENTROPY INDEX	Measure of diversity that describes the extent to which a single school's distribution of racial/ethnic groups reflects the District's distribution of racial/ethnic groups. An entropy index of 0 indicates that the school reflects the overall population distribution; a negative entropy index indicates that the school is more evenly distributed than the overall population, or "hyper-integrated" (Reardon & O'Sullivan, 2004); and a positive entropy index indicates that the school is more homogeneous than the overall population. In this study, the entropy index refers to the kindergarten populations of each school in the study. Also called Theil's information index or the information theory index.
MY SCHOOL DC COMMON LOTTERY	The My School DC common lottery is a single, random lottery that determines placement for new students at all participating schools. Student-school matches are based on the number of available spaces at each school; sibling, proximity, and other lottery preferences; how each student ranked his or her school choices; and each student's random lottery number." (My School DC: https://www.myschooldc.org/about/about-my-school-dc/)
ONE-WAY PROGRAM	Program in which the majority of students are native speakers of the dominant language (English in the United States) or program in which the majority of students are native speakers of the partner language. Normally, in the former type of one-way program, the instruction model is designed for non-native speakers of the partner language to learn that language while simultaneously learning grade-level content, whereas in the latter type of one-way program, the instruction model is designed primarily for English language learners (ELs) to access content faster and more easily while building English competence and retaining proficiency in their home language. Also called one-way immersion.
PARTNER LANGUAGE	Language of a DLI program other than the typical language of instruction in that location (that is, other than English in the United States). Also called target language. DLI programs can offer one or multiple partner languages.
SPECIAL EDUCATION STUDENTS	Defined by the Office of the State Superintendent of Education (OSSE) as students between the ages of 3 and 21 who are eligible to receive special education services.
STATISTICALLY SIGNIFICANT	When results are described as "significant" or "statistically significant," the evidence strongly indicates that there are some differences between the groups on the outcome measures and that these differences are unlikely to be due to random chance. Mathematically, this occurs when the model's coefficient of interest is statistically different from zero and is rejected at the 95% level of confidence. Throughout this report, a .05 level of significance is used (α=.05).
STRAND	Program that is offered to only a subsection of students and not to the whole school on any given grade level. For the purposes of this study, schools that offer more than one DLI program to all students in the school (for example, a DLI program in French alongside a DLI program in Spanish) are referred to as whole school programs.
TWO-WAY PROGRAM	Programs in which the class population is approximately balanced between students who are native speakers of the partner language and students who are English native speakers. Normally, in a two-way program the instruction model is designed for students to learn with and from each other, with both groups of students advancing in English and the partner language while simultaneously gaining proficiency in grade-appropriate content areas. Also called two-way immersion.

VARIANCE	Statistical measure of the degree to which cases of a measure are spread around their average: the greater the variance, the more spread out the data are. It is calculated by squaring the standard deviation of a measure.
WARD	Washington, DC, is divided into eight geographic wards for the purpose of politically representing approximately 75,000 residents each (https://planning.dc.gov/page/neighborhood-planning-01).
WEIGHTED EFFECT CODING	Method that allows for the use of categorical variables as predictors in regression models while allowing for the proportion of cases represented by each code to vary and be represented equally. Weighted effect codes were used to represent ward in the snapshot analysis's regression model, as the number of schools in wards varies greatly.
WHOLE SCHOOL	A whole school program is a DLI program that is offered to all students in a school (or in the case of a school that is implementing a DLI program, to all students in the grades in which the implementation has happened).

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