Mathematics & Maps

Boston's Foreign-Born Population

Who? Where? How Many?

LOCATION: Boston, United States

TIME PERIOD: 2015

GRADES: 7–12

OVERVIEW

Inspired by the Leventhal Map Center exhibition *Who We Are: Boston Immigration Then and Now* and in coordination with the Boston Planning and Development Agency Research Division, this investigation has students **think critically** about the 2015 foreign-born population data for Boston and its neighborhoods. Students analyze a data table, graph the data, and discuss their findings using the critical thinking strategy *What Do You Notice?/What Do You Wonder?*. They reflect on a Boston neighborhood map that incorporates the data and develop their own questions that can be answered from the table, graphs, and map.

The mathematics focuses on **proportionality** for different sized populations. Students calculate proportions and construct **segmented bar graphs.** They analyze and discuss how to compare the bar graphs.

The humanities focus is on how **country of origin of foreign born** varies among Boston neighborhoods and has changed over time**.**

TIME COMMITTMENT

Three 45–60 minute class periods plus homework and optional interview project

MATH & HUMANITIES LEARNING GOALS

Students learn that analyzing subgroups (neighborhoods) of a population (City of Boston) is essential to understanding how subgroups may vary in very significant ways.

Students learn to compare counts and compare proportions for neighborhoods of different sizes.

Students learn how to make segmented bar graphs and compare them**.**

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CURRICULUM STANDARDS

Common Core State Standards

3.MD.3: Draw a scaled bar graph to represent a data set with several categories.
6.RP.A.3: Use ratio and rate reasoning to solve real-world and mathematical problems.
6.SP.B.5: Summarize numerical data sets in relation to their context.
HSS.IC.B.6: Evaluate reports based on data.

Standards for Mathematical Practice

SMP 1. Make sense of problems and persevere in solving them.
SMP 3. Construct viable arguments and critique the reasoning of others.
SMP 5. Use appropriate tools strategically.
SMP 6. Attend to precision.

MATERIALS

Accessible in a Map Set on the Leventhal Map Center Digital Collections website

https://collections.leventhalmap.org/map-sets/297

Graphs: Top Regions & Top Countries of Origin for Boston's Foreign Born

Table: Boston Neighborhood Populations by Nativity and Place of Birth for Foreign Born: Countries that are in Top 3 for Any Neighborhood

Map: Boston Neighborhoods: Top 3 Countries of Birth for Foreign-Born Population

Map: Leading Immigrant Group By Ward, City of Boston, 1910

Included in this file following the Lesson Plan Procedure

Survey Slips *(1 small slip per student)*

Graph paper to chart survey results

Student Handouts (can be printed double-sided)

Graphs: Top Regions & Top Countries of Origin for Boston's Foreign Born

Worksheet: Boston & Your Neighborhood Comparison

Table: Boston Neighborhood Populations by Nativity and Place of Birth for Foreign Born: Countries that are in Top 3 for Any Neighborhood

Worksheet: Boston & Your Neighborhood Segmented Bar Graph

Map: Boston Neighborhoods: Top 3 Countries of Birth for Foreign-Born Population

To be provided by the teacher

Projector

This lesson was written by Sharon Hessney, retired Boston teacher and graph curator, writer, and moderator of the New York Times Learning Network's *What's Going On In This Graph?*. Math teacher Nikan Hodjat and his students at Boston's John D. O'Bryant School of Mathematics and Science piloted the lesson. The graphics were provided by and this project is supported by:

boston planning & development agency

LESSON PLAN OUTLINE

This is a three-day unit as designated below, but it can be shortened by not covering some segments.

A. Hypothesize
   - Students guess which countries are the major countries of birth of Boston's foreign-born populations (Day 1)

B. Analyze (Noticing. Wondering. The Story.)
   - Students analyze Boston's foreign-born population from two graphs: by region and by country of birth (Day 1)
   - For top three countries of birth for foreign-born population in Boston and an assigned neighborhood, students create and analyze a table (spreadsheet) and segmented bar graph (Day 2)
   - Students analyze the map *Boston Neighborhoods: Top 3 Countries of Birth for Foreign-Born Population* (Day 3)

C. Reflect
   - Students write a news article comparing the foreign-born population for their selected Boston neighborhood to the entire city or to other neighborhoods.
   - Students interview someone who is foreign-born, preferably from the neighborhood that they analyzed, to get more insight into their experiences in Boston. The final product will relate to what they learned from the data and may be written or made into a video.

INSTRUCTIONAL PLAN

A. Make a Conjecture about Boston's Foreign-Born Population (4 steps)

1. "*We are going to take a class survey about the three largest countries of origin (birth) of Boston's foreign-born population. But, first, we need to define foreign-born.*"

   "Foreign-born" residents were born outside the United States and don't have U.S. citizenship from birth, although they may get U.S. citizenship through a process called naturalization. The opposite of foreign-born is native-born. "Native-born" people have U.S. citizenship from birth and were usually born in the United States.

   Many students will think falsely that they are foreign-born because others think of them as foreign-born or because their parents are foreign-born. Also, people born in Puerto Rico are native-born.

2. *Hand out the confidential* **Survey Slips** *and ask, "What are the top three countries of birth for Boston's foreign-born population?"*

Cut slips. Distribute slips to students. Students give their response and turn over. Collect slips.

Ask students not to share their responses since you don't want students influencing each other. We want their responses to be their own.

3. *Make a quick **bar graph** of responses*

   Project **Graph Paper to Chart Survey Results** on the board (or just draw a graph on board). List countries on the x-axis. Ask a student to fill in the graph with Xs or fill in boxes for each response.

4. *Analyze the bar graph*

   This graph is a **bar graph**. A bar graph records **categorical data**, like favorite pizza topping. Categorical data has no units, no order, and is discrete (separate and not continuous). Bar graphs look similar to **histograms**, which record **quantitative** data, like height. Bar graphs usually have spaces between the bars since the data is discrete, while histograms do not have spaces.

   The bar graph displays a **distribution**—all possible values (possible responses: China, Haiti, etc.) on the x-axis with their frequency (counts or proportion of students giving this response) on the y-axis. Here, we use count. The countries can be in any order including the most to least frequent or alphabetical.

   In describing a bar graph, we talk about which categories are the most or least frequent. It is not appropriate to describe bar graphs with center spread, and shape, as we do with histograms.

   Ask students what they **notice** and then what they **wonder** about the bar graph of their guesses.

   - Which country is guessed most frequently? Less frequently?
   - Are there countries, like Ireland, which may be guessed frequently, that are the country of origin of the family but not of birth?

   After students notice and wonder, ask them what **story** does the graph tell?

   Example: "I notice more of us said that Vietnam is the top country of birth of foreign born, but others said Dominican Republic and Jamaica. I wonder why there is such a difference in our answers. Maybe it has to do with where you live and who you see every day."

B. Noticing & Wondering: Critical Thinking Strategy for Analyzing Graphs & Maps

Initially we ask students to tell the class what they notice and wonder about the graphs and maps. We expect students to use informal language. As students progress in their quantitative understanding, they will use more formal academic language.

The questions ***What Do You Notice?*** and ***What Do You Wonder?*** are advanced by the National Council of Teachers of Mathematics' Math Forum to encourage students to become active and curious critical thinkers. They help students make sense of math. When students discuss in small groups and with the whole class what they notice and wonder, they meld their insights to discover deeper perspectives. Since we don't give directed questions, students do not just go for the answer, with some students staying on the sidelines discouraged and disengaging. Instead students communicate and engage with self-confidence. Everyone is involved in seeing the bigger picture by discovering multiple strategies for tackling a problem.

Annie Fetter explains how she uses the notice and wonder strategy in this video: https://www.youtube.com/watch?v=a-Fth6sOaRA.

The final question—***What Story Does This Graph Tell?*** invites students to think critically using what they noticed and wondered. Their answers reveal their own interpretations and discoveries.

The example above incorporates "What do you Notice?, What do you Wonder?, and What Story does this graph tell?".

C. Thinking about Graphs of Boston's Foreign-Born Population (3 steps)

1. *Distribute copies of* **Top Regions & Top Countries of Origin for Boston's Foreign-Born** *to students. As a full class, examine the two graphs*

   Ask "What is similar in the two graphs?" Examples: Boston's foreign-born. Percentages.

   Ask "What is different?" Examples: Regions vs. countries. Regions add to 100% but countries do not.

2. *Ask "What do you notice?" and "What do you wonder?"*

   Individually, in pairs, and/or small groups, have students think about and write down what they notice and what they wonder about these graphs.

   Remind students to think about ALL of the information on the page—titles, sources, colors, etc.

As a whole class, record concise answers on the board or projection (the questions can be done sequentially, which will probably bring out more ideas but take longer). Give each student or group of students an opportunity to answer. Be supportive, but neutral about their responses, writing down all without restating. If students are reluctant to answer, be more specific and ask what a Bostonian, a mathematician, or some other person with a different "lens" might notice. Maybe the graph looks different to different people.

Noticings are the graph's "facts." Encourage students to discuss what these noticings imply. Dig deeper! Here are some noticings:

- About ½ of Asian foreign born are from China
- About 2/3 of Caribbean foreign born are from Dominican Republic and Haiti.
- Europe has 12.7% of the foreign born, but Ireland is the only European country in the top 10 and it has a mere 1.5%. There is a lot of diversity in European foreign born.
- Nigeria and Cape Verde are the only African countries in the top 10.

Wonderings are the graph's questions. What are you curious about? Let students answer each other's wonderings. Here are some wonderings.

- Why are there so many Caribbeans and Asians? Where do they live in Boston? Do they go to other cities in the US?
- Why are there two kinds of graphs (pie chart and bar graph)? Could they both be shown in the same way? (No)
- Do students and undocumented people show up in this population data?
- How have these statistics changed from 10 years ago? Are they changing a lot now?

Ask if anyone wants a noticing or a wondering clarified. Does any noticing answer a wondering?

3. Ask *What Story Does This Graph Tell?* Record responses.

   Have students differentiate between claims and opinions. A claim should be supported by what is seen in the graph. An opinion is not.

   Let students know that we all need to examine a graph many times to uncover its story and should combine other's ideas.

Ask students how their findings based on these graphs differ from their guesses. Why do they think they had different impressions on the foreign-born population than the data show?

You may want students to write up their story as a news article or record a video. (See Follow Up)

D. Thinking about Foreign-Born Population by Neighborhood (4 steps)

1. *Project* **Boston Neighborhood Populations by Nativity and Place of Birth for Foreign Born: Countries that are in Top 3 for Any Neighborhood** *on board for class discussion.*

   Ask "What do you notice?" And "What do you wonder?"

   Expect the students not to be very responsive. There are just too many rows, columns, and numbers here. We want them to feel that the next step of making a summary table, and then graphs, is more informative.

2. *Complete* **Boston & Your Neighborhood Comparison** *worksheet*

   There are a lot of numbers here. Let's use this data in a more consolidated form.

   Assign individually, in pairs, or small groups, some or all of the neighborhoods to students. The ones with the largest populations and percentage of foreign born are Dorchester, Roxbury, Brighton, East Boston, Jamaica Plain, Mattapan, and Hyde Park. Distribute the following handouts to each student:

   Boston & Your Neighborhood Comparison

   Boston Neighborhood Populations by Nativity and Place of Birth for Foreign Born: Countries that are in Top 3 for Any Neighborhood

   Boston & Your Neighborhood Segmented Bar Graph

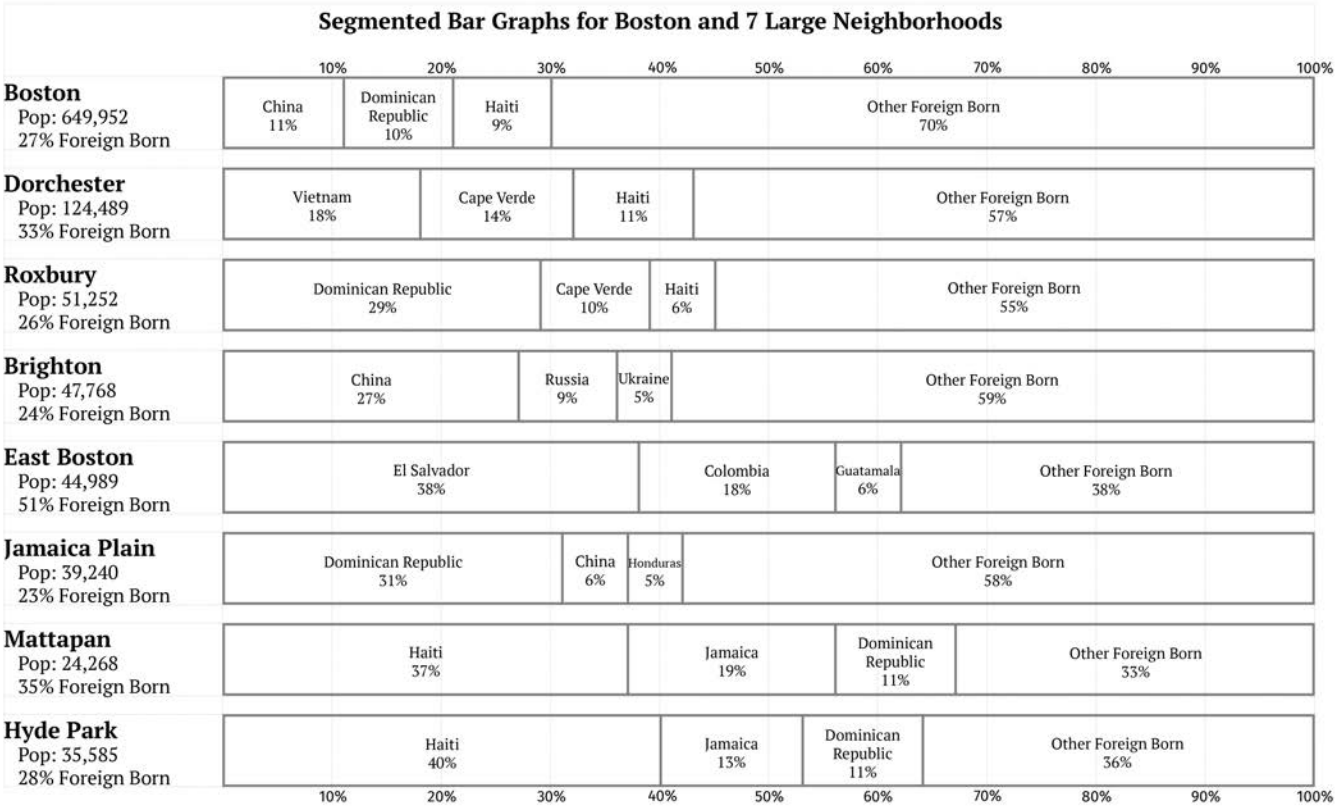
   Complete the **Boston & Your Neighborhood Comparison** worksheet, including writing down the most significant noticings and wonderings.

   - Compare the City of Boston statistics to the neighborhood's statistics
   - For Boston and the student's selected neighborhood, compare the percentage foreign-born, the percentage native-born, and the percentage Other Total (neighborhood's foreign-born who come from countries other than the neighborhood's top three countries). Which countries in a neighborhood are not in Boston's top three? Which neighborhood countries are "unusual"?

3. *Make **segmented bar graphs***

   These statistics may become clearer if we can compare Boston and its neighborhoods using segmented bar graphs.

   Segmented bar graphs are used because it is easier to compare the distribution of percentages when the population sizes are different. Here, we can compare foreign-born percentages for neighborhoods of different sizes. With the bar representing 100%, the bar is divided with vertical lines into segments, here representing the percentage of the total foreign-born population for the top three countries plus a segment for all other countries. You may want to now take a look these examples:



Using the **Boston & Your Neighborhood Segmented Bar Graph** worksheet, each student/group should make a segmented bar graph for Boston and their assigned neighborhood using the percentages they recorded on their Boston & Your Neighborhood Comparison Worksheet.

- For Boston and the neighborhood, use the percentages from the worksheet to complete the segmented bar graphs.

- Make segments for the top 3 largest countries of origin–largest to smallest, plus Other Foreign-Born (all countries of origin other than the top 3). For each segment, clearly write country name and percentage. Each student or group should have a graph for Boston and one for the neighborhood.

Display the students' segmented bar graphs together to have students compare the neighborhoods' foreign-born distributions by country of origin.

- Compare again the Boston and neighborhood statistics using *What do you notice?* and *What do you wonder?*
- Noticings may include: countries that most frequently appear on the graphs, neighborhoods that have the largest percentage of foreign born, neighborhoods that have the largest population of other foreign born, neighborhoods that have the most "diversity" (how did you define diversity?)
- Wonderings may include why people born in the same country live in a particular neighborhood, etc.

4. *Analyze map* **Boston Neighborhoods: Top 3 Countries of Birth for Foreign-Born Population**

   Project the color version. The handouts include the black and white version. It uses the same data that is in the table and was used for the segmented bar graphs.

   For each neighborhood:

   Total population is given with the percentage foreign born.

   The sizes of the pie charts (as measured by the diameter, radius, or area) are proportional to the total foreign-born population for the neighborhood. For example, the foreign-born population of Dorchester (41,685) is about three times the size of Roxbury (13,449). Dorchester's pie chart area is about three times the area of Roxbury's area. Its radius, however, is about $\sqrt{3}$ of Roxbury's radius, since area is proportional to the square root of the radius.

   Top three countries of origin for foreign born is shown in the neighborhood **pie charts**.

   - Some countries and their percentages are too small to be legible, either because the neighborhood is so small and/or the country's foreign-born population is small. Have students check back to the table for the country's foreign-born population.
   - Compare the students' segmented bar graphs and the map's pie charts. They use the same data but are not the same. How are the pie charts similar and how are they different from the segmented bar graphs?

Similar: Both show 100% and divide circle/bar into segments for subgroups by percentage.

Different: Pie charts are divided by angles and bar graphs are divided by lengths. To compare the graphs, angles or lengths have to be compared. Since lengths are easier to measure and compare than angles, segmented bar graphs are preferred.

Analysis of the pie charts

- What do you **notice**? Some examples include:

  The pie charts are of different sizes, based on the size of the foreign-born population in the specific neighborhood.

  Some countries appear in several or only a few neighborhoods. What does this imply? *Several*: China (10 neighborhoods), Dominican Republic (9), and Haiti (5); *Few*: Columbia and El Salvador only in East Boston.

  All but East Boston have more than 50% of their foreign-born population spread over many countries.

  The percentage of foreign born varies from 12.4% (South Boston and its waterfront) to 50.5% (East Boston).

  Dorchester, by far, has the largest population of any neighborhood with the most foreign born.

- What do you **wonder**? Some examples include:

  Why are most Chinese in the northern part of Boston?

  After the top three, what are the next largest foreign-born populations by countries? (See note at bottom of **Boston Neighborhood Populations by Nativity and Place of Birth for Foreign Born: Countries that are in Top 3 for Any Neighborhood**.)

  Why does East Boston have three large groups of foreign born (El Salvador, Columbia, and Guatemala) that are not in the top three of any other neighborhood?

  Why does South Boston have such a low percentage of foreign born and adjacent Dorchester has such a large percentage?

  Do these population totals include students? Do they include undocumented individuals?

  How has the number of foreign born by neighborhood changed over time? How have the percentages changed over time? (**Leading Immigrant Group by Ward,**

City of Boston, 1910 is included in the Map Set and can be projected for the class to make these comparisons.) Ask how the data for this map is similar and different.)

- What is the **story** that the map tells? Some examples include:

  China, Dominican Republic, and Haiti are the largest foreign-born populations in Boston.

  Dorchester has a large number of foreign born.

  Far less than 50% of Boston is foreign born.

  All parts of Boston have a significant number of foreign-born residents.

E. Follow Ups

1. *Write an article or create a short video for your neighborhood's website or newsletter: compare Boston's foreign-born population with your group's selected neighborhood.*

   The headline/title should include their major finding -- The Story.

   Show and explain the Boston and selected neighborhood segmented bar graph.

   Show and explain the map **Boston Neighborhoods: Top 3 Countries of Birth for Foreign-Born Population**

   Give supporting evidence for what they noticed.

   Raise what you are curious about or concerns (wonderings).

2. *Interview a foreign-born Boston resident.*

   Assign students to interview a foreign-born Boston resident, possibly from the neighborhood that they analyzed and from one of the top countries of origin.

   Questions: Where the person was born? Why they came to the US and Boston, specifically? What it has been like to live in Boston?

   After sharing the data they have on the number and percentage of other foreign-born residents of Boston from the same country and in the neighborhood, report on what the resident responds. Combining the data, statistics, and the first-person experience, what is the story about some foreign-born in Boston?

Survey Slips *(A.2)*

What are the top THREE countries of birth for Boston's foreign-born population?

1.

2.

3.

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1.

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3.

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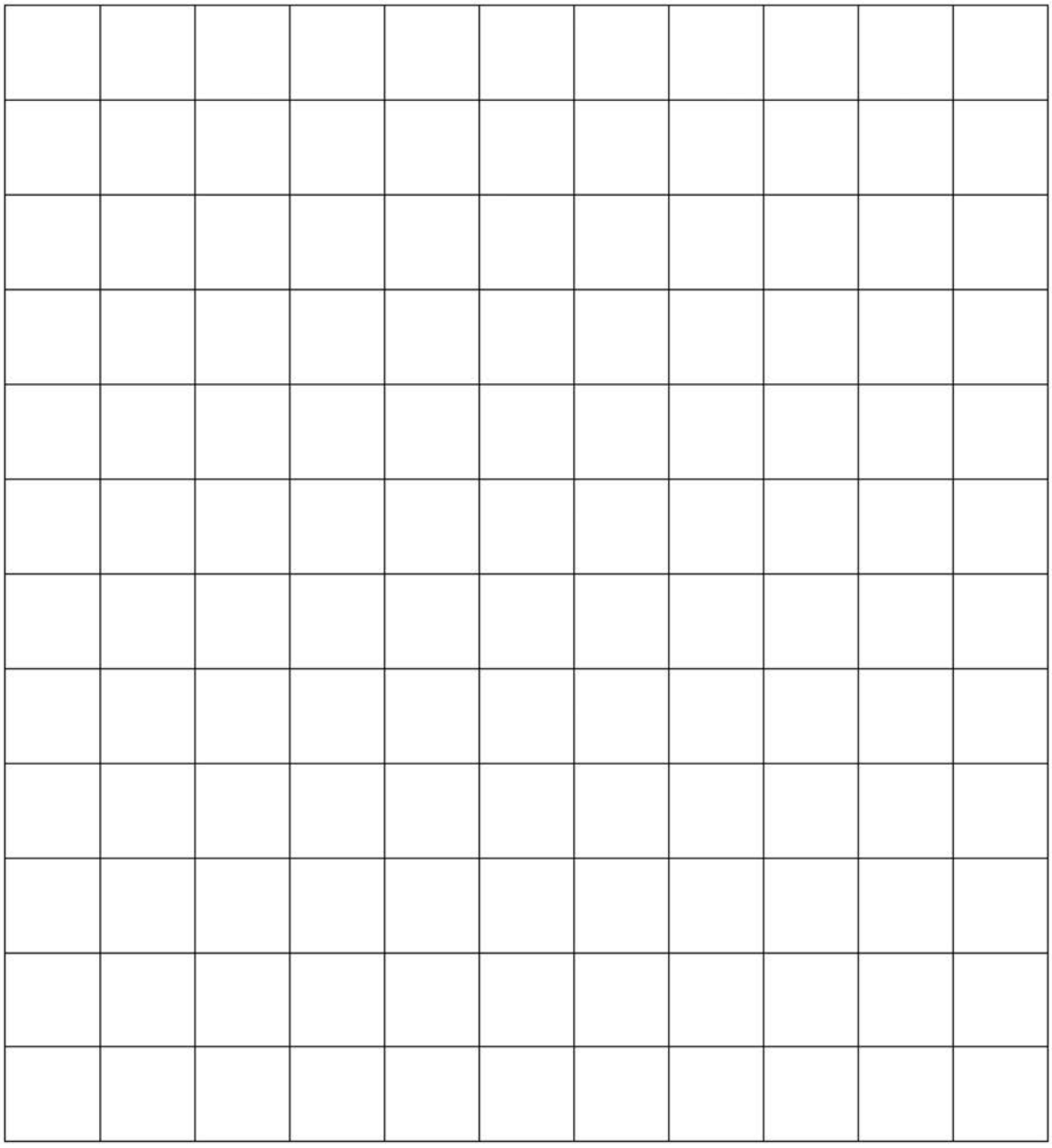
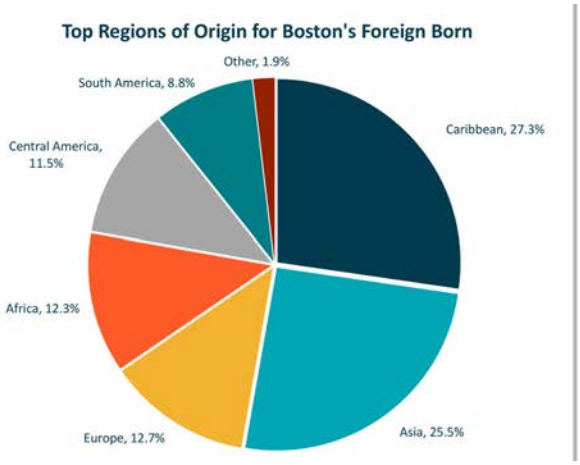
2.

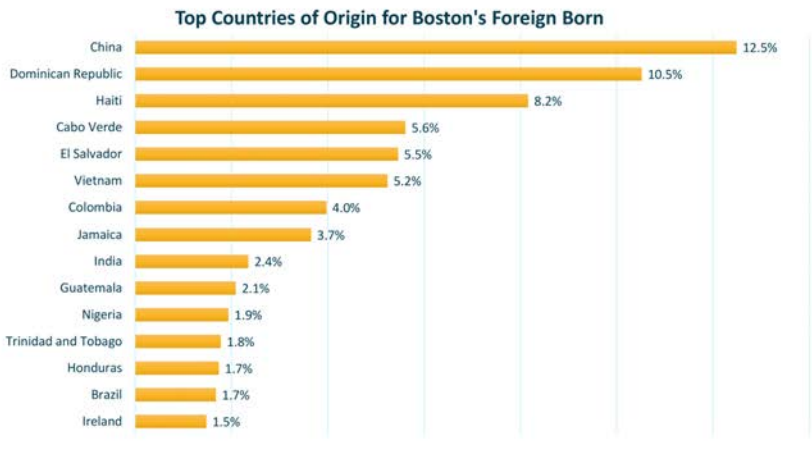
3.

Graph Paper to Chart Survey Results *(A.3)*



Top Regions & Top Countries of Origin for Boston's Foreign Born *(C.1-3)*





Courtesy of the Boston Planning & Development Agency Research Division
Sources: U.S. Census Bureau, 2015 American Community Surveys, BPDA Research Division

What do you NOTICE?	What do you WONDER?
1.	1.
2.	2.
3.	3.
4.	4.

Boston & Your Neighborhood Comparison *(D.2-3)*

CIRCLE the neighborhood you are analyzing.

Allston Back Bay/Beacon Hill Brighton Charlestown Dorchester
Downtown/Chinatown/West End/North End East Boston Fenway Hyde Park Jamaica Plain
Longwood/Mission Hill Mattapan Roslindale Roxbury South Boston & Waterfront
South End/Bay Village West Roxbury

Complete these tables using the data from the table: Boston Neighborhood Populations by Nativity and Place of Birth for Foreign Born: Countries that are in Top 3 for Any Neighborhood.

Boston		
	Number	% Boston Population
Total Population	649,952	100%
Native Born	472,423	
Foreign Born	177,529	

Your neighborhood:		
	Number	% Neighborhood Population
Total Population		100%
Native Born		
Foreign Born		

I notice _____

I wonder _____

For your neighborhood, list top 3 countries of birth of the foreign-born population. Input the number. Calculate Boston & your neighborhood percentages.

Boston		
Top 3 countries of birth of foreign born in descending order (biggest to smallest)	Number	% Boston Population
China	19,732	
Dominican Republic	18,566	
Haiti	15,901	
Other Foreign Born	123,330	
Total Foreign Born	177,529	100%

Your neighborhood:		
Top 3 countries of birth of foreign born in descending order (biggest to smallest)	Number	% Neighborhood Population
Other Foreign Born		
Total Foreign Born		100%

I notice _____

I wonder _____

What's the story? _____

Boston Neighborhood Population by Nativity and Place of Birth for Foreign Born: Countries that are in Top 3 for Any Neighborhood *(D.2)*

	Boston Total	Allston	Back Bay/ Beacon Hill	Brighton	Charlestown	Dorchester	Downtown/ Chinatown/ West End/ North End	East Boston	Fenway	Hyde Park	Jamaica Plain	Longwood/ Mission Hill	Mattapan	Roslindale	Roxbury	South Boston & Waterfront	South End/ Bay Village	West Roxbury
Total Population	**649,952**	**19,761**	**26,882**	**47,768**	**18,058**	**124,489**	**31,955**	**44,989**	**32,210**	**35,585**	**39,240**	**21,933**	**24,268**	**28,644**	**51,252**	**38,522**	**31,601**	**32,795**
Total Native Born	**472,423**	**14,115**	**22,349**	**36,272**	**14,922**	**82,804**	**23,765**	**22,257**	**24,109**	**25,492**	**30,361**	**16,663**	**15,702**	**21,516**	**37,803**	**33,757**	**24,525**	**26,011**
Total Foreign Born	**177,529**	**5,646**	**4,533**	**11,496**	**3,136**	**41,685**	**8,190**	**22,732**	**8,101**	**10,093**	**8,879**	**5,270**	**8,566**	**7,128**	**13,449**	**4,765**	**7,076**	**6,784**
China	19,732	1,302	462	3,111	748	1,239	3,785	595	1,822	53	541	1,224	24	136	418	835	2,502	935
Dominican Republic	18,566	35	66	271	625	4,113	70	1,109	68	1,080	2,759	390	915	1,169	3,930	929	571	466
Haiti	15,901	92	6	129	123	4,691	55	79	36	4,015	380	226	3,142	1,249	857	210	48	563
El Salvador	9,670	141	22	78	0	428	8	8,588	0	45	82	0	0	46	199	31	2	0
Vietnam	9,537	80	33	158	52	7,616	27	330	218	47	75	62	309	9	67	192	201	61
Cape Verde	7,860	3	19	10	44	5,796	7	35	0	52	129	34	138	21	1,313	52	190	17
Jamaica	6,894	0	17	5	6	2,859	0	1	26	1,262	204	64	1,607	195	554	54	34	6
Colombia	6,108	211	141	228	9	196	128	4,127	122	94	187	85	5	235	77	42	105	116
Guatemala	4,301	536	11	169	47	1,046	48	1,469	15	161	211	17	95	65	335	7	49	20
India	3,478	283	206	305	86	472	276	24	572	5	82	502	20	74	126	104	272	69
Ireland	3,196	0	108	264	46	1,052	51	0	12	155	140	16	61	198	3	419	146	525
Honduras	2,921	63	0	102	129	686	7	329	0	293	437	17	198	193	400	55	12	0
Russia	2,820	234	77	1,024	59	24	143	83	261	0	44	252	0	89	79	35	71	345
Canada	2,521	174	317	138	32	361	128	117	230	70	219	107	52	53	141	90	189	103
Korea	2,353	138	204	364	52	53	163	39	534	24	189	298	0	17	66	39	120	53
Ukraine	1,405	94	8	550	17	25	84	18	141	0	89	108	0	50	5	22	52	142
Greece	1,375	12	73	201	5	53	26	0	61	34	28	8	0	630	10	36	31	167
Venezuela	1,023	24	206	119	26	23	25	34	103	8	10	28	41	105	31	35	132	73

Source: U.S. Census Bureau, 2011-2015 American Community Survey, BPDA Research Division Analysis

Note: The following countries are not included in this chart because they are not in the top 3 of foreign born in any of these neighborhoods. Their members are spread throughout Boston. They include: Trinidad & Tobago (3,635), Brazil (3,204), Mexico (2,615), Nigeria (2,108), Italy (2,043), Barbados (1,639), Peru (1,575), Albania (1,285), and Cuba (659).

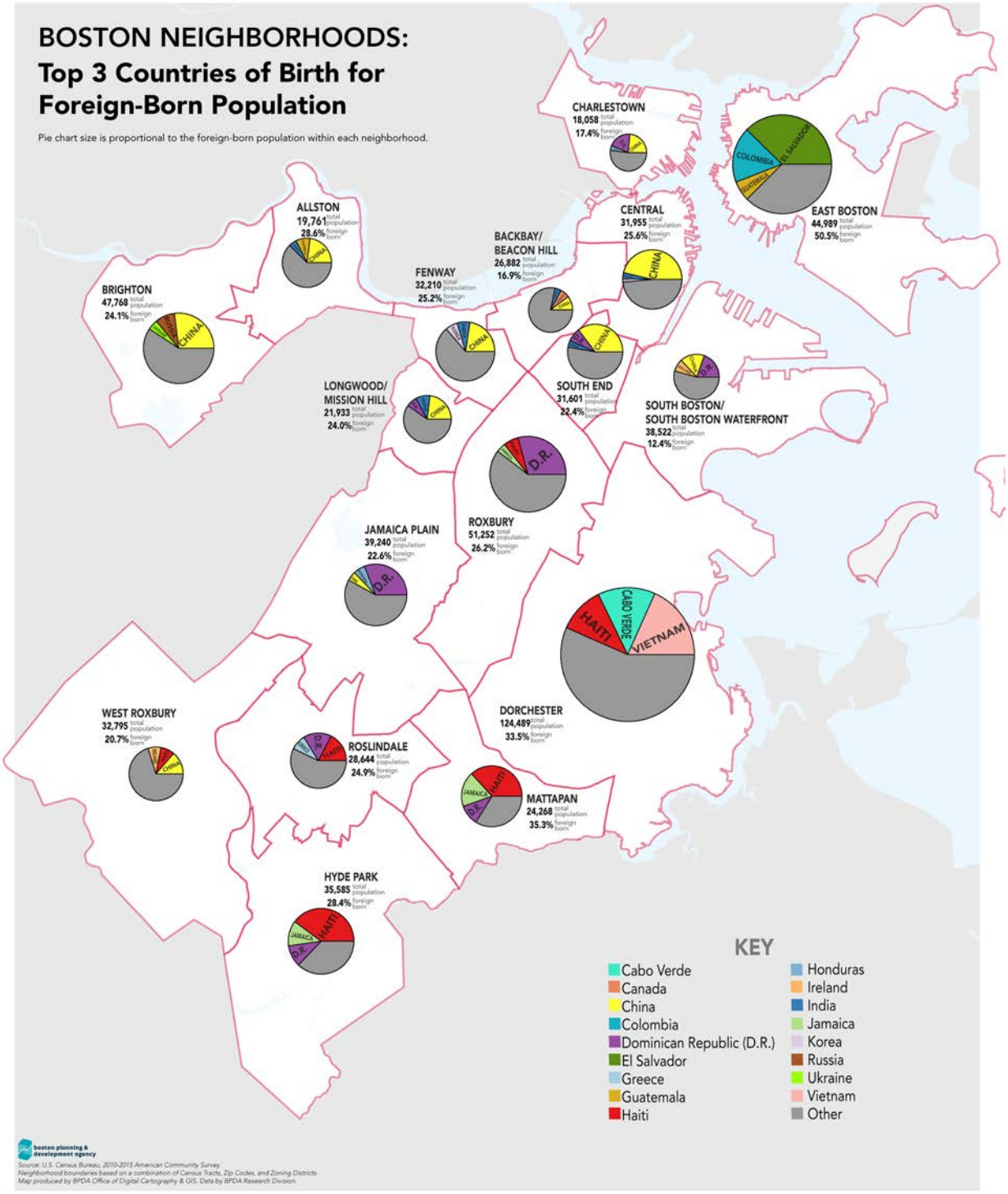
Boston & Your Neighborhood Segmented Bar Graph *(D.3)*

Use the data you generated on your Boston & Your Neighborhood Comparison Worksheet to create a segmented bar graph showing the foreign-born **percentage** for the Top 3 countries and all other foreign-born residents for the city of Boston and your neighborhood.

Boston

Your neighborhood: _____

What do you NOTICE?	What do you WONDER?
1.	**1.**
2.	**2.**
3.	**3.**

What's the story?

Boston Neighborhoods: Top 3 Countries of Birth for Foreign-Born Population *(D.4)*