

# INTERNATIONAL STUDENTS OF HIGHER EDUCATION IN THE UNITED STATES: A GIS STUDY OF THEIR ORIGIN AND LOCATION

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## ABSTRACT

*This study investigated the places of origin of international students and their distribution in the United States higher education. The data concerning the population of international students were obtained from the official website of International Institution of Education (IIE), and transferred into three maps using geographic information systems (GIS) software so that a more direct view of the data was available. The results of the study showed that 1) A larger proportion of international students come from Asian countries; 2) California, New York, and Texas are the top three states hosting international students; 3) most of the universities enrolling international students are located in the eastern part of the country; and 4) the states with already large international student populations experienced a faster growth in the population of international students over the past five years. Some implications for policy planning are discussed at the end of this paper.*

## INTRODUCTION

The internationalization of higher education is a common phenomenon nowadays around the world. Nearly all the capable universities and institutions are actively involved in the trend, promoting the communications among the countries and bringing significant revenues in support of the universities as well. Internationalization of higher education has positive impacts on a country's policy making (Lau & Lin, 2017; Viczko & Tascón, 2016; Wadhwa & Jha, 2014) and institutional reform (Wadhwa, 2016). Moreover, it is also a manifestation of a country's soft power capabilities (Popa, 2014).

Of all the aspects covered on the topic of higher education internationalization, the origin and distribution of international students in a country and the fluctuation of their number are worth exploring. For policy makers, the availability of the above information enables a better understanding of the current situation, based on which they can implement corresponding policies to meet the needs of business and industry in the near future.

As the most successful country with industrialized higher education, the United States is always the ideal destination for international students. In 2016, there were 1,043,839 international students studying in America, a 7.1% increase over the previous year (Institute of International Education, 2016). International students have become bridges of culture and knowledge between the United States and other countries. At the same time, they also bring in a significant amount of revenue every year through their tuition and local expenditures, helping to boost the development of U.S. economy.

This paper examines the origin and distribution of international students in THE United States, as well as the changes of student numbers in the past five years. With the support of the Geographic Information Systems (GIS), maps can be generated to visualize the information and distribution of international students studying in the United States so that we can have a clearer view of where they are.

## LITERATURE REVIEW

Most of the existing literature concerning international students focuses on their acculturation and adaptation to the new environment. When international students have opportunities for social interaction and self-expression, they are more likely to adjust to another culture with the support of place attachments (Terrazas-Carrillo, Hong, & Pace, 2014). Not only individual factors such as language fluency and coping ability affect the international students' lived experiences and perceived satisfaction level of their study in the United States, but environmental factors such as the culture and reception of the host society also shape the experiences of international students (Leong, 2015).

Some existing literature elucidates on the mobility of international students. Bessey (2012) found that when making decisions on which country to go to, international students always tend to choose the countries nearer to their original countries. Similarly, González, Mesanza, and Mariel (2011) juxtaposed several elements that have impacts on international students' choice of destination, such as country size, cost of living, distance, educational background, university quality, the host country language and climate. Since the mobility of international students can bring great benefits such as financial income and constantly emerging talents to a country or region, governments of many countries either introduce preferential policies to encourage international students to study in their countries (Kayani, Ahmed, & Shah, 2015), or leverage public and private interests in the mobility of international students (Oleksiyyenko, Cheng, & Yip, 2013).

Still other literature elaborates on international students' mobility choice after graduation. McGill (2013) discovered that scholarship aid, optional practical training, and temporary work visa applications were significantly correlated to a graduate's choice of residence on whether to stay in the U.S. or not after graduation. Further, Han, Stocking, Gebbie, and Appelbaum (2015) stated that the increasing global competitiveness in STEM (Science, Technology, Engineering, and Mathematics) education and the complex, restrictive nature of U.S. immigration policies are driving the international STEM students out of America.

## RATIONALE OF THE STUDY

Despite the abundant literature on international students' mobility, the distribution of international student in the United States is not explored. However, some agencies (e.g., International Education) are doing research in this field and publish reports as open data on the origin and distribution of international students in the United States every year. Their data are mostly displayed in tables. With these open data available, we can visualize the data and produce several maps that display the origin and distribution of international students in the United States, as well as the fluctuation of student numbers within the last five years. The Geographic Information System (GIS) is employed as the research tool in this study.

GIS refers to the use of information technology and data to input, structure, manipulate, integrate, analyze, and display information with a geospatial aspect (Sandra, 2001). According to Goodchild (2010), geographic information science is the science underlying geographic concepts, applications, and systems. It includes a group of technologies, processes, and methods. Nowadays, it is widely applied in various fields such as engineering, planning, management, transport, logistics, insurance, telecommunications, and business (Maliene, Grigonis, Palevičius, & Griffiths, 2011). With the support of GIS software, people can transform the traditional spatial data displayed in tables into maps with dots, lines, and different layers, making it more straightforward for readers to

understand the content. The application of GIS in education research is still relatively new compared to applications in other fields. Some professional training programs are found to effectively facilitate K-12 teachers to apply GIS technologies in their daily teaching (Hong, 2017; Moore, Haviland, Moore, & Tran, 2016). In addition, Web-based GIS supports students' special thinking in a world geography course (Jo, Hong, & Verma, 2016).

### **PURPOSE OF THE STUDY**

The current study utilizes GIS to produce maps about the origin and distribution of international students in the United States, and the fluctuation of the population of international students in the past five years. The current data relative to the above information are mainly displayed in tables or charts. In spite of the accuracy of the data, users of the data will have a clearer view when they can observe, for example, the distribution of international students in each state by a glimpse of the maps with dots representing student distribution. Therefore, it is worthwhile to apply GIS technology in this study, which will provide experiences for future researches in the same field.

### **RESEARCH QUESTIONS**

The following four questions guided the research: (1) what are the top twenty-five countries or regions sending international students to the United States higher education? (2) What is the distribution of international students in each U.S. state? (3) What are the international students' top five destinations of United States universities in each state? (4) What are the changes of the number of international students in the past five years across states?

### **METHODOLOGY**

#### **Input of the Study**

This study collected data from the official website of the Institute of International Education (<https://www.iie.org/>) that contain information answering the above four questions. Since all the data were publicly available, no IRB approval was needed.

#### **Output of the Study**

The output of the study included three maps addressing the last three research questions. The data concerning the first research question were presented in a table<sup>1</sup>. Map 1 described the distribution of international students in each state, with bar graphs comparing the population of international students. Map 2 showed the top five destinations of United States higher education institutions by state using dots to denote each of them. Map 3 displayed the changes in the number of international students in the past five years across states. Bar graphs were used to show the fluctuation of the population of international students.

#### **The Design of the GIS Model**

The design of the GIS model is illustrated by the following figure:

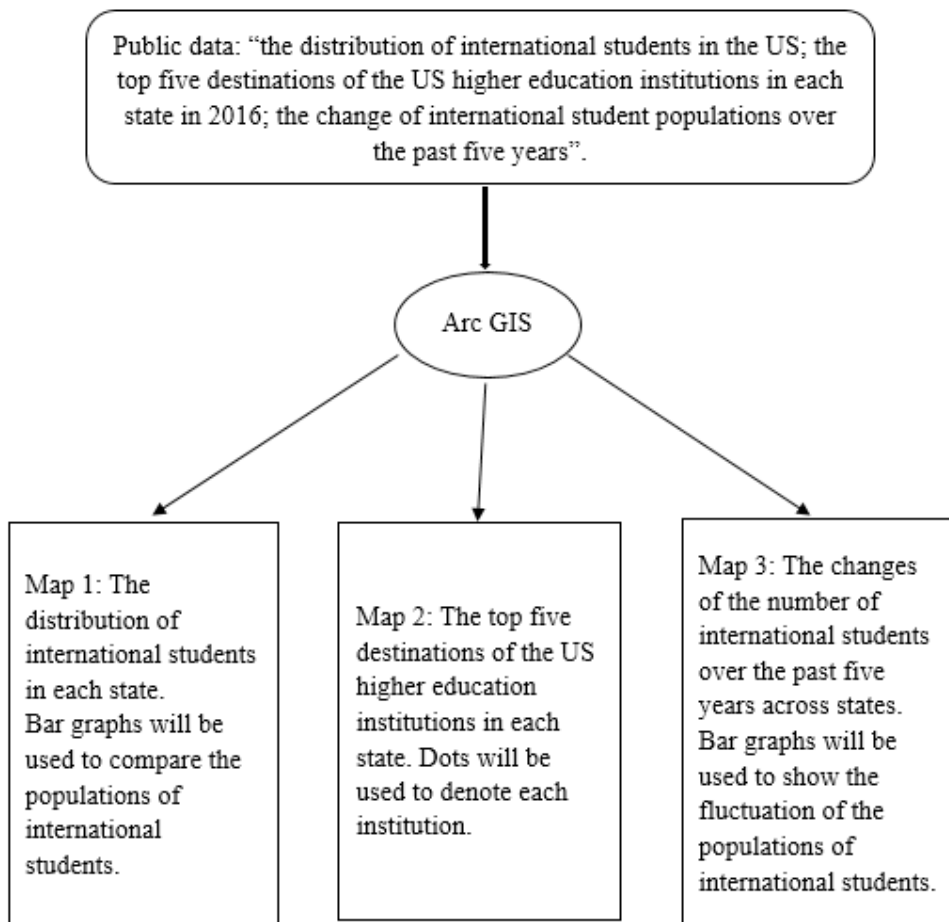


Figure 1. GIS Flowchart: Data Input into ArcGIS and Subsequent Maps

### Data collection and organization

The data used in this paper were shapefiles and international students' population. The world and U.S. state shapefiles were all downloaded from the public website <http://www.naturalearthdata.com/downloads/10m-cultural-vectors>. The data concerning international students' population were collected from the official website of the Institute of International Education (<https://www.iie.org/>), and they were reorganized into four excel files to be adaptable to each of the four maps in the following ways.

The international students' populations from the top twenty-five countries were collected. In the Excel file, the first column was country name and the second the population of international students in 2016. The international students' populations in each U.S. state were collected for the first map. The first column in the Excel file was the state name and the second the population of international students in 2016. The third Excel file was the geographical location of the universities that ranked the top five in accepting international students in each state. With the support of the

website <http://www.gps-coordinates.net/>, the exact longitude and latitude of each higher education institution were obtained. In the Excel file, the first column was the name of each institution, and the second and third column the longitude and latitude of the institution. The fourth Excel file included the name of each U.S state and the population of international students within the latest five years. The first column of the file was the name of each state and the rest are columns of the populations by each year respectively. All the data were organized in such ways that they could be compatible to the arc GIS software and joined to the attribute tables of each map directly.

## RESULTS

The output of the study was presented in four maps, each addressing one of the four re-search questions. To make an accurate description of the population of international students, tables and graphs were utilized to facilitate the demonstration of the figures.

### The distribution of the top twenty-five places of origin of international students

The top twenty-five places of origin of international students in 2016 were displayed in Table 1.

Table 1

*Top Twenty-five Places of Origin of International Students in 2016*

Rank	Place of Origin	Student Population	% of Total	Rank	Place of Origin	Student Population	% of Total
1	China	328,547	31.5	14	Nigeria	10,674	1.0
2	India	165,918	15.9	15	Germany	10,145	1.0
3	Saudi Arabia	61,287	5.9	16	Kuwait	9,772	0.9
4	South Korea	61,007	5.8	17	Nepal	9,662	0.9
5	Canada	26,973	2.6	18	France	8,764	0.8
6	Vietnam	21,403	2.1	19	Indonesia	8,727	0.8
7	Taiwan	21,127	2.0	20	Venezuela	8,267	0.8
8	Brazil	23,675	1.9	21	Hong Kong	7,923	0.8
9	Japan	19,370	1.8	22	Malaysia	7,834	0.8
10	Mexico	16,733	1.6	23	Colombia	7,815	0.7
11	Iran	12,269	1.2	24	Thailand	7,113	0.7
12	United Kingdom	11,599	1.1	25	Spain	6,640	0.6
13	Turkey	10,691	1.0				

Note: Adapted from Institute of International Education. (2016a)

It is clear from Table 1 that China and India together sent more students to U.S. universities than did the total of the other twenty-three countries. Although Saudi Arabia and South Korea ranked the third and fourth on the list, international students from each country counted for only about 6% of the total population. From the fifth country, Canada, to the last on the list, Spain, the number of international students decreased gradually from 26,973, to 6,640, and the percentage dropped from 2.6% to 0.6%.

Table 1 provided answers to the first research question: what are the top twenty-five countries sending international students to U.S. higher education? China and India, undoubtedly, sent more international students than did other countries. If we viewed this issue from a continental point of view, Asian countries or regions made huge contribution to the total population of international students in the U.S. higher education system. Of all the top twenty-five countries and regions, four-

teen were from Asia, five countries were from Europe, three countries were from South America and only two countries were from North America.

### The distribution of international students in each state of the United States

After finding out where international students are from, the next question was to identify where these students went. Figure 2 illustrates the data.

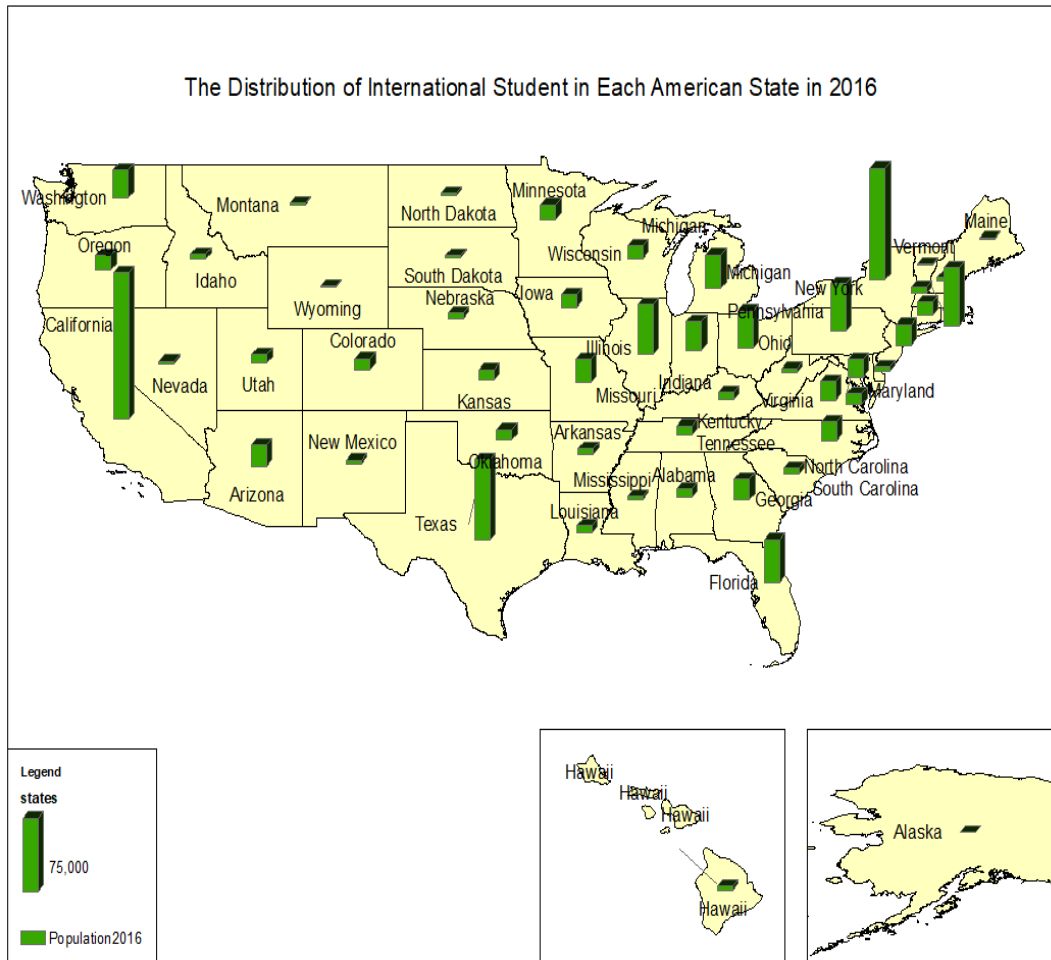


Figure 2. The Distribution of International Student in Each U.S. State

The above map demonstrated the distribution of international students in each U.S. state. Obviously, California, New York, and Texas were the top three states that accepted international students. Roughly, states that resided in the Northeast of the country host a majority of international students. Except for California and Texas, the population of international students in the Southern, Western, and Midwestern states was much smaller than that of the Northeastern states. The following Table 2 gave a detailed description of the population of international students in each state.

The distribution of international students in fifty states and Washington DC were included in this table. California, New York, and Texas had a much larger population of international students than did other states, with each hosting 149,328, 114,316, and 82,184 international students, respectively. The mean of the population is 20,452, and only the first fifteen states had larger population of international students than this number. The population of international student in twenty-two states was between 10,000 and 50,000; twenty-four states host less than 10,000 international students.

In addition to the original populations of international students in each state, it is worthwhile to investigate the proportion of international students' populations to the state populations. This enables us to have a better understanding of the distribution of international students. The current population in each state was obtained from the website: <http://www.ipl.org/div/stateknow/popchart.html#statesbypop> (IPL2, 2018, June 3). The proportion of international student population to state population ranges from 0.07% (Alaska) to 1.85% (Washington DC). The proportion in most states (37 states) ranges from 0.2% to 0.6%, and thus it seems that there is no obvious difference in the proportion of international student population to state population in each state.

Table 2  
*The Distribution of International Students in Each American State in 2016*

State	ISP*	ISP/SP*	State	ISP	ISP/SP
California	149,328	0.40%	Oklahoma	10,330	0.28%
New York	114,316	0.59%	Tennessee	9,094	0.14%
Texas	82,184	0.33%	Alabama	8,561	0.18%
Massachusetts	59,436	0.91%	Utah	8,302	0.30%
Illinois	50,327	0.39%	Kentucky	8,043	0.19%
Pennsylvania	48,453	0.38%	Louisiana	7,835	0.17%
Florida	43,462	0.23%	South Carolina	6,253	0.14%
Ohio	37,752	0.33%	Nebraska	5,910	0.32%
Michigan	33,848	0.34%	Arkansas	5,665	0.19%
Indiana	29,219	0.45%	Rhode Island	5,409	0.51%
Washington	28,624	0.43%	Delaware	5,052	0.56%
Missouri	24,171	0.40%	New Hampshire	4,506	0.34%
Arizona	22,212	0.35%	Idaho	4,501	0.34%
New Jersey	21,228	0.24%	Hawaii	4,295	0.32%
Georgia	21,122	0.22%	West Virginia	4,150	0.22%
Virginia	19,549	0.24%	New Mexico	3,767	0.18%
North Carolina	18,884	0.20%	Mississippi	3,533	0.12%
Maryland	18,304	0.32%	North Dakota	2,571	0.38%
Minnesota	14,941	0.28%	Nevada	2,518	0.09%
Oregon	14,382	0.38%	South Dakota	1,981	0.24%
Connecticut	13,564	0.38%	Montana	1,735	0.18%

Wisconsin	13,449	0.24%	Vermont	1,712	0.27%
Iowa	12,711	0.42%	Maine	1,396	0.11%
Colorado	11,346	0.23%	Wyoming	1,157	0.21%
Washington DC	11,120	1.85%	Alaska	488	0.07%
Kansas	10,351	0.36%			

Note: Adapted from Institute of International Education. (2016b)

ISP: International student population

SP: State population

ISP/SP: The proportion of international student population to state population

### Top five universities enrolling international students in each U.S. state

The next map, Figure 3, denotes the exact location of the top five universities that hosted most international students in each state. There should have been 255 universities on the map since fifty-one states and one district were involved (fifty states and Washington DC). However, Alaska had only four universities on the list and Delaware only two. Thus, the locations of 251 universities are mapped. The longitude and latitude of each institution were obtained from the website <http://www.gps-coordinates.net/>.

Each blue dot on the map denoted one institution. The density of dots on the eastern part of the continent was larger than that on the western part. If we treat North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas as the separation line between the east and the west, the comparison is more obvious. On the east coast, the dots cover the land from Maine all the way down to Florida. The density of dots was extremely large in the areas from Maine to Virginia. However, on the west coast, the dots mainly located on some large cities such as Seattle, Los Angeles, San Francisco, and San Diego.





Figure 3. The Geographic Location of the Top Five Universities Enrolling International Students in Each State of America

### The change of international student population within the past five years

The third map describes the changes of international student population in each state of the United States over the past five years. Five different colors represent the population from 2012 to 2016, respectively.

A general trend was that the states with already large international student populations had been continuously enrolling more international students. Take California, New York, and Texas for example. The ascending trend of the bars from left to right is obvious. Conversely, the growth of international student populations was not discernible in some states such as North Dakota, Hawaii, Maine, and Wyoming, where relatively small international student populations existed. The following Table 3 included data from the five states that had a rapid increase in international student population and the five states that had slow increase or even decrease in international student population, which made a clearer demonstration of the trends mentioned above.

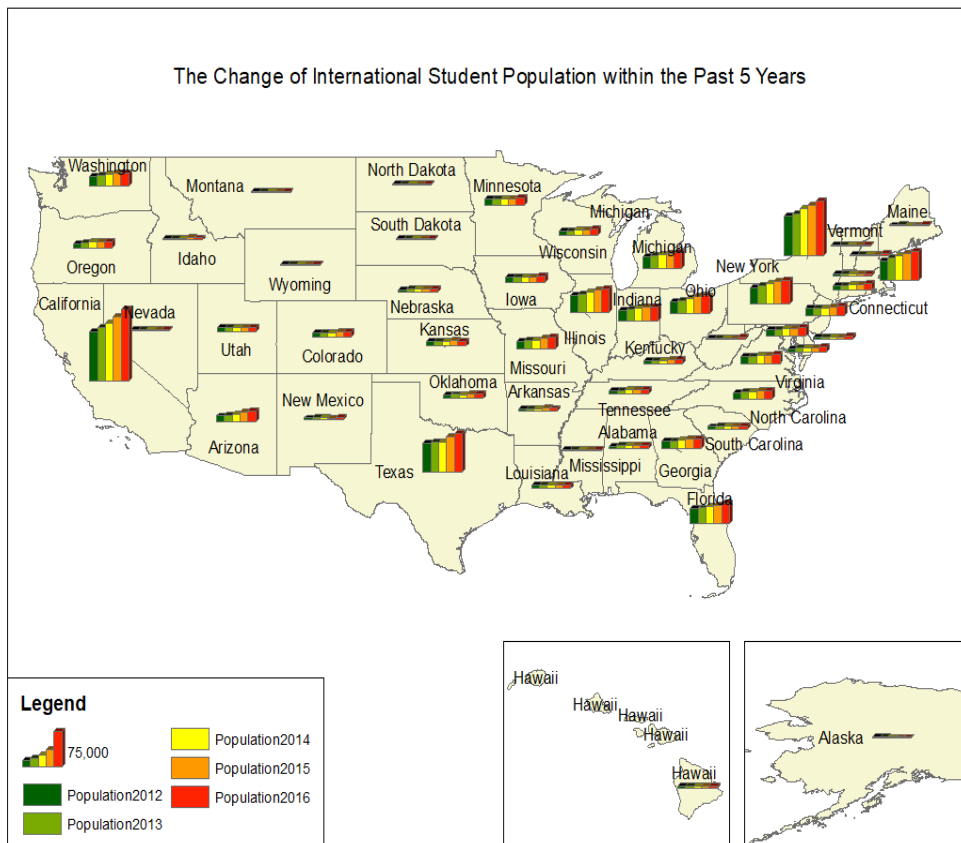


Figure 4. The Change of International Student Population within the Past Five Years

Table 3. *The Change of International Student Population in Ten American States within the Past Five Years*

States	2012 International Student Population	2013 International Student Population	2014 International Student Population	2015 International Student Population	2016 International Student Population
California	102,789	111,379	121,647	135,130	149,328
New York	82,436	88,250	98,906	106,758	114,316
Texas	61,511	62,923	64,277	75,588	82,184
Massachusetts	41,258	46,486	51,240	55,447	59,436
Illinois	35,920	39,132	42,527	46,574	50,327
Hawaii	4,446	4,450	4,388	4,035	4,295
North Dakota	3,182	3,087	2,773	2,677	2,571
Maine	1,250	1,415	1,198	1,354	1,396
Wyoming	1,072	1,097	1,124	1,174	1,157
Alaska	603	603	542	533	488

Note: Adapted from Institute of International Education. (2016b)

Figures 5 and 6 described the two different trends in international student population change. In Figure 5, all the five lines, which represented the five states, went upward from left to right. In Figure 6, the five lines either remained horizontal from left to right or went downward.

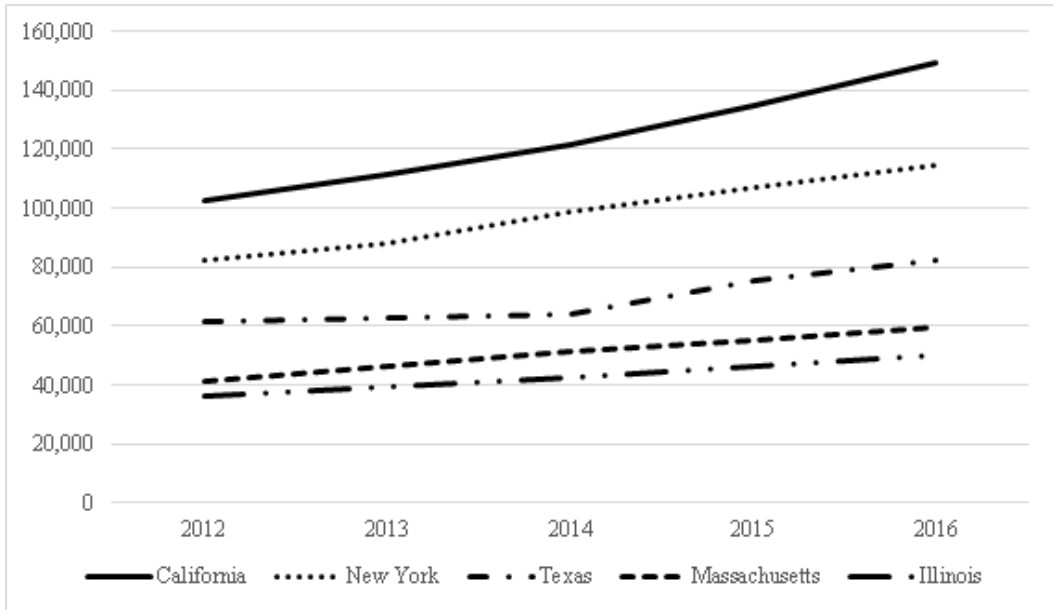


Figure 5. Five American States with Obvious International Student Population Growth

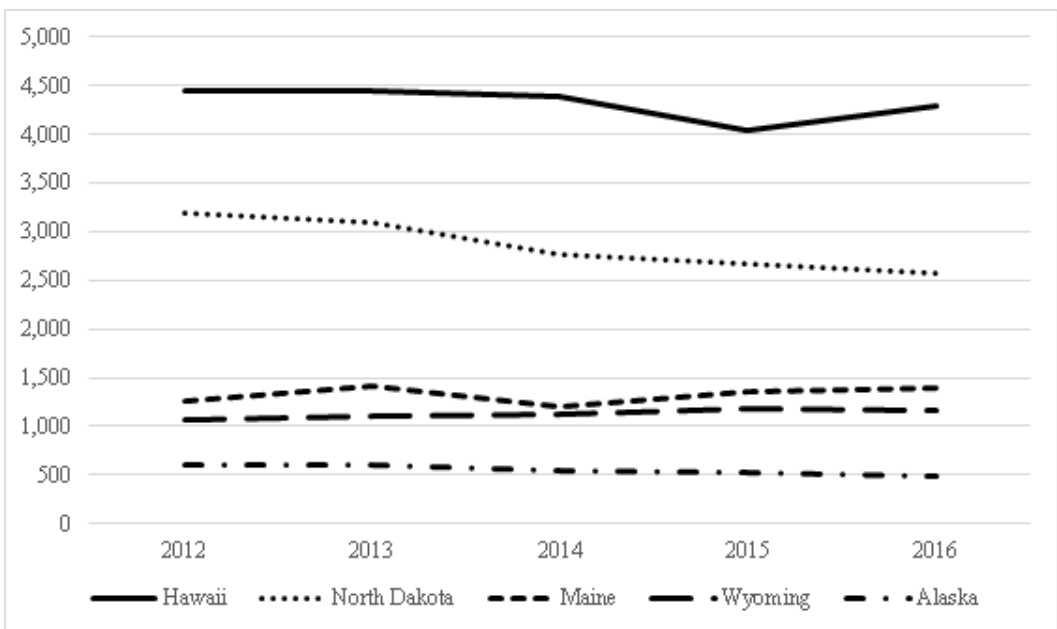


Figure 6. Five American States with Slow or Negative International Student Population Growth

## DISCUSSION

The results of the study are clearly demonstrated by the maps and tables. Table 1 showed that international students mainly came from Asian countries. Map 1 and 2 (Figure 2 and 3) showed that eastern states roughly hosted more international students than did western states. Map 3 (Figure 4) demonstrated that the states with already large international student populations experienced fast growth of the population of international students within the past five years. The reasons and impacts of the above phenomena were addressed as follows.

As to the first phenomenon, when compared to European countries that had sophisticated higher education systems, most Asian countries were still developing nations that were left behind in the construction of their higher education systems. Thanks to the advancement of technology and the development of globalization, Asian countries had witnessed fast economic growth in the past fifteen to twenty years. Therefore, students in these countries had the necessary requirements as well as the incentives to pursue better higher education in the United States, either through government or private funding. Moreover, given the large population base of Asia, it is not surprising that Asian countries sent the most international students to the United States. China and India, which ranked first and second, respectively, on the world population list, also took the first and second positions on the international student population list.

The second and third phenomena could be attributed to the following two reasons: 1) climate and geographic location, and 2) the population of immigrants. The top three states that hosted most international students were California, New York, and Texas. These three states were all located in coastal areas with comfortable climates. In addition, there were large cities in these states such as Los Angeles and San Francisco in California, New York City in New York state, and Huston in Texas, which provided not only more career opportunities but entertainments as well. Therefore, it was normal that these places were more attractive than other states for international students. Conversely, some states were either located in remote areas (e.g., Alaska) or less populated inner land (e.g., North Dakota); therefore, less international students went to these states. The other reason that accounted for the unbalanced international student population among different states was the population of immigrants. It was not uncommon for international students to cluster in the places where there were many immigrants from their own countries when choosing destinations to pursue higher education. This facilitated international students in the process of adapting to the new environment and provided them with a cultural atmosphere that was similar to that of their own countries. A significant correlation was found to exist between the population of immigrants and international students in each state.

The data of the population of immigrants in each state for 2015 was found on the website <http://www.migrationpolicy.org/>. Since the data did not meet the assumption of normality, the Spearman coefficient rather than the Pearson coefficient was calculated for the population of immigrants and international students in each state for 2015. The results showed that the population of immigrants and international students were highly correlated ( $r = .876$ ,  $r^2 = .767$ ,  $p < .01$ ).

Table 4.

*Spearman Correlation between the Population of Immigrants and International Students in Each American State for 2015*

		International Student Population for 2015	Immigrant Population for 2015
International Student Population for 2015	Spearman Correlation	1	.876**
	Sig. (2-tailed)		.000
	N	51	51
Immigrant Population for 2015	Spearman Correlation	.876**	1
	Sig. (2-tailed)	.000	
	N	51	51

Note: \*\* Correlation is significant at the 0.01 level (2-tailed).

### IMPLICATIONS FOR EDUCATIONAL PLANNING

Based upon the results of the existing study, two implications for educational planning are proposed. First, since the coming of international students boosts local economy, it is necessary for universities or institutions in those states with small international student populations to promote the level of higher education internationalization through different methods. For example, establishing relationship with foreign institutions or setting up overseas branches is conducive to increasing exposure, which will finally lead to the increase of international student populations.

Second, considering the large group of international students coming from Asian countries, a common problem for the U.S. higher education institutions was to recognize and foster cultural diversity in higher education (Gurin, Dey, Hurtado, & Gurin, 2002; Otten, 2003; Guo & Jamal, 2007). Since the Asian culture was considerably different from the culture in the United States, Asian students might confront various challenges and experience anxieties when studying in the U.S. higher education institutions. Thus, measures and policies need to be introduced to address this issue so that Asian students could adapt quickly to the new environment and release fully their potential academic abilities.

### CONCLUSION

The current study examined the origin and distribution of international students in U.S. higher education. With the publicly available data from IIE, three maps were created using Arc GIS.

For the first research question, the findings of this research identified the location of the twenty-five countries or regions and provided the percentages of international students from those countries. China, India, and Saudi Arabia ranked the top three countries on the list.

For the second research question, California, New York, and Texas were the top three states hosting international students. A majority of international students were in the northeastern part of the United States. While in the vast western United States, the population of international students was relatively small, with California and Texas being the two exceptions.

For the third research question, states in the Eastern region had obviously more higher education institutions hosting international students than did the Western states.

For the last research question, though the population of international students grew steadily in the past five years, those states with already large international student populations experienced fast growth, while the states with small international student populations had slow or even negative growth.

The first limitation of the current study was that more data concerning International students' academic levels and majors should be collected so that a more detailed description of the situation can be obtained. Moreover, the study would be more valuable if the predictions about the future distribution of international students in the United States can be made based upon the past and existing data. These two limitations can be the direction of future research. Despite the limitations, this study still provides some policy implications. On the one hand, given the large number of international students from Asia, higher education institutions should be aware of the issue that this group of students experience cultural differences in United States higher education. On the other hand, both the U.S. institutions and governments should promote the enrollment of international students to facilitate the growth of their respective states, especially those institutions and states in the western regions.

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#### NOTE

Originally there was a map addressing the first research question. Various colors were used to denote different countries. Since the journal is printed in black and white, this map was not printed. Readers interested in the maps in color are welcome to contact the authors.