Statistical Analysis of STEM fields' progression in American Graduation Initiative-2020 plan

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Abstract

President Barack Obama set a goal for our nation to have the highest proportion of college graduates in the world by the year 2020. To meet that goal America needs over 10 million a post-secondary degree or credential within a decade that will be imperative for the growing jobs of the new econothe. We analyzed US Department of Education data by using statistical analysis and to conduct a current feasibility analysis of this plan.

Introduction

The United States has been the world's leading economic power since conquering the United Kingdom in 1872. The reason America has reined as the leading economic country for so long, is mostly in result of technological innovation and its exceptional quality of education [4]. Likewise, according to the world's leading statistical agencies, the United States is on the verge of losing its status as the world's largest econothe, most likely to China. Economist previously predicted China to pull ahead by 2019, but this analysis only depends on the accuracy of Chinese economic statistics [4]. To detour this troubling statistic from happening, President Barack Obama has set forth a plan to ensure the United States has the best educated and most competitive work force in the world [4].

On February 24, 2009, President Barack Obama set a goal for our nation to have the highest proportion of college graduates in the world by the year 2020. To reach this goal, the U.S. Department of Education projected that the proportion of college students in the U.S. must increase by 50 percent nationwide, by the end of the decade. Therefore, 3.7 million more Americans must earn a degree and 6.3 million must earn a certificate within the next decade. Initially, America needs over 10 million high school students and adult learners to seek and complete some sort of higher education. There is a high demand for such a huge increase in numbers because earning a post-secondary degree or credential within the next decade will now be imperative for the growing jobs of the new econothe [3]. These jobs will mainly be in the fields of STEM [5]. STEM is an acronym referring to the academic disciplines of science, technology, engineering, and mathematics. These fields hold the key to scientific advancement and innovation which is the United States strongest traits for maintaining national security and economic competitiveness.

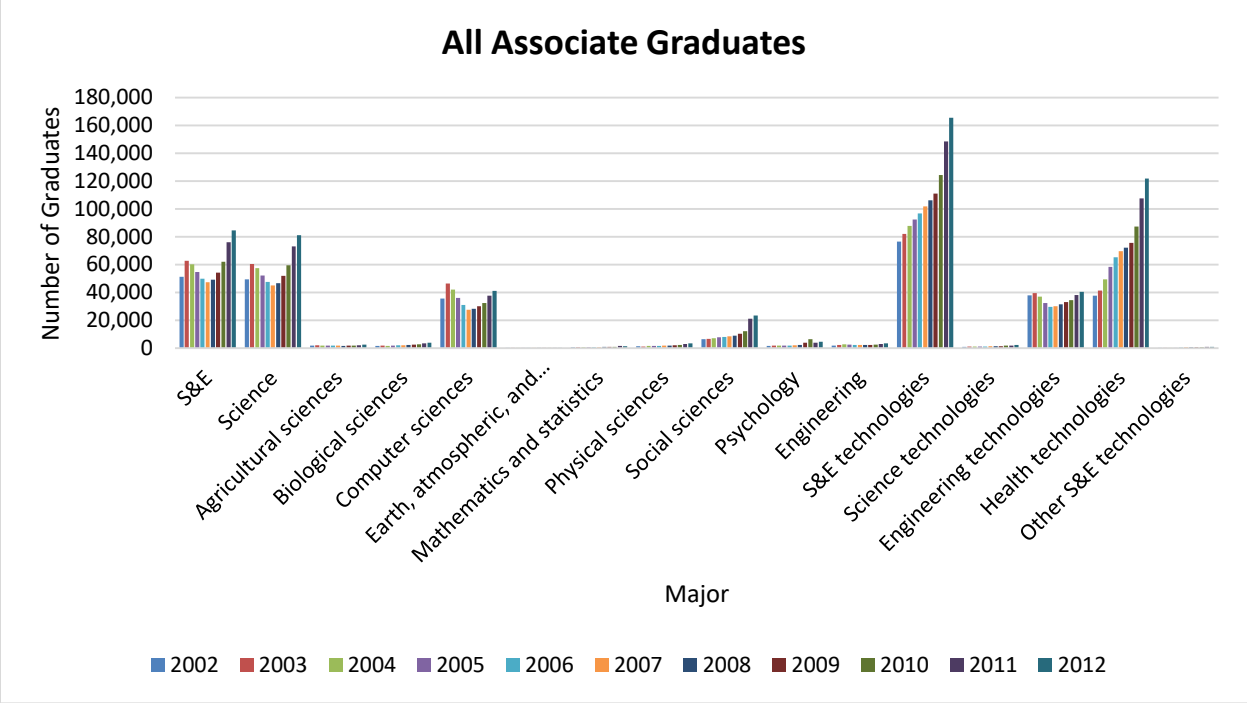
One of the most troubling obstacles that our nation acquire today is improving recruitment and retention in STEM fields. Therefore, in this study it analyzes enrollment and graduation rates from the year 2002 to 2012 by STEM disciplines in respect to gender and race. In further detail, the analysis compares students obtaining Associate and Bachelor degrees. By obtaining this information, a comparison of the president's goal was made in reference to the data found in post- secondary achievement. We forecasted the number of all graduates up to the year 2020 and calculated the deficit of the 2020 target from the predicted number of graduates. Regression analysis is used to analyze the data.

Methodology

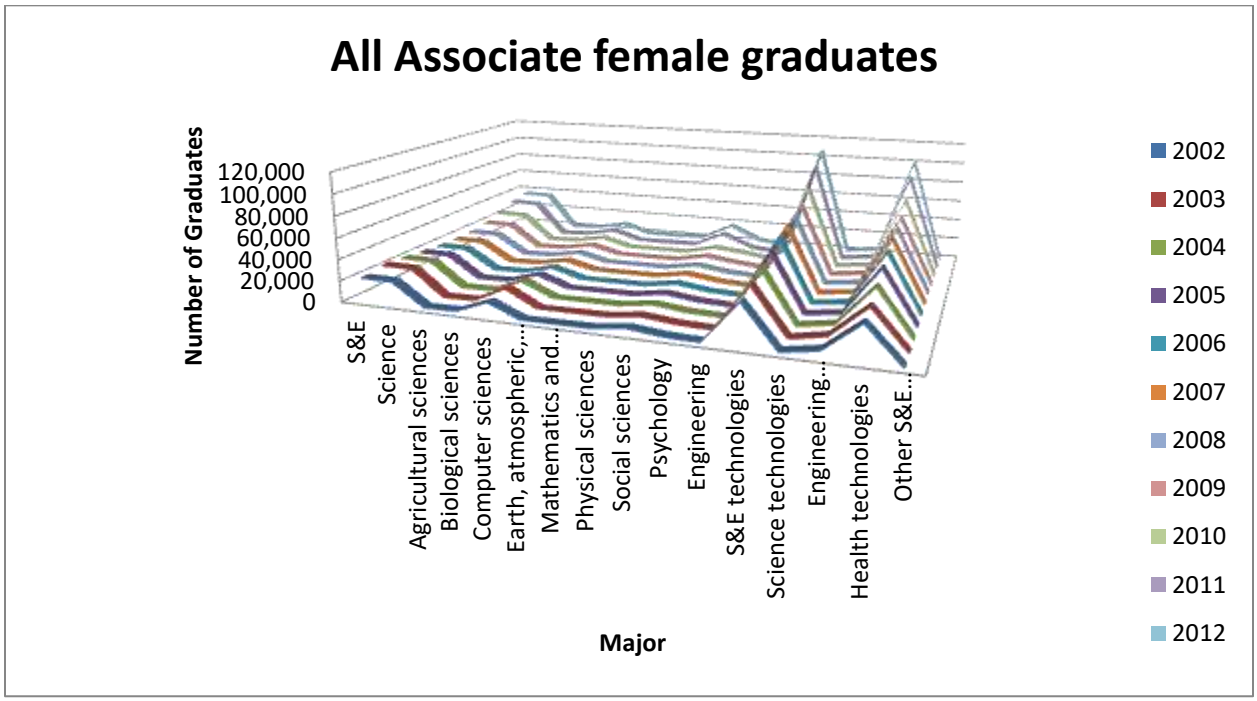
The objective of this project is to forecast the number of graduates in the year 2020, and compare it to President Barack Obama's 2020 goal for the United States. The difference of the targeted number of graduates and the forecasted number of graduates must be calculated to determine whether America will fall short, meet, or exceed the stipulations of American graduation initiative 2020 plan. To do so, first a linear regression analysis is used to fit a predictive model from 2002 to 2012 graduation data provided by department of education.

Results and Discussion

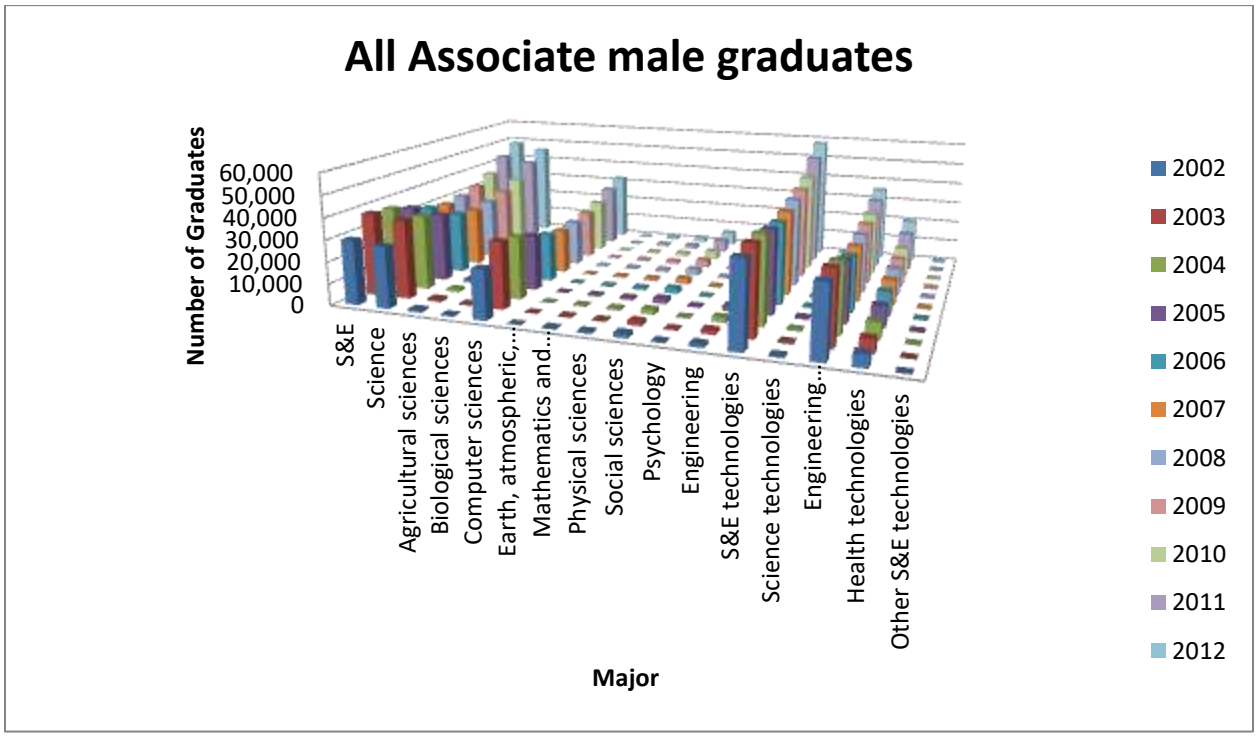
The data used within the study was found by Dr. Salam Khan, extracted from the United States Department of Education. It was sixteen spreadsheets of data representing students within the United States who were enrolled and also graduates of STEM fields from the year 2002 to 2012. Within the data, the graduates were also separated by gender and race. The various ethnicities that were used throughout the study were African American, American Indian or Alaska Native, Asian or Pacific Islander, Caucasian, and Hispanic. After collecting the data, it was used to construct various types of graphs. The data was then evaluated within the graphs and given descriptive statistics about each.



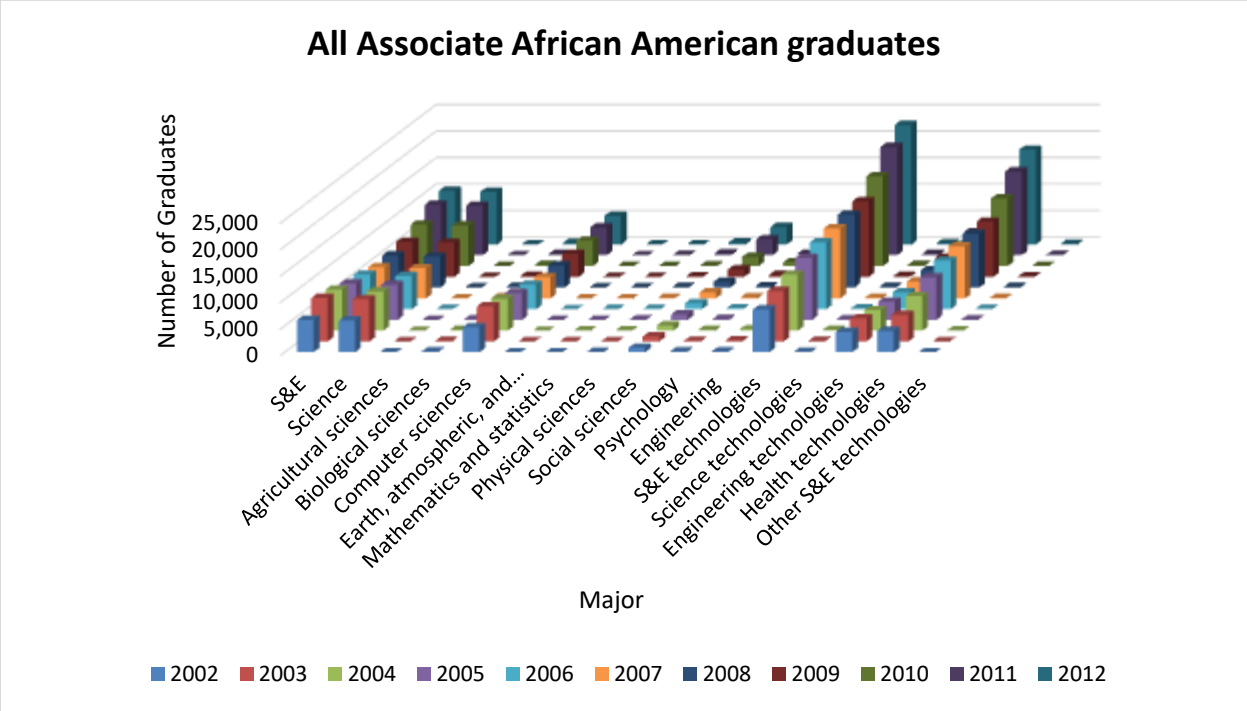
This graph displays all students of both sexes enrolled in college who received an Associate degree between the years of 2002 and 2012. In further detail, there are more graduates in science and engineering technologies than science and engineering fields. S&E technologies have a peak of 165,631 graduates while S&E only reach a peak of 84,641. Moreover, concentrations within health technologies are the only fields that continuously increase from 2002 to 2012; with a peak of 121,797 graduates. In contrast, the fields with the lowest number of graduates are Earth, atmospheric, and ocean sciences with a peak of only 103 graduates. Most of the other fields increase until 2004, then the number of students begin to take a fall. It isn't until about 2008 before the number of students began to rise again. Lastly, after the year 2010 the number of graduates begins to increase more than ever with a 22,430 graduate increase difference through 2012. Extracted from the graph above, the regression model is calculated as: $\hat{y} = -4034547 + 2039.8x$. This model's usage is to predict the number of graduates for the year 2020, which reflects 85,849.49 Associate graduates. The regression model is significant with p-value < 0.05.



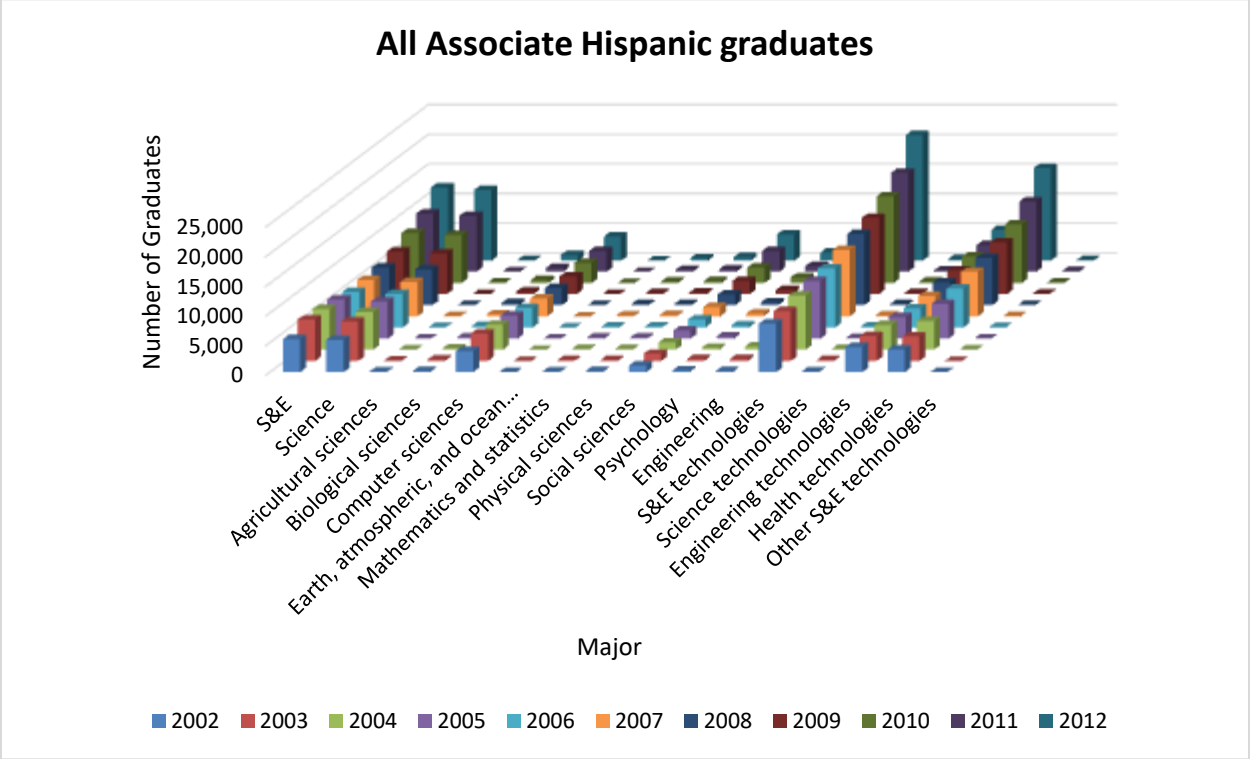
This graph displays all female students enrolled in college who received an Associate degree between the years of 2002 and 2012. Concentrations within health technologies are the fields with the highest number of female graduates with a peak of 101,423. There are also about three times more female graduates enrolled in S&E technologies than S&E fields. S&E has a peak of 107,403 while S&E only has 35,865 graduates. In continuation, the fields with the least number of female graduates are Earth, atmospheric, and ocean sciences with a peak of only 34 graduates. This graph also shows more increase than decrease throughout the years for women being enrolled in college. Likewise, there are no other fields that have had over 6,000 females graduates other than Computer Sciences and Health Technologies. Extracted from the graph above, the regression model is calculated as: $\hat{y} = -2017379 + 1017.073x$. This model's usage is to predict the number of graduates for the year 2020, which reflects 37,107.76 Associate female Graduates. The regression model is significant with p-value < 0.05.



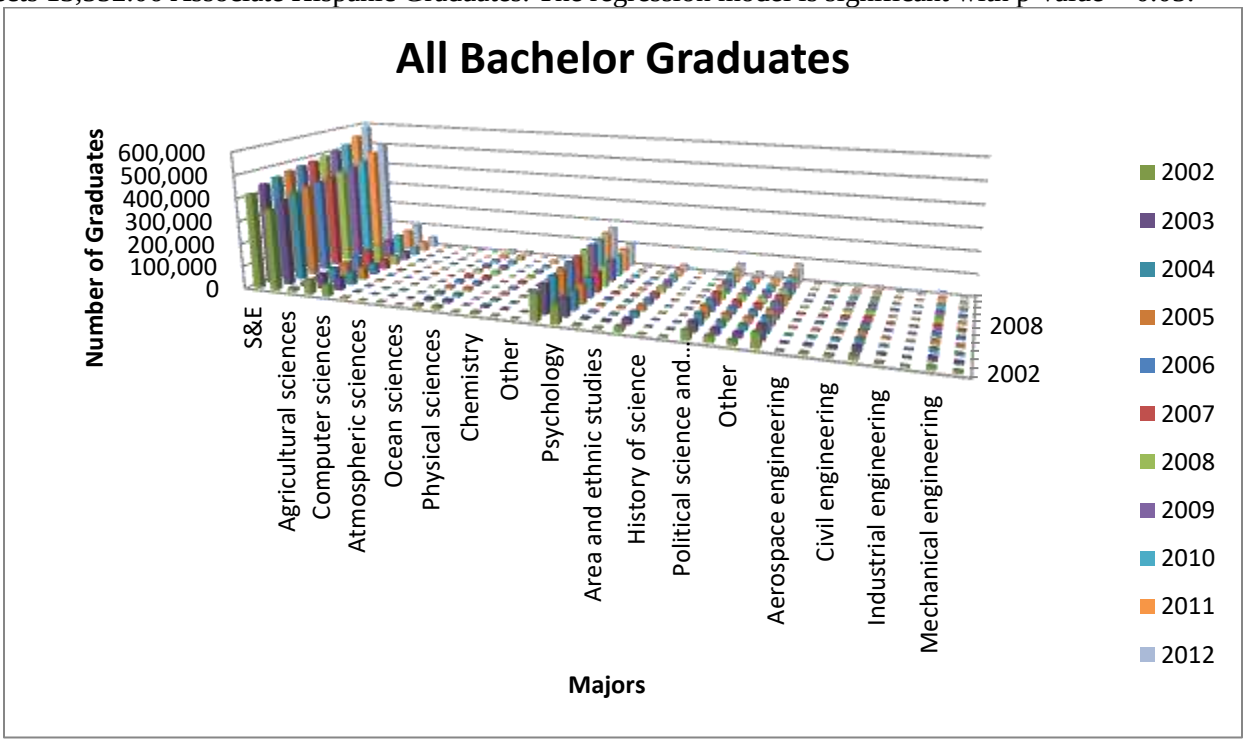
This graph displays all male students enrolled in college who received an Associate degree between the years of 2002 and 2012. There is a high enrollment for males in STEM fields from 2002 to 2012 compared to females. Although male graduates didn't reach a peak of 107,403 students in one year, like the females, males still have more graduates overall within STEM fields. Engineering technologies and Computer Science are the two fields with the most males enrolled. The number of males in Engineering Technologies increased from 2002 until 2004. After, the number of male graduates only decreased slightly for 2005 and 2006. It then went on to increase through 2012 with a peak of 3,049. In Computer science, there is an increase from 2002 to 2003; then number of male graduates begins to decrease. The decrease only lasted for 2004 through 2007. After taking a turn, the number of graduates went on to increase with a peak of 32,288 graduates. Overall, S&E technologies also outnumber S&E fields, unlike females. Earth, atmospheric, and ocean sciences are also the fields with the least male graduates with a peak of only 69 students. Moreover, in every field there isn't a consistent increase from 2002 to 2012 of male enrollment. Likewise, overall the male gender continues to be the majority in STEM fields compared to women. Extracted from the graph above, the regression model is calculated as: $\hat{y} = -2017167 + 1022.727x$. This model's usage is to predict the number of graduates for the year 2020, which reflects 48,741.73 Associate male Graduates. The regression model is significant with p-value < 0.05.



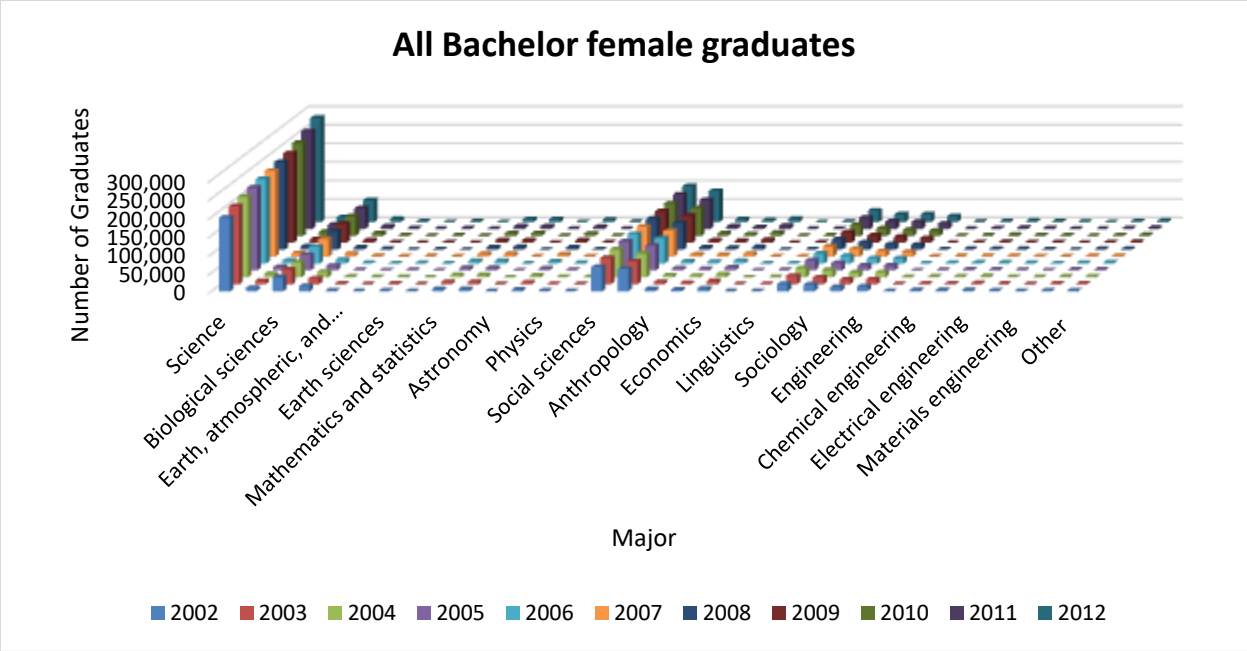
This graph displays all African Americans students enrolled in college who received an Associate degree between the years of 2002 and 2012. It further shows a gradual increase in the number of graduates in S&E technologies from 2002 to 2009. In 2010, there is a vast increase in enrollment of those fields. Within those fields, are also concentrations within Health Technologies, which are the fields with the highest number of African American graduates. These fields are the only fields that consistently increase from 2002 through 2012 and have a peak of 17,889. Likewise, in Computer Science the graduation rate increases until 2004 with a peak of 6,636 graduates in 2003, and then decrease into a plateau of around 4,000 graduates. The number of graduates begins to increase again in 2011 but only slightly into the 5,000 range. The fields with the lowest number of African American graduates are Earth, atmospheric, and ocean sciences; with a shocking peak of 4 students in 2006 and in 2004, 2007, 2009, and 2012 having no African American graduates at all. All of the other fields have very little African Americans graduates except for Engineering Technologies. Likewise, Engineering Technologies only reached a peak of 4,364 graduates in 2003 which still isn't considered very high. Lastly, in the overall view of science and engineering fields, African American graduates increased from 2002 to 2003, then decreased from 2004 to 2009, and increased from 2010 to 2012 with a peak of 10,152 graduates. Extracted from the graph above, the regression model is calculated as: $\hat{y} = -444641 + 225.2364x$. This model's usage is to predict the number of graduates for the year 2020, which reflects 10,336.71 Associate African American Graduates. The regression model is significant with p-value < 0.05.



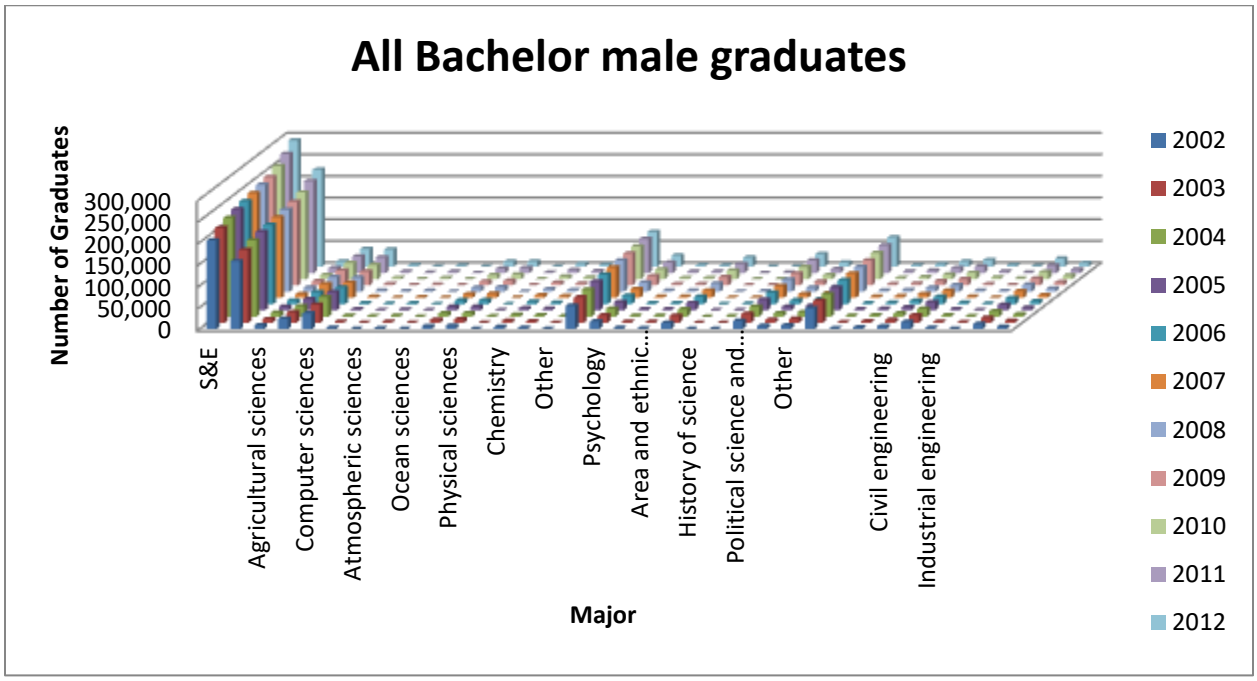
This graph displays all Hispanic students enrolled in college who received an Associate degree between the years of 2002 and 2012. Concentrations within health technologies are the fields with the highest number of Hispanic students enrolled overall. Moreover, S&E technology fields continuously grow in the number of Hispanic students enrolled from 2002 to 2012 consistently. Also, Computer sciences are the fields the most Hispanic students enrolled within science fields. Furthermore, between the years 2002 and 2004 all STEM fields decreased in Hispanic students. Lastly, from 2005 to 2012 the enrollment of Hispanic students began to increase with big leaps of increase in 2010 on up. Extracted from the graph above, the regression model is calculated as: $\hat{y} = -928484 + 466.3545x$. This model's usage is to predict the number of graduates for the year 2020, which reflects 13,552.06 Associate Hispanic Graduates. The regression model is significant with p-value < 0.05.



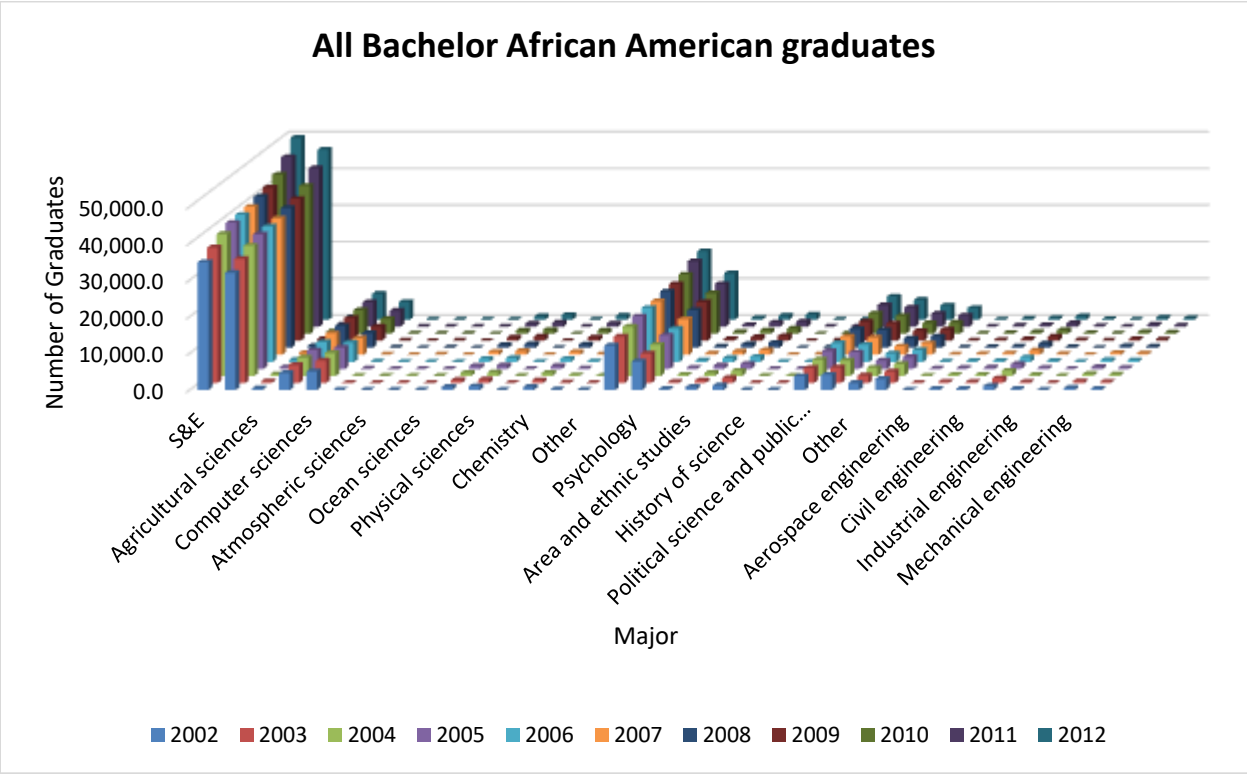
This graph displays all students of both sexes enrolled in college who received a Bachelor degree between the years of 2002 and 2012. Overall, the number of students in STEM fields increases consistently from 2002 to 2012. Science fields obtain the most graduates compared to Engineering, on a Bachelor level. Although Science fields greatly outnumber Engineering fields, Engineering manages to consistently increase the number of graduates from 2002 to 2012. Within those fields, Electrical engineering had the highest number of students enrolled until 2008 with a peak of 21,459 graduates in 2005. In 2008, Mechanical engineering began to have highest number of students and continued to increase through 2012; with a peak of 20,889 graduates in 2012. Materials engineering have the lowest number of overall students enrolled with a peak of 1,322. Likewise, Psychology has the most graduates overall with a peak of 109,716 graduates within Social Science fields in 2012. Extracted from the graph above, the regression model is calculated as: $\hat{y} = -28719349 + 14555.227x$. This model's usage is to predict the number of graduates for the year 2020, which reflects 682,210 Bachelor Graduates. The regression model is significant with p-value < 0.05.



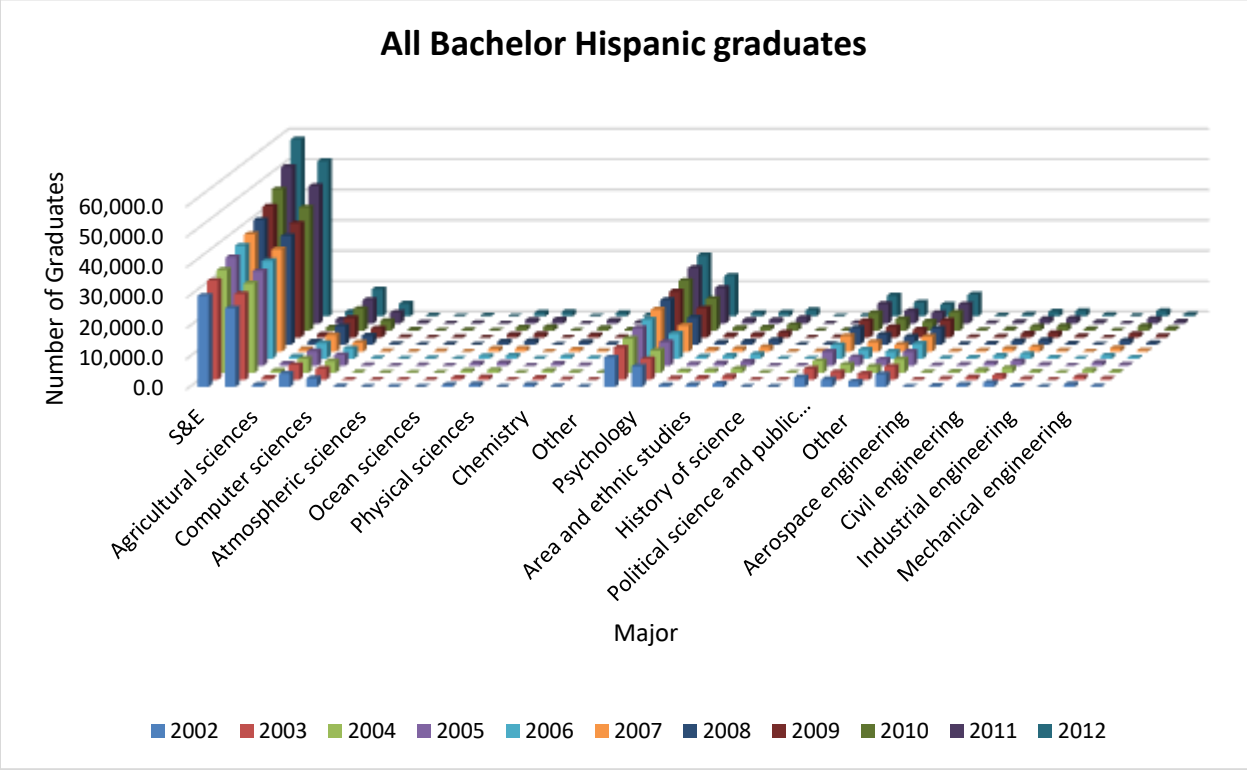
This graph displays all female students enrolled in college who received a Bachelor degree between the years of 2002 and 2012. In further detail, the female graduation rate consistently increases throughout the years. Female graduates are the minority within engineering fields. In every field of engineering there are no more than 4,000 female graduates each year between 2002 and 2012. However, Psychology is the field with the most female graduates throughout social science fields, with a peak of 84,126 graduates. Overall, the female graduation rate in engineering fields increases from the year of 2002 until 2006. Between 2007 and 2009 the rate of female students graduating fluctuates. Lastly, from 2010 until 2012 female graduation dramatically increases. Extracted from the graph above, the regression model is calculated as: $\hat{y} = -14379208 + 7288.2455x$. This model's usage is to predict the number of graduates for the year 2020, which reflects 343,048.1 Bachelor female Graduates. The regression model is significant with p-value < 0.05.



This graph displays all male students enrolled in college who received a Bachelor degree between the years of 2002 and 2012. There is a consistent increase, overall, of the male graduation rate on a Bachelor level. The number of male graduates in science fields greatly outnumbers the male graduates in engineering fields. No field within engineering reaches a peak of at least 20,000 male graduates throughout the years of 2002 to 2012. Furthermore, Electrical engineering is the field with the most male graduates within engineering fields; with a peak of 18,614 graduates in 2005. Electrical engineering had the most male students enrolled from 2002 until 2006. Likewise, Mechanical engineering had the most male students enrolled from 2007 through 2012. Overall, Computer science is the field with the most male graduates with a peak of 44,902 graduates in 2004. Although computer science has the highest number of male graduates, it also was the field with the greatest fluctuating behavior. It decreases after 2004 and doesn't start to increase again until 2010. Lastly, there were no male graduates within the majors of Linguistics and History of science through 2002 to 2012. Extracted from the graph above, the regression model is calculated as:$\hat{y} = -14340141 + 7266.9818x$. This model's usage is to predict the number of graduates for the year 2020, which reflects 339,161.9 Bachelor male Graduates. The regression model is significant with p-value < 0.05.



This graph displays all African American students enrolled in college who received a Bachelor degree between the years of 2002 and 2012. The African American graduation rate in STEM fields has a gradual increase but it is also consistent throughout the years. Engineering fields have the lowest number of African American graduates with a shocking peak of only 3,227 graduates in 2004. Although the African American graduation rate increases consistently throughout all STEM fields, in engineering a decrease occurred between the years of 2006 and 2010. On the other hand, science fields have a great deal of African American graduates compared to engineering fields. Social Science fields have the highest number of African American graduates. Also within the Social Sciences, Psychology is the major with the highest number of African American graduates, with a peak of 12,709 graduates in 2012.According to the data, African Americans have the least number of graduates within any field compared to any other race in respect to population. Extracted from the graph above, the regression model is calculated as: $\hat{y} = -2341995 + 1187.455x$. This model's usage is to predict the number of graduates for the year 2020, which reflects 6,663.18 Bachelor African American Graduates. The regression model is significant with p-value < 0.05.



This graph displays all Hispanic students enrolled in college who received a Bachelor degree between the years of 2002 and 2012. There is a consistent increase in enrollment of Hispanic students throughout the years. Much like African Americans, Hispanics have very little graduates in engineering fields. Civil, Electrical, and Mechanical engineering are the concentrations with the majority of Hispanic graduates within engineering fields. Likewise, these concentrations never reach at least 2,000 Hispanic graduates. Between the years of 2002 to 2007, Electrical engineering was the only concentration to obtained at least 1,000 Hispanic graduates. In comparison, Science fields have a significantly large amount of Hispanic graduates with a peak of 50,973 graduates in 2012. Psychology also has the highest number of Hispanic graduates, in regard to African American graduates. Its peak reaches up to 13,353 graduates. Lastly, all of the other fields, except Biological science, have very little graduates throughout the years. Extracted from the graph above, the regression model is calculated as: $\hat{y} = -4270638 + 2147.8x$. This model's usage is to predict the number of graduates for the year 2020, which reflects 72,970.48 Bachelor Hispanic Graduates. The regression model is significant with p-value < 0.05.

Forecast	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
All Associate Graduates	67491.29	69531.09	71570.89	73610.69	75650.49	77690.29	79730.09	81769.89	83809.69	85849.49	766703.9
All Associate female Graduates	27954.11	28971.18	29988.25	31005.33	32022.4	33039.47	34056.55	35073.62	36090.69	37107.76	325309.4
All Associate male Graduates	39537.18	40559.91	41582.64	42605.36	43628.09	44650.82	45673.55	46696.27	47719	48741.73	441394.6
All Associate African American Graduates	8309.582	8534.818	8760.055	8985.291	9210.527	9435.764	9661	9886.236	10111.47	10336.71	93231.45
All Associate Hispanic Graduates	9354.873	9821.227	10287.58	10753.94	11220.29	11686.65	12153	12619.35	13085.71	13552.06	114534.7
All Bachelor Graudates	551212.9	565768.1	580323.4	594878.6	609433.8	623989	638544.3	653099.5	667654.7	682210	6167114
All Bachleor female Graduates	277453.9	284742.1	292030.4	299318.6	306606.9	313895.1	321183.4	328471.6	335759.9	343048.1	3102510
All Bachelor male Graduates	273759	281026	288293	295560	302826.9	310093.9	317360.9	324627.9	331894.9	339161.9	3064604
All Bachelor African American Graduates	45976.09	47163.55	48351	49538.45	50725.91	51913.36	53100.82	54288.27	55475.73	56663.18	513196.4
All Bachelor Hispanic Graduates	50608.67	53093.32	55577.96	58062.61	60547.25	63031.9	65516.55	68001.19	70485.84	72970.48	617895.8

Conclusion

After much research and analysis, there were new and various statistical predictions and theories concluded. According to the calculations, the stereotype of women being the minority in STEM fields is changing with time. Females now outnumber males in STEM fields on a Bachelor level, and will continue to do so with a predicted peak of 343,048 graduates in 2020. In contrast, male graduates only lag behind with a predicted peak of 339,162 graduates in 2020. On the contrary, females still lag behind males on an Associate level with a predicted peak of 37,108 graduates compared to the male peak of 48,742 graduates. Overall, females are predicted to still lag 7,748 graduates behind males, on both an Associate and Bachelor level. Over the decade of 2011 to 2020, the gap between males and females decreased by 140 graduates. Although it appear to be a slight improvement, with time the gap will soon be non-existent.

In regard to race, African Americans are considered to have least number of graduates in STEM fields in relation to population quantity. Although African American's graduation rate is consistently increasing for the decade of 2011 to 2020, the deficit gap of African American graduates in STEM fields still remains at large. The forecast predicts there will be 766,704 Associate graduates in the year 2020. Of those graduates, only 93,231 of them are predicted to be African American, which makes up only 12% of those graduates. On a Bachelor level, the forecasted number of graduates was 6,167,114 for the year 2020. Only 513,196 of those graduates are predicted to be African American, which makes up a shocking 8% of those graduates. Overall, it is predicted that there will be 606,427 African American graduates in 2020; which will make up 9% of graduates that year.

In continuation, graduates of Hispanic decent also share similar behaviors of the African American graduation rate. The number of Hispanic graduates in STEM fields is also predicted to steadily increase for the decade of 2011 to 2020. Likewise, the deficit gap still greatly outlasts the growth of Hispanic graduates in STEM fields. Out of the 766,704 predicted number of Associate graduates for 2020, there will 114,535 Hispanic graduates. In addition, the predicted percentage of those graduates being of Hispanic decent is 15%. Of the 6,167,114 predicted Bachelor graduates it was determined that 617,896 of them will be classified as Hispanic. Moreover, the predicted percentage of those graduates being of Hispanic decent is 10%. Overall, the predicted number of Hispanic graduates in the year 2020 is expected to be 618,545; which will make up another 9% of the United States graduates on an Associate and Bachelor level.

Once the following data was obtained and evaluated, a deficit then was computed to determine if Barack Obama's 2020 goal will be reached, exceeded, or shortcoming. The deficit can be calculated by taking the difference of the targeted number of graduates by the predicted number of graduates. The target number of graduates was to get 10 million more graduates from community colleges, four-year colleges and universities within the decade of 2011 to 2020. The predicted number of graduates was calculated by first completing the forecast of graduates for the years of 2013 through 2019 [3]. Next, the sum of graduates was found by adding the number of graduates for the years of 2011 through 2020 on an Associate and Bachelor's level. This sum reflects a projection of 6,933,818 Associate and Bachelor graduates for the decade of 2011 to 2020. Therefore, it is predicted that the United States will not meet Obama's 2020 goal; while lacking 3,066,182 graduates.

In efforts to detour from this predicted deficit, it is imperative to condense the gap of African Americans and Hispanics in the United States. It is alarming to see such low percentages from these two ethnic groups because by 2044 the United States is projected to become a plurality nation. Meaning, "the non-Hispanic White alone population will still be the largest, no race or ethnic group is projected to have greater than a 50 percent share of the nation's total" [1]. Likewise, "the child population within the United States is even more diverse and is projected to experience the majority-minority crossover in 2020" [1]. As of today, Hispanics are the largest growing minority group within the United States. "In 2014, Hispanics are projected to account for 17 percent of the U.S. population" [1]. By 2060, their population is expected to reach 29%, -"more than a quarter of the total population" [1]. Therefore, it should be a priority to start recruiting more Hispanics into STEM fields if the United States wishes to keep a more dominant education and work force throughout the world.

Although the African American population isn't growing as rapidly as Hispanics, there are other obstacles that hinder their advancement in STEM fields. The African American incarceration rate is greater than any other race in the world. "Today, the US is 5% of the World population and has 25% of world prisoners" [2]. Of that percentage, "African Americans now constitute nearly 1 million of the total 2.3 million incarcerated populations" [2].

Moreover, the majority of incarcerated African Americans are men. “One in six black men had been incarcerated as of 2001. If current trends continue, one in three black males born today can expect to spend time in prison during his lifetime” [2]. On the other hand, “1 in 100 African American women are in prison” [2]. Although, African American women are less likely to be incarcerated and also consistently growing in STEM fields, it is nearly not enough to close the deficit gap. Some sort of incarceration reform must be implemented to cease this ongoing tragedy. The continued growth of women, in STEM fields, within these two ethnic groups is the biggest attribute to decreasing the gap. Likewise, more must be done to truly change the outcome of defeat.

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