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Immigrants' Success in Science Education and Careers

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Abstract:

The contribution of immigrants to the scientific and technological innovation and progress of the United States is significant. Beyond the existing statistics describing their status, this study explored the factors driving such immigrants' success in science, technology, engineering and math (STEM) education and careers, focusing on their learning and career growth environments. The goal of this study was to seek and expose qualitative information for the development of a pro-active STEM curriculum of education and career enhancement, in addition to fostering such academic policy guidelines for STEM students and scholars in multicultural and diverse settings. The study targeted first generation students and scholars in terms of immigration status as well as university education, while also intentionally including all STEM field people, regardless of immigration status, in an effort to offer a more comprehensive view of success factors and needs in STEM, and also to seek non-immigrants' view points on their immigrant peers' issues. Anonymous survey responses were collected from 156 STEM individuals in North America, Asia, Europe and Africa, all of whom had higher education and/or career experiences in the United States. The survey revealed that the success of immigrants and non-immigrants alike in STEM education and careers is enhanced by a variety of factors including past education, institutional environment for mental and professional growth and active mentorship. Their success cannot be defined by grades, graduation rates, publications or patents alone. Other metrics of success identified by this study include the acquisition of respect from supervisors, peers, and community; the knowledge and skills for work and life gained within and beyond the university; and opportunities



to provide significant measurable contribution in STEM fields throughout one's career, regardless of immigration status. Considering the shifting US diversity and economic landscape mirrored by the changing definitions, roles and potential of minority and immigrant groups in US STEM fields, corresponding policies should be formulated, implemented and enforced from institutional to federal levels with the incorporation of such findings and continuous input from all stakeholders.



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CREATING ACADEMIC COMMUNITY FOR FIRST-GENERATION COLLEGE STUDENTS A Graduate Student Instructor Guidebook

Immigrants' Success in Science Education and Careers

Gyami Shrestha*

Environmental Systems Program

Center for Research on Teaching Excellence Graduate Teaching Fellow

The contribution of immigrants to the scientific and technological innovation and progress of the United States is significant. Beyond the existing statistics describing their status, this study explored the factors driving such immigrants' success in science, technology, engineering and math (STEM) education and careers, focusing on their learning and career growth environments. The goal of this study was to seek and expose qualitative information for the development of a pro-active STEM curriculum of education and career enhancement, in addition to fostering such academic policy guidelines for STEM students and scholars in multicultural and diverse settings. The study targeted first generation students and scholars in terms of immigration status as well as university education, while also intentionally including all STEM field people, regardless of immigration status, in an effort to offer a more comprehensive view of success factors and needs in STEM, and also to seek non-immigrants' view points on their immigrant peers' issues. Anonymous survey responses were collected from 156 STEM individuals in North America, Asia, Europe and Africa, all of whom had higher education and/or career experiences in the United States. The survey revealed that the success of immigrants and non-immigrants alike in STEM education and careers is enhanced by a variety of factors including past education, institutional environment for mental and professional growth and active mentorship. Their success cannot be defined by grades, graduation rates, publications or patents alone. Other metrics of success identified by this study include the acquisition of respect from supervisors, peers, and community; the knowledge and skills for work and life gained within and beyond the university; and opportunities to provide significant measurable contribution in STEM fields throughout one's career, regardless of immigration status. Considering the shifting US diversity and economic landscape mirrored by the changing definitions, roles and potential of minority and immigrant groups in US STEM fields, corresponding policies should be formulated, implemented and enforced from institutional to federal levels with the incorporation of such findings and continuous input from all stakeholders.

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BACKGROUND AND INTRODUCTION

Dreams and aspirations

Immigrant students and scholars arrive in the United States, thousands of miles away from home, believing the myth that America is a land of dreams, where success is won through hard work and sacrifice. That myth transforms into a bleak reality for some. Immigrant students and scholars often leave their comfortable existence at home, seeking new possibilities that are perceived as limitless. Many of them accept without question perennial separation from their loved ones in order to devote undistracted years at US STEM institutions. For marginalized women and other members of some conservative societies, these tradeoffs are happily accepted in the pursuit of the American dream of social, intellectual and financial freedom. Intelligence and talents can flourish uninhibited here, in a manner that would most probably have been impossible in their homeland. However, many immigrant students and scholars view their American liberty of speech and employment security as provisional with the constant uncertainty of having to return home by necessity, choice or force. These perceptual factors and qualitative experiences influence Science, Technology, Engineering and Math (STEM) fields in the US, as international students and scholars contribute heavily to these disciplines, often at personal expense. This article will summarize these experiences and explore some options to improve STEM employment.

Gratitude

For first generation immigrants who arrive here as international students and scholars, the opportunity to collaborate with professors, scientists and peers in US universities comes once in a lifetime. This experience is often embraced by them with deep gratitude for the host institution and adviser(s). Their education and research experience appears to be enhanced by the schooling and skills they initially bring from their native lands, particularly in STEM fields.

Success

Between the years 1995 and 2006, 70% of all new scientists and engineers were immigrants. Furthermore, the 2000 census indicated that immigrants comprise approximately half of the scientists and engineers with doctorate degrees, a remarkable statistic given that they otherwise represent only 12% of the US population (Herman and Smith, 2010). Wasdhwa et al., (2007) found that 25.3% of all engineering and technology companies established in the US between 1995 and 2005 have at least one immigrant founder. Improving on this study, Hart and Acs (2011) included a broader

range of high impact science and technology industries beyond the Silicon Valley. They observed that 12.8% of these companies' founders were foreign born, most of them disproportionately concentrated in states with large immigrant populations and two-thirds of them obtained their highest degree in the US. This number also corresponds closely with the percentage of foreign-born residents of the US.

What drives these high numbers and success rates of immigrants in STEM fields? Is it a competitive drive and scientific knowledge already instilled from a home nation? Is it the aforementioned appreciation and the consequential desire to please their US supervisor(s)? Inclusive or exclusive of the above, are the high expectations and demands of their same supervisor(s) leading to the immigrants' rational or irrational fear of losing the privilege to live, study and work in this country unless they exceed their expectations?

Post-immigration employment

A new report by the Brookings Institute (Hall et al. 2011) showed that high-skilled immigrants with at least one college degree currently constitute at least 30% of the total working age immigrant population in the US. However, these immigrants showed a likelihood of higher unemployment compared to highly skilled natives, particularly in metropolitan areas, which are typical immigrant gateways. These findings suggest that college degrees and skills alone, whether attained before or after immigration to the US, do not appear to help many of these immigrants achieve the expected success in their careers in their locations of choice.

Kochhar, Espinoza and Hinze-Pifer (2010) reported that immigrants now represent 15.7% of the US workforce, an increase from 9.7% in 1995. Without identifying individual STEM workers, this study analyzed aggregate employment data from social services, hospital, public administration, manufacturing, construction and hospitality. The rate of unemployment for native-born workers increased whereas for immigrant workers, it had fallen over the one-year period from June 2009 through June 2010, marking the official end of the recession (Table 1). A gain of 656,000 jobs was observed for the immigrants who had lost 1.1 million jobs the previous year. The median weekly income loss over that period for immigrants was higher than for natives (Table 1). It appears that non-Hispanic foreign-born workers have been earning more wages than all other worker classes in the US. Their job loss rate was 1.7% from 2009 to 2010, compared to native-born workers' 0.7% loss. Kochhar, Espinoza and Hinze-Pifer (2010) suggested that immigrants' higher mobility and wage flexibility compared to native-born workers might be the reason behind their slightly better employment scenarios.

Could the STEM sector immigrants also be embracing similar occupational traits in order to achieve success in their education and careers?

Table 1: Native and foreign-born workers' unemployment and income loss from June 2009 to June 2010 (adapted from Kochhar, Espinoza and Hinze-Pifer, 2010)

June 2009 to June 2010 ('official' end of recession)	Native	Foreign-born
Unemployment rate %	9.7 from 9.2	8.7 from 9.3
Median weekly income loss	1% or \$653	4.5% or \$525

Better metrics of success in STEM fields?

It is also imperative to ask whether any or all of the aforementioned statistics represent true metrics of success or failure for immigrant populations in STEM education and careers. The number of patents, publications, citations and membership in the National Academy of Sciences and Engineering demonstrate that immigrants contribute at disproportionately high rates to STEM in the US; however, they also occupy less valued temporary positions with lower salary and no job security in high numbers in academe (Stephan and Levin 2007). Regardless of immigration status, success in STEM education and careers is a very subjective matter. In the traditional sense, passing all graduate courses with at least of B grade, a series of highly cited publications, eventual receipt of a PhD degree, followed by a post-doc or two or three or more, a tenure track appointment, patents, more publications, and then the pinnacle of completed tenure would define a successful STEM education and career for many. However, are experiences like assimilation of course knowledge and holistic growth with multiple marketable and transferrable skills overlooked in favor of traditional output statistics such as number of graduates, patents, and publications in STEM? Obviously and logically, institutions cannot sustain these research values they so ardently champion without some balance.

Perceptions and reality

Misconceptions concerning immigrants' barriers to success prevail even among researchers investigating these issues, as evident from some prior studies and their conjectures. For instance, Mak et al. (1999) remark that not all immigrants recognize the importance of socio-cultural competence in pursuit of success to rationalize some immigrants' inclination to work through lunchtime instead of socializing with their colleagues. Is this interpretation of social behavior revealing a cultural bias?

Alternatively, is it accurate to assume that social behavior is an indicator of cultural difference? Though such statements may represent valid opinions in some cases, they can also simply be misinformed perceptions of social behavior versus professional conducts, which may vary among different people and societal circles by personal choice, need and cultural differences, regardless of immigration status. Without bidirectional survey data, it is difficult to ascertain the cause or reason of such behavior, attitudes and assumptions.

STUDY OBJECTIVES AND GOAL

Against this backdrop, we conducted a study focusing on the learning and career growth environments of STEM students, scholars and professionals who migrated by themselves to the United States for higher education or who are the offspring of immigrants. We investigated success factors by employing an internationally disseminated survey that explored non-immigrant and immigrant perceptions of immigrants' contributions to STEM fields. Analysis of institutional data collected from the University of California, Merced (UC Merced), the newest of all the ten UC campuses and the University of California, Berkeley (UC Berkeley), the oldest campus, was also conducted to compare their immigrant and first generation STEM student status, given their disparate localities, age and size. The goal of this study was to seek and expose qualitative information for the development of a pro-active STEM curriculum for education and career enhancement, in addition to fostering related academic policy guidelines for STEM students and scholars in multicultural and diverse settings. This qualitative information is particularly useful for those who are first generation in terms of immigration status and/or university attendance in the United States.

METHODOLOGY

Survey

The main issues that were investigated were as follows: (1) Factors within and beyond the US university environments helping in STEM success; and (2) Factors that may have hampered further intellectual and career growth. Focus groups included recent migrants to the US for higher education and the offspring of recent immigrants. The survey was also intentionally inclusive of all STEM scholars, regardless of immigration status in an effort to offer a more comprehensive view of success factors and needs in STEM.

The survey incorporated 25 questions of single and multiple-choice types compiled by using www.SurveyGizmo.com and disseminated through the following internet outlets:

- (1) Professional listservs: Earth Science Women’s Network (ESWN) and National Academies Mirzayan Science and Technology Policy Fellows;
- (2) UC Merced graduate students listserv; and
- (3) LinkedIn: Professional Network of members belonging to the American Association for the Advancement of Science and author’s professional contacts and colleagues.

Over a one-week period after which the survey was closed, 156 responses were submitted anonymously by survey recipients from North America, Asia, Europe and Africa (Figure 1).

Figure 1: Geographic origin of survey responses



Institutional data collection: University of California Berkeley and Merced

Employing publicly available institutional data from the University of California, we analyzed the undergraduate students’ demographics and focus in STEM education at two University of California campuses – the University of California, Berkeley (UC Berkeley) and the University of California, Merced (UC Merced). Established in 1869 as the first University of California campus, UC Berkeley has the second largest UC campus population and the third most ethnically diverse UC population (US News and World Report, 2011). It also has the largest financial endowment (US \$2.34 billion) among the ten UC campuses and is located in one of the most technologically advanced, financially robust and ethnically diverse regions of the nation. Immigrants in this part of the nation mostly comprise of highly skilled and educated workforces (Hall et al. 2011). The youngest UC campus, UC Merced, was officially established in 2005 to serve one of the highest poverty-stricken regions in California. Achieving phenomenal

academic progress in the face of the State of California’s recent financial crisis, UC Merced is the smallest UC in terms of student population and endowments. Its location in the ethnically rich Central Valley has made it the destination for many first and second generation immigrants. We elected to compare these campuses not only due to the disparity in their size and economic status but also due to the similarities in their ethnic diversity and the high percentage of students involved in research. Comparing the youngest UC with the oldest one was envisaged to develop recommendations that could help UC Merced carve its own innovative path in STEM education, with a balanced and optimized approach to preparing its diverse student population for successful STEM careers.

FINDINGS

Survey

Composition of respondents

The majority of the respondents were female (67%) and PhD level (30%, Table 2). Only 29% were first generation university students, defined as students whose parents did not complete a four year university or college degree. Native English speakers comprised 56% of this population, with the 14% Spanish speakers and 30% a mixture of native Chinese, Hindi, Arabic, Farsi, French and various other European and Asian languages. The percentage that identified themselves as an immigrant student or scholar, defined as those who relocated to the US for higher education or work, was 42%. When factoring in the option of identifying as first generation immigrant someone who came to the US on their own or with their family, this number rose to 50%. While 27% were second or third generation immigrants, the rest, 23%, were not descendents of recent immigrants. Most of the respondents were of European origin, followed by Asians and others (Figure 1). Environmental scientists/Geoscientists comprised the majority of the responses (21%), followed by biologists, engineers and others (Figure 2). The survey instrument is available in the Appendix section of this article.

Table 2: Academic and professional status of respondents

Status	Count	Percent
PhD student	47	30.1%
Masters level student	14	9%
Instructor/lecturer	4	2.6%

Professor (tenured)	3	1.9%
Professor (tenure-track)	13	8.3%
Post-doctoral researcher/research associate (temporary)	16	10.3%
Non-faculty University Staff (researcher, program manager, etc.)	5	3.2%
Non-university Professional	37	23.7%
Not currently working, but with higher university degree (Masters/PhD)	5	3.2%
Upper level University Administrator (Director, Dean, Chancellor etc.)	3	1.9%
Other	21	13.5%

Figure 1. Region of origin of the survey respondents. 'Other' represent mixed origins and 'other values' represent Mexico 5.8%, Canada 3.2% and Central America 3.8%.

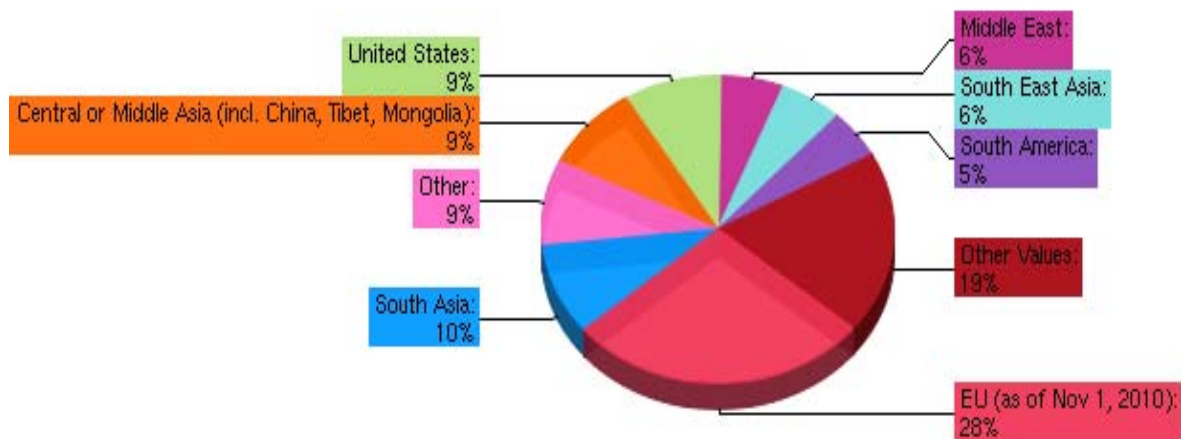
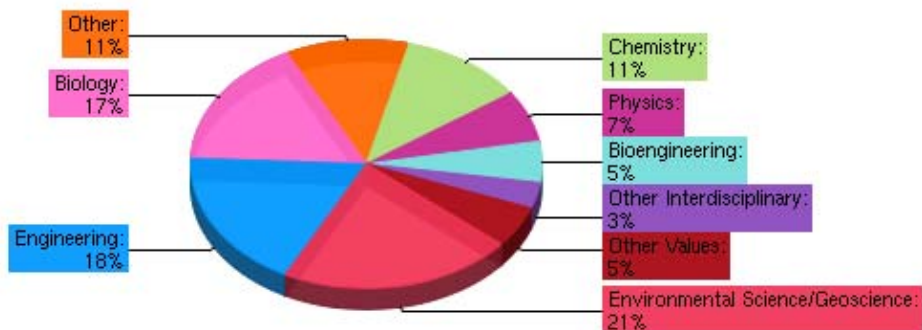


Figure 2. STEM fields of respondents



Retention and success in STEM

Of the 156 respondents, 10% reported no longer being involved in STEM because of change of interest, and 3% reported the reason to be higher earning potential. Single responses addressed a lack of familial support, finances, or degree progress. Other single responses cited a desired focus on the bigger science policy picture or unhappiness in laboratory environments during graduate school. A total of 5% of the participants (5 Asians, 1 African, 1 Egyptian and 1 from EU) reported being unemployed for reasons such as need to take care of family or children, inability to find suitable positions and losing their old jobs. All of them except one, who is a second or third generation immigrant, are first generation immigrants.

A majority of the participants (69%) attributed their retention and success in STEM education to the mentorship of professors (Table 3). The community of friends/peers beyond one's own culture/religion was also considered a significant factor (40%). Minority programs, scholarships, fellowships, monetary loans, and organizations beyond the university were also cited separately by the participants.

Table 3: Factors attributed to retention and success in STEM education

US Education	61.70%
Education/Preparation from home country	34%
Communication and social skills gained in US classroom	30.50%
Communication and social skills gained in US work environment (e.g. lab, office) during university years	34.80%
Career Resources available on-campus	17%
Administrative/career guidance support of university staff	17%
Mentorship of professors	68.80%
Internet resources	25.50%
Community of friends within your own culture/religion	29.10%
Community of friends/peers beyond your own culture/religion	40.40%
Networking at conferences and career events beyond your university	33.30%
Other	13.50%

Mentorship of professors was also emphasized as the most important factor in the retention and success of the survey participants in STEM careers, just like in STEM education, followed by US education, communication skills gained in the US work

environment, and the networking opportunities at conferences and career events beyond the university (Table 4). Off-campus career opportunities and workshops, primary and middle school education abroad, and minority access to research career fellowships awarded during undergraduate years were also acknowledged separately. When asked what could have improved their US university and career experiences and consequent success in STEM fields, a need for better faculty mentorship was emphasized, followed by practicum/ internships/ fellowships beyond the university lab, opportunities for professional skill development courses and better career support and grooming (Tables 5 and 6).

Table 4. Factors attributed to retention and success in STEM career

Factors	Percentage
US Education	56.90%
Education/Preparation from home country	25%
Communication and social skills gained in US classroom	22.40%
Communication and social skills gained in US work environment (e.g. lab, office) during university years	41.40%
Career Resources available on-campus	9.50%
Administrative/career guidance support of university staff	12.90%
Mentorship of professors	60.30%
Internet resources	20.70%
Community of friends/peers within your own culture/religion	23.30%
Community of friends/peers beyond your own culture/religion	35.30%
Networking at conferences and career events beyond your university	41.40%
Other	6%

Table 5. Needs for improved US university experience and success in STEM

Needs	Percentage
Faculty mentorship	46%
Non-faculty support and mentorship	20.10%
Better career center support and grooming	35.30%
Financial support	36%
Family support	11.50%

US Immigration laws	30.90%
Practicum/internships/fellowships beyond your own university labs	41%
Encouraging participation in extra-curricular activities	28.10%
Opportunities for professional skill development courses	40.30%
Other responses: More diverse group of peers, better team work, grants, more classes, gender bias in grad school, acceptance by American colleagues as equal from start, friends, information on career options beyond academia (which were disdained)	7.90%

Table 6. Needs for improved US career experience and success in STEM

Needs	Percentage
Faculty mentorship	41.70%
Non-faculty support and mentorship (from administrative staff)	17.50%
Better career center support and grooming	34.20%
Financial support	23.30%
Family support	10%
US Immigration laws	27.50%
Practicum/internships/fellowships beyond your own university or lab	33.30%
Encouraging participation in extra-curricular activities	29.20%
Cultural sensitivity training in the workforce	17.50%
Opportunities for professional skill development courses	43.30%
Other responses: grants/fellowships, better treatment of foreign (Indian) women	2.50%

Immigrants' retention and success in STEM and United States

A total of 8% of the survey participants did not plan to stay in the US after the completion of the STEM education and job duties here because of reasons such as immigration visa restrictions (19), better job options abroad (7), family commitments (5), lack of financial resources (4), and cultural clashes (4). Other reasons given were an increase in xenophobia, interest in international STEM policy and desire for international development jobs.

Most of the respondents (57%) had observed or experienced immigrants' higher willingness to relocate for work in STEM fields, compared to native-born workers while only 39% thought that such higher mobility actually helped immigrants succeed in their careers. Only 39% of the respondents had observed or experienced immigrants' acceptance of lower wages than native-born workers in STEM. Surprisingly, a majority (59%) thought that this lower wage acceptance helps with immigrants' success in STEM fields.

In their own words

The following highlights from the survey responses present a more personalized reflection of the respondents' experiences and provide extremely helpful advice. The appendix contains more detailed opinions and statements.

What has/could help you or your first generation immigrant colleagues succeed in the STEM fields, both at the university and careers?

- (1) Adviser guidance and connections is very important.
- (2) Advisers have to be trained to deal with students from different cultures and backgrounds and to understand that first generation students need to adjust.
- (3) Community building between immigrant students/early career professionals to alleviate some of the negative pressures that one faces in the school environment or work place is needed.
- (4) Find a mentor early on, and several so that you can learn the ropes right away instead of learning things right after they would have been useful!

Additional comments from survey respondents concerning relocation and lower wages as possible factor for immigrants' success:

- (1) Everyone from graduate school relocated for work, regardless of ethnicity.
- (2) I think the lower wages for immigrants, usually tied to H1B visas, contribute to overall lower STEM salaries and turn-off native born scientists. Allowing immigrants to transfer an H1B visa between jobs would improve this.

Comments regarding adviser student relationship:

Community building between immigrant students/early career professionals is needed to alleviate some of the negative pressures that one faces in the school environment or work place.

Question to immigrants: How did/do you directly or indirectly contribute to the success of other STEM students and professionals?

- (1) I helped people interested in STEM be it native or immigrant by tutoring, psychological support, work or money support. I continue doing it until this day... and will continue doing it.
- (2) Promoting the development of bi-lateral scientist exchanges and international collaboration programs
- (3) Lead and participate in STEM outreach to school and college students; helped develop program for early career professional training for retention.

How did your immigrant colleagues in STEM directly or indirectly contribute to success in your own STEM career and education?

- (1) They were friends the same as anyone else; they did not contribute more or less than non-immigrants.
- (2) I direct a dozen staff. All but three are first generation immigrants. It has broadened our world view, but we spend more time on technical writing tasks because of second language issues.
- (3) The knowledge you get from learning about other cultures, which frequently happens working in STEM fields, is invaluable. It makes you a more understanding and culturally aware person, which is essential for professional success in any field
- (4) They have been a source of motivation. When somebody struggles that much to success, I can only say that I need to do it to!

Institutional data findings: UC Merced versus UC Berkeley

In the fall of 2010, 25.1% of UC Berkeley's freshmen were first generation. In the previous year, 66% of the freshmen had at least one foreign-born parent. In the same year, its most popular majors in decreasing order were Electrical Engineering and Computer Science; Political Science; Molecular and Cell Biology; Environmental Science, Policy and Management; and Economics. In 2008, 52% of their seniors had assisted in faculty research or creative projects (UC Berkeley, 2011) compared to 68% of all UC Merced students (UC Merced, 2011). In 2009, UC Merced awarded its highest number of undergraduate degrees in biology (31%). That year, only 1% of the total undergraduate students and 33% of the total graduate student population were reported as foreign born. A total of 52.4% of the total freshmen were first generation students in terms of college attendance.

From 2005 to 2010, the percentage of Asians, Hispanic and minority (African-Americans and Native Americans) undergraduates who were dismissed from STEM majors at UC Merced respectively decreased from 29% to 10%, from 17% to 9% and from 8% to 3%.

The year 2009 was the only year in which international students (1.4%) were dismissed from STEM majors (UC Merced Institutional Planning and Analysis, 2010, in prep.)

Both UC Berkeley and UC Merced students appear to show a high interest in STEM fields, compared to other fields. The high number of first generation immigrants and/or immigrants' offspring in these schools as well as their increasing retention in and graduation with STEM degrees are indicative of their persistence and successful STEM education. Though new, UC Merced's STEM student retention and research participation is increasing at a fast rate among all ethnic groups. This is indeed a very good sign for the future of this new university. Although a majority of its undergraduates are first-generation and one-third of graduate students are international, UC Merced appears to be making strides in its STEM education success at rates that are comparable to UC Berkeley's.

DISCUSSION AND RECOMMENDATIONS

The findings of this study show that success of immigrants and non-immigrants alike in STEM education and careers is enhanced by a variety of factors, including past education, institutional environment for professional growth, and active mentorship. This success cannot be defined by grades, graduation rates, publications or patents alone. In addition to obtaining education and skills, appropriate employment and other metrics of success identified by this study include respect of supervisors, peers, and community, knowledge and skills for work and life within and beyond the university, and opportunities to provide significant measurable contribution in STEM fields throughout one's career, regardless of immigration status. Merely providing a Ph.D. is not enough -- institutions need to ensure that their Ph.D. students are capable of generating sustainable solutions for science and society's problems. The following key observations were gathered from the survey responses:

- (1) Faculty mentorship is critical for success in STEM education and career;
- (2) Socio-cultural, networking and professional skill development opportunities are also crucial;
- (3) Immigrants' contribution in STEM is substantive and acknowledged by non-immigrants too; and
- (4) Cases of exploitation (lower or no wages) are surprisingly common circumstances for immigrants, a cycle that is sometimes perpetrated by immigrant advisers themselves.

Mentorship

Students and scholars in STEM fields should actively seek and establish 'board of mentors' from the beginning of their STEM education throughout their careers and also become a mentor to others who follow in their footsteps. The findings of this study also provide insight into how supervisors and senior level colleagues can improve mentoring approaches and techniques, for immigrants and non-immigrants alike. The following are recommendations based on these findings:

- (1) Take the time and initiative to reach out, not once, not twice but several times to all new and returning students and scholars.
- (2) Since those who are first generation in terms of immigration and/or college access may not be aware of this culture of mentorship that exists in the United States, there is a dire need to be aware of their inhibitions, apprehensions or even ignorance about mentor-mentee dynamics. University orientations and advising are one option to address these needs.
- (3) Each university should incorporate non-exclusive mentorship development trainings for its faculty and staff aimed at motivating and preparing those involved. Many times, at least at their initiation, such activities may have to be made mandatory. Specific periods of mentorship with clearly outlined accomplishment oriented mentor-mentee 'contracts' could be informally drawn to assure the success of the relationship and to avoid any misunderstandings owing to cultural differences or miscommunications.

Success with fairness and respect

The experiences of immigrant students and scholars and the observations of their native counterparts, indicate that the treatment of immigrants in some US research environments may require reevaluation and improvement to promote equality and fairness. Beyond the physical and direct demands of a STEM career, the indirect expectations associated with work or student visa sponsorships undoubtedly have consequences. Unless universities wish to label themselves as degree and publication mills at the cost of well-balanced and successful graduates and scholars, it is in an institution's best interest to formulate guidelines for professors and administrators to ensure fair treatment of all employees, regardless of immigration status. Policies should be clarified to improve implementation among both professors and their employees not only during orientation but also throughout an employment period.

Networking and professional skills development

Oftentimes, the pressure of producing above average research and/or obtaining good grades at the university level obscures the importance of networking and professional skills development for post-degree or post-university careers. Other factors also introduce challenges, including a lack of time, resources, access and encouragement for such opportunities. Supervisors and university programs need to proactively facilitate the flow and exchange of information regarding such activities, which are often free, within and beyond the university. In the long term, the availability of and access to these opportunities will expand the career success of their students and the prestige of their own institutions and laboratory groups. Reiterating the above “Mentorship” section recommendations, active mentorship and advocacy of students should supplement this process. This effort is particularly important to new immigrants and first generation students who may not initially have the social skills or the confidence to initiate a meaningful relationship with new professional acquaintances in a new setting. The record of accomplishment of the most prestigious US universities show that investing in students’ and scholars’ professional development and providing opportunities beyond the classroom or laboratory benefits everyone.

Relation to other cohorts

Findings from this study relate to another cohort -- women in STEM. Issues and progress related to their retention, graduation, employment and wage gaps appear analogous to those immigrants and first generation scholars. A recent study published by the US Department of Commerce (2011) found that even after controlling for age and education, women in full-time STEM jobs earned on average, only \$31.11 per hour, a wage considerably less than men, who earn, on average, \$36.34 per hour in this sector. Although this 14% gender wage gap in STEM wages is less than the existing 21% gap in non-STEM jobs, and overall the STEM wages are higher than non-STEM ones, this situation cannot be ignored or taken lightly. This Department of Commerce study also observed that only 26% of women with STEM degrees work in STEM fields, compared to 40% for men. Just like immigrants and first generation students, women comprise a large proportion of US university population and degree holders; however, their STEM education and employment scenario exhibits significant quantitative and qualitative disparity compared to their male counterparts. It can undoubtedly be said that the findings and recommendations from our study could be applicable to women in STEM as well.

CONCLUSION

History will often teach us that science cannot prosper for the greater benefit of humankind without the unrestricted transfer of ideas and collaboration among successive generations of scientists. Such prosperity cannot be sustained without the continuous reevaluation of attitudes and customs. In the past, access to and success in STEM education and careers may have been the privilege of only limited members of society by virtue of their birth and/or intellectual excellence. However, the recent accelerated growth in internet access and opportunities in STEM have given rise to virtual floods of students and scholars into STEM fields from some of the most deprived corners of the world. The mere import and utilization of intellectuals from previously underrepresented sectors of society or other nations, without their well-balanced grooming holistic career success, cannot advance and sustain healthy scientific achievements and innovation within an institution or country. The results and observations generated from our study support this idea and emphasize the urgency for pro-active mentorship and opportunities for career success beyond the academic training environment for all students and scholars -- immigrant or not. We do have to keep in mind shifts in the US's diversity profile and economic landscape, particularly how these changes mirror evolving roles for minority and immigrants in STEM fields. Corresponding policies at the institutional, state and federal levels should incorporate these issues with input from all stakeholders.

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APPENDIX

A. In their own words: Detailed responses and comments from survey participants

What has/could help you or your first generation immigrant colleagues succeed in the STEM fields, both at the university and careers?

(0) Adviser guidance and connections is very important. Nonetheless, these advisers have to be trained to deal with students from different cultures and backgrounds and to understand that first generation of students need to adjust.

(1) Community building between immigrant students/early career professionals to alleviate some of the negative pressures that one faces in the school environment or work place.

(2) Find a mentor early on--and several so that you can learn the ropes right away instead of learning things right after they would have been useful!

(3) The fellowship I received as an undergraduate, which provided 2 years of financial support--tuition paid--conference and lab funds--and support from a research mentor, has truly been the best assistance I could possibly receive.

(4) There are individuals who highly influenced me to pursue a STEM field: my Trigonometry teacher in high school (in the U.S), and my doctoral major professor. Both become my mentors, and both are minorities.

(5) AGEPE, SOARS

Additional comments from survey respondents concerning relocation and lower wages as possible factor for immigrants' success:

(6) Everyone from graduate school relocated for work, regardless of ethnicity.

(7) I think the lower wages for immigrants, usually tied to H1B visas, contribute to overall lower STEM salaries and turn-off native born scientists. Allowing immigrants to transfer an H1B visa between jobs would improve this.

Comments regarding adviser student relationship:

(8) One professor always had Chinese students, and they did not seem to have the same rights as the rest of us but i do not know how they were paid.

(9) Working for a minority primary faculty or boss may not help because they more often abuse your immigrant status (cannot move easily, visa issue etc) than non-minority.

(10) Community building between immigrant students/early career professionals is needed to alleviate some of the negative pressures that one faces in the school environment or work place.

(11) Improve Immigration laws, homesickness, xenophobia

Question to immigrants: How did/do you directly or indirectly contribute to the success of other STEM students and professionals?

(12)I tutored them, helped others with their family life, and gave money to struggling people.

(13)I helped numerous other people interested in STEM be it native or immigrant by tutoring, psychological support, work or money support. I continue doing it until this day... and will continue doing it.

(14)Promoting the development of bi-lateral scientist exchanges and international collaboration programs

(15)lead and participate in STEM outreach to middle school, high school, and college students; helped develop program for early career professional training for retention at former workplace

(16)Others: Usual professor duties of mentoring students

How did your immigrant colleagues in STEM directly or indirectly contribute to success in your own STEM career and education?

- They were friends the same as anyone else; they did not contribute more or less than non-immigrants.

- I direct a staff of 12. All but three are now first generation immigrants. It has broadened our world view, but we spend more time on technical writing tasks because of second language issues.

- The knowledge you get from learning about other cultures, which frequently happens working in STEM fields, is invaluable. It makes you a more understanding and culturally aware person, which is essential for professional success in any field

- They have been a source of motivation. When somebody struggles that much to success, I can only say that I need to do it to!

B. Survey Questions

Immigrants' University and Career Success in US Science, Technology, Engineering and Math (STEM)

Please answer the questions that are relevant to you, and feel free to skip the ones that do not apply to you. Please use the 'other' option to write comments where needed.

1.) Gender

- Female
- Male

2.) Your current academic or professional status is

- PhD student
- Masters level student
- Undergraduate student
- Instructor/lecturer
- Professor (tenured)
- Professor (tenure-track)
- Post-doctoral researcher/research associate (temporary)
- Non-faculty University Staff (researcher, program manager, etc.)
- Non-university Professional
- Not currently working, but with higher university degree (Masters/PhD)
- Upper level University Administrator (Director, Dean, Chancellor etc.)
- Other

3.) Are/were you a first generation university student (i.e. your parents never completed 4 years of university and did not get a Bachelors degree)?

- Yes
- No

**4.) Are/were you an immigrant student/scholar/professional in the United States?
(You relocated to the US for higher education or work)**

- Yes
- No

5.) You describe your immigration status as

- First generation (you came here for education on your own or with your family, others)
- Second/third generation (descendent of first generation immigrant)
- Beyond third generation (not immigrant or descendent of recent immigrant)

6.) Region of origin (yours or your family's')

- South Asia
- South East Asia
- North, East, Central or Middle Asia (incl. China, Tibet, Mongolia)
- Middle East
- Australia
- Canada
- EU (as of Nov 1, 2010)
- Non-EU Europe (as of Nov 1, 2010)
- Africa
- Caribbean
- United States
- Central America
- South America
- Other

**7.) Are/were you involved in the Science, Technology, Engineering and/or Math
(STEM) fields of study or profession? ***

- Yes

No

If you answered 'No' to above question , the remaining questions will be not relevant to you. You may quit this survey now by clicking on the SUBMIT button at the end of the survey.

8.) Which STEM field are/were you involved in?

- Math
- Engineering
- Biology
- Physics
- Chemistry
- Bioengineering
- Environmental Science/Geosciences
- Other Interdisciplinary
- Other

9.) If you are not involved in the STEM fields anymore, why?

- Change of interest
- Too difficult to understand/learn
- Expensive education
- You realized you can earn more in other fields
- Lack of family support
- Other

10.) If you are not working, why?

- to take care of family/children
- physical health issues
- mental health issues
- lost job

- unable to find suitable job
- Other

11.) If you are completed or are completing your education in the STEM fields, what factor(s) have helped you the most with your retention and success?

- US Education
- Education/Preparation from home country
- Communication and social skills gained in US classroom
- Communication and social skills gained in US work environment (e.g. lab, office) during university years
- Career Resources available on-campus
- Administrative/career guidance support of university staff
- Mentorship of professors
- Internet resources
- Community of friends within your own culture/religion
- Community of friends/peers beyond your own culture/religion
- Networking at conferences and career events beyond your university
- Other

12.) If you are still involved in a STEM career after your university education, what has proved most helpful to you in achieving this?

- US Education
- Education/Preparation from home country
- Communication and social skills gained in US classroom
- Communication and social skills gained in US work environment (e.g. lab, office) during university years
- Career Resources available on-campus
- Administrative/career guidance support of university staff
- Mentorship of professors
- Internet resources
- Your own community of friends within your culture/religion
- Your own community of friends/peers within and beyond your own culture/religion

- Networking at conferences and career events beyond your university
- Other

13.) What could have improved your US UNIVERSITY experience and success in the STEM fields?

- Faculty mentorship
- Non-faculty support and mentorship
- Better career center support and grooming
- financial support
- family support
- US Immigration laws
- Practicum/internships/fellowships beyond your own university labs
- Encouraging participation in extra-curricular activities beyond the classroom
- Opportunities for professional skill development courses
- Other

14.) What could have improved your CAREER experience and success in the STEM fields?

- Faculty mentorship
- Non-faculty support and mentorship (from administrative staff)
- Better career center support and grooming
- financial support
- family support
- US Immigration laws
- Practicum/internships/fellowships beyond your own university or lab
- Encouraging participation in extra-curricular activities beyond the classroom
- Cultural sensitivity training in the workforce
- Opportunities for professional skill development courses
- Other

15.) Do you plan to stay in the US after your current STEM education/job?

- Yes
- No
- Other

16.) If not, why not?

- Immigration laws/work permit restrictions
- Fulbright Fellowship/J-1 or other visa restrictions
- Bad experience in US University
- Better job options in home country/abroad
- lack of financial resources
- language difficulty
- Family commitments
- Cultural clash/hard to adjust to life here
- Other

17.) Have you observed or experienced immigrants' higher willingness to relocate for work (within the US) in STEM fields, compared to native born workers?

- Yes
- No

18.) If you answered yes to the above, do you think such higher mobility helps immigrants' success in STEM careers?

- Yes
- No

19.) Have you observed or experienced immigrants' acceptance of lower wages than native born workers in STEM fields?

- Yes
- No

20.) If you answered yes to the above, do you think the willingness to accept lower wages than native workers has helped immigrants' success in STEM fields?

Yes

No

21.) If you have anything else to add, concerning your experiences and what has/could help you or your first generation immigrant colleagues succeed in the STEM fields, both at the university and career stages, please jot them down here.

22.) Optional question for immigrant STEM person: How did/do you directly or indirectly contribute to the success of other STEM students and professionals?

23.) For non-immigrant STEM field person: Please jot down how your immigrant colleagues in the STEM fields may have directly or indirectly contributed to success in your own STEM career and education.

Thank You!

**Thank you for taking our survey. With much appreciation and best regards -
Gyami Shrestha**
