The Effects of Stereotypes on Engineering Identities Among Latinx Undergraduate Engineering Students

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Abstract

Latinx undergraduate engineering students often experience stereotypes during their degree programs that can affect their engineering identity. Engineering identity is a student's sense of belonging within the engineering community and plays a significant role in a student's educational and professional persistence in engineering programs. This research provides an analysis of the effects of stereotypes on engineering identities among Latinx undergraduate engineering students. An online survey was developed and deployed across one Hispanic Serving Institution and two Predominately White Institutions. A total of 165 students completed the survey across the three universities. The survey asked students to rank their opinions for each question utilizing the Likert-scale. The questions were broken down into nine categories with a total of fifty-one questions. Results from this research suggest that regardless of ethnicity or gender, when stereotype threats are present, there is a loss in a student's engineering identity.

Keywords

engineering identity, stereotype threat

Introduction

Within the undergraduate engineering community, there is a growing need to understand engineering identities and how they can be used to address stereotype threats that exist. Engineering identity is a form of role identity that individual students create for themselves based on their experiences in engineering. This particular identity is typically formulated when a student is working on their undergraduate degree[1]. Engineering identity has recently become an important research topic conducted primarily using qualitative analysis methods in the Science, Technology, Engineering, and Math (STEM) communities. A majority of the research literature primarily focuses on measurement methods, engineering identity development, and experiences of women in engineering. However, there is minimal existing research on engineering identities among minority ethnic groups. Only 20% of the Latinx population in the U.S. is enrolled in public four-year bachelor's degree programs[2]. Of those, only 11% of Latinx students receive their bachelor's degrees in STEM fields, and just 4.5% of the 11% decided to continue their education with post-graduate degrees in the same field[3].

A stereotype is an oversimplification of an idea or image that is a part of one's social identity, commonly in the form of one's ethnicity, gender, race, religion, and more[6]. Stereotypes most commonly have negative impacts on a student's experience as they can lead to stereotype threats, which can negatively affect a student's academic performance and persistence[7]. A stereotype threat is when fear or anxiety of one's performance or actions within a group could be viewed as a negative stereotype[4]. For example, Spencer et al.[5] performed a study that evaluated the underperformance of women in math or science by giving individuals a difficult math test. The study found that when individuals were told that the test had shown gender differences prior to taking the test, women performed significantly worse on the test compared to men. Spencer et al.[5] explains how the stereotype of women's inability to do math was made relevant by mentioning the gender difference indicators. This made the women concerned with the gender-based stereotype, which, subsequently negatively affected how they performed when compared to men, changing the stereotype to a stereotype threat. Loss of academic performance and persistence is tied to a student's grades and participation in engineering-related organizations, this in turn affects their engineering identity[8].

Purpose

This research measures the engineering identity of Latinx undergraduate engineering students and quantifies the differential extent of ethnicity-based and gender-based stereotype threats across Predominantly White Institutions (PWI) and Hispanic Serving institutions (HSI). The authors asked the following research question: *"Do stereotype threats based on ethnicity or gender lead to higher engineering identities?"*

Methods

This study was conducted through the analysis of a set of responses from an Likert-scale online survey, allowing results to be analyzed through quantitative analysis. The online survey was distributed across two PWI – Auburn University (AU) and Iowa State University (ISU)- and one HSI – University of Texas at San Antonio (UTSA). At the time of this study, the undergraduate student population demographics at AU, ISU, and UTSA, consisted of 77% White and 4% Hispanic, 84% White and 6% Hispanic, and 22% White and 57% Hispanic, respectively.

The survey was released at the beginning of March 2021 and closed within the first week of May 2021. A total of 165 students completed the survey across the three institutions. Fifty-one Likert-scale questions were divided into nine categories with each category containing at least one reversed scored question, see Table 1. The question categories asked participants their opinion on centrality, private regard, public regard, group identification, ethnicity stereotypes threats, gender stereotype threats, along with additional background information consisting of their class standing, university, major, gender, and ethnicity. The Likert-scale questions were scored on a scale ranging from one (strongly disagree) to seven (strongly agree). The reverse scale questions were reversed after the survey was completed. This structure was obtained from Hamlet et al.[9], where the higher response score indicates a stronger engineering identity - i.e., the more the individual's identification is connected with themselves identifying as an engineer.

In this study, centrality is an engineering identity coined from one's sense of belonging within a community. This identity is formed when one agrees with the beliefs, values, and identities that

individuals hold with that particular identity[10]. Private regard focuses on how the individual feels about their decision to be an engineer and if they have a sense of pride in being a part of the community. Public regard inquiries on how the individual views engineers, the engineering workforce within society, and engineers' impact on society[9]. Social validation stems from a group or social identities that build a framework for how an individual interprets the world[11]. The questions asked over this topic focused on how the student felt among fellow engineering student peers and how they worked together as a group. Self-efficacy is one's own judgment of their capability to complete a given task[12]. This category was approached by students answering questions regarding their confidence level to complete and master tasks, classes, or challenges they might see during their undergraduate engineering career.

Data Analysis and Results

Table 2 presents descriptive statistics and correlations of all variables used. Results reveal that the mean score for Ethnicity Stereotype Threat and Gender Stereotype Threat is 4.21 (SD = 1.61) and 3.83 (SD = 1.76), respectively. These results indicate that, on average, Latinx students are experiencing both ethnicity and gender stereotype threats. The positive correlation of 0.70 between the two Stereotype Threats suggests a strong correlation that students who experience Ethnicity Stereotype Threats are likely also to encounter Gender Stereotype Threats and vice versa. Group Identity poses a mild significance of -0.22 and -0.25 for Ethnicity Stereotype Threats and Gender Stereotype Threats, respectively. These results indicate that when ethnicity and gender stereotype threats are present, students are less likely to identify themselves in a group of fellow undergraduate engineers. This trend of a negative correlation is minimal but present for almost all variables except for centrality and the PMI versus HSI institutions. Based on linear regression results, Ethnicity Stereotype Threat is a significant predictor of the engineering identity change in a Latinx engineering student (Table 3). The negative coefficient indicates that a Latinx engineering student who feels a higher ethnicity stereotype threat predicts a lower engineering identity. The same results were found when a linear regression was run for Gender Stereotype Threat (Table 4). The only difference between the two regressions is that the Ethnicity Stereotype Threat regression had a significance of less than 0.05. In contrast, the Gender Stereotype Threat regression had a significance of less than 0.01.

Conclusion

As the demand for engineers grows, there have been increased efforts to recruit and retain engineering students. Even though the number of bachelor's degrees being awarded has increased, there has been no significant change in diversity. This research aims to evaluate the effects of ethnicity-based and gender-based stereotype threats as they relate to an undergraduate engineering student's engineering identity who identifies as Latinx. When exposed, both the ethnicity and gender stereotype threats were linked to decreasing a Latinx student's engineering identity. This lack of identity then drives students to leave the discipline. Investigating and better understanding the possible factors present in engineering programs can aid in addressing stereotypes that remain in the field. This research will contribute to the limited knowledge of Latinx students in engineering, along with the stereotype threats and engineering identities that Latinx engineering students experience. Engineering program leaders and instructors should use this information to construct better practices for the inclusion of Latinx students in engineering.

Data Availability Statement

All data, models, and codes generated or used during this study are property or confidential and may only be provided with restrictions (e.g., anonymized data).

Disclaimer

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Appendix

Table 1. Survey Questions

Latent Construct	Likert Scale Based Questions
Centrality based Engineering Identity	Overall, being an engineering student has very little to do with how I feel about myself. In general, being an engineering student is an important part of my self-image. My destiny is tied to the destiny of other engineering students. Being an engineering student is unimportant to my sense of what kind of person I am. I have a strong sense of belonging to the engineering student community. I have a strong attachment to other engineering students. Being an engineering student is an important reflection of who I am. Being an engineering student is not a major factor in my social relationships.
Private Regard based Engineering Identity	I feel good about engineers. I am happy that I am going to be an engineer. I feel that engineers have made major accomplishments and advancements. I often regret that I am going to become an engineer. I am proud to be an engineer. I feel that the engineering community has made valuable contributions to this society.
Public Regard based Engineering Identity	Overall, engineers are considered good by others. In general, others respect engineers. Most people consider engineers, on average, to be more ineffective than other professionals. Engineers are not respected by the broader society. In general, other professionals view engineers in a positive manner. Society views engineers as an asset.
Group Identity based Engineering Identity	I identify with engineering students. I am glad to belong to a group of engineering students. I feel held back by engineering students I think engineering students work well together. I see myself as an important part of engineering students on campus. I fit in well with the other engineering students. I consider engineering students to not be important. I feel uneasy with other engineering students. I feel strong ties to engineering students.

Self-Efficacy based Engineering Identity	I can master the content in the engineering-related courses I am taking this semester. I can master the content in even the most challenging engineering course if I try. I can do a good job on almost all my engineering coursework if I do not give up. I can do an excellent job on engineering-related problems and tasks assigned this semester. I can learn the content taught in my engineering-related courses. I can earn a good grade in my engineering-related courses.
Ethnicity based Stereotype Threat	In testing situations, I worry that people will draw conclusions about my ethnic group based on my performance. I often think about issues concerning ethnicity. I often feel that people's evaluations of my behavior are based on the ethnic group to which I belong. I worry that people will draw conclusions about me based on what they think about my ethnic group. In an academic setting, I often worry others will assume I am aggressive and/or loud based on my ethnic group. I often worry that people will assume my academic abilities based on my ethnicity. I often feel that people make assumptions about my ethnic group based on how I present myself. I often worry that people will make assumptions about my ethnicity based on my physical appearance.
Gender based Stereotype Threat	In testing situations, I worry that people will draw conclusions about my gender group based on my performance. I often think about issues concerning gender. I often feel that people's evaluations of my behavior are based on the gender group to which I belong. I worry that people will draw conclusions about me based on what they think about my gender group. In an academic setting, I often worry others will assume I am aggressive and/or loud based on my gender group. I often worry that people will assume my academic abilities based on my gender. I often feel that people make assumptions about my gender group based on how I present myself. I often worry that people will make assumptions about my gender based on my physical appearance.

Table 2. Descriptive statistics and correlations

Variable	Mean	Std. Dev.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Ethnicity Stereotype Threat	4.21	1.61	1.00										
(2) Gender Stereotype Threat	3.83	1.76	0.70	1.00									
(3) Centrality	4.21	0.90	0.09	0.02	1.00								
(4) Private Regard	6.12	0.72	-0.12	-0.18	0.50	1.00							
(5) Public Regard	5.82	0.66	-0.10	-0.15	0.27	0.51	1.00						
(6) Group Identity	5.06	1.00	-0.22	-0.25	0.52	0.64	0.36	1.00					
(7) Self-Efficacy	5.05	1.08	-0.22	-0.11	0.12	0.33	0.15	0.33	1.00				
(8) Year	2.79	1.13	-0.13	-0.10	0.07	-0.02	0.14	-0.05	-0.02	1.00			
(9) PWI vs. HSI	2.81	0.70	0.09	0.13	0.13	0.14	-0.01	0.06	0.04	0.15	1.00		
(10) Major	0.18	0.38	-0.02	-0.05	0.02	-0.04	0.04	0.09	0.02	0.11	0.06	1.00	
(11) Gender	0.67	0.52	-0.28	-0.42	-0.10	-0.03	-0.04	0.02	0.08	0.08	-0.16	-0.11	1.00

Table 3. Linear regression results of determinates of Ethnicity Stereotype Threats

Variable	Coef.	Std. Err.	t-value	p-value	[95% Conf	Interval]	Sig
Year	-.009	.043	-0.20	.844	-.094	.077	
Uni	.098	.069	1.42	.159	-.039	.235	
Major	.049	.126	0.39	.7	-.2	.297	
Gender	-.049	.097	-0.51	.614	-.24	.142	
Ethnicity Stereotype Threat	-.074	.031	-2.40	.018	-.135	-.013	**
Constant	5.487	.246	22.28	0	5	5.973	***

Mean dependent var	5.331	SD dependent var	0.612
R-squared	0.047	Number of obs	165
F-test	1.551	Prob > F	0.177
Akaike crit. (AIC)	309.108	Bayesian crit. (BIC)	327.743

*n=165; standard errors are in parenthesis; *** p<.01, ** p<.05, * p<.1*

Table 4. Linear regression results of determinates of Gender Stereotype Threats

Variable	Coef.	Std. Err.	t-value	p-value	[95% Conf	Interval]	Sig
Year	-.005	.043	-0.13	.9	-.09	.079	
Uni	.104	.069	1.50	.135	-.033	.24	
Major	.027	.126	0.22	.829	-.221	.275	
Gender	-.103	.102	-1.01	.314	-.304	.098	
Gender Stereotype Threat	-.083	.03	-2.77	.006	-.142	-.024	***
Constant	5.512	.238	23.12	0	5.041	5.983	***

Mean dependent var	5.331	SD dependent var	0.612
R-squared	0.058	Number of obs	165
F-test	1.942	Prob > F	0.090
Akaike crit. (AIC)	307.184	Bayesian crit. (BIC)	325.820

*n =165; standard errors are in parenthesis; *** p<.01, ** p<.05, * p<.1*