

Non-Curricular Activities Help African American Students and Alumni Develop Engineer of 2020 Traits: A Quantitative Look

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Abstract

This research lays a foundation for understanding the unique experiences of African American engineering students and alumni who participate in non-curricular activities. Three non-curricular activities were examined for the scope of this study: National Society of Black Engineers (NSBE), Black Greek Organizations (BGOs), and Minority Engineering Programs (MEPs). This study demonstrates the value of these three activities by quantifying participants' perceptions on how involvement in these organizations aid the development of traits named in the National Academy of Engineering's *Engineer of 2020* report. Statistical analysis of data from over 250 student and alumni participants, from across the US, reveal that participants perceive each organization to make a statistically significant contribution to the development of at least one *Engineer of 2020* trait. Results of this study provide leaders and advisors of these programs and organizations with empirical data that can be used to advocate for funding and institutional support.

Introduction

The number of minority students in engineering remains low despite numerous calls to action to increase the number of students in engineering from the growing minority population in the US. Hispanics, African Americans, American Indian, and Native Hawaiian/Pacific Islanders together represent 29% of the overall U.S. population,¹ yet account for only 13.8% of bachelor's degrees earned in engineering. More so, African Americans make up 4.2% of this group with approximately 3,385 bachelor degrees awarded in 2012.² Furthermore, underrepresented minority graduates are even less present in the workforce: African

Americans represent 5% of the engineering workforce, Latinos 6% and American Indian/Alaska Natives combined represent 0.4%.¹ To improve the low representation of minorities in college and in the workforce, peer-led groups and non-curricular activities have been found to support students' persistence and development of critical professional competencies. This study explores how such non-curricular organizations and activities specifically help African American students and alumni members develop *Engineer of 2020* traits and the implications for campus program directors, organization advisors, leaders and members.

Literature Review

For the scope of this discussion, non-curricular activities occur within an academic setting but outside of the classroom. In this study we specifically focus on activities that African American students participate in frequently, namely NSBE, MEPs, and BGOs. Professional organizations (e.g. NSBE), student support centers (e.g. MEPs), and fraternities and sororities (e.g. BGOs) offer community involvement, academic services, and professional development opportunities. Previous research has shown that organizations like NSBE and BGOs have a positive impact on students in their ability to expose members to role models, national conferences, industrial and academic professionals, and other engineering students.³ Researchers in higher education have shown that student participation in out-of-class activities generally offers positive outcomes.^{4,5} In addition, NSBE, BGOs, MEPs and similar organizations have been shown to provide a sense of community for student members, often seen as a family bond,^{6,7} and as providing academic support to retain minority students.⁸ While these organizations are not the sole answer to increasing minority representation in

engineering, prior research^{9,10} suggests that they provide a unique means of social integration and academic support for African American students, and perhaps help alumni in acquiring traits that contribute to their development as professionals. This study aims to investigate the development of *Engineer of 2020* traits as measurable outcomes of non-curricular participation.

The *Engineer of 2020: Visions of Engineering in the New Century* report include ten traits established by the National Academy of Engineers in 2004 as necessary for engineering students to successfully face the challenges of the future. The ten traits include 1) analytical skills, 2) practical ingenuity, 3) creativity, 4) communication skills, 5) business & management skills, 6) high ethical standards, 7) professionalism, 8) leadership, 9) dynamism/agility/resilience/flexibility, 10) desire to be a lifelong learner.

Research Approach

The study takes a quantitative approach to analyzing an on-line survey conducted with a national sample of 289 African American student and alumni members participating in up to three types of non-curricular activities: BGOs, MEPs, NSBE. “Students” in this study are defined as current undergraduate members of an organization and “alumni” are members who are no longer enrolled as undergraduate students (i.e., graduate students, employed professionals). The research questions guiding this study are:

1. What, if any, are the differences in participants’ perceptions of the overall influence of membership in the three organizations (NSBE, MEPs and BGOs)?
2. When African American engineers are involved in any two of the three organizations, do they perceive membership in one organization to have more influence than another

organization on the development of one or more of the Engineer of 2020 traits? If so, to which organization do African American engineers uniquely link trait development?

Participants

Participants were required to have either an undergraduate or graduate degree in engineering. Participants with non-engineering undergraduate degrees, but who had obtained a graduate degree in engineering were included in the sample since all three organizations allow for post undergraduate participation and/or membership. However, only 2.4% of the participants fit this category. A wide range of engineering disciplines was represented in the study with 70% of participants holding undergraduate degrees in Chemical, Electrical, Computer, Industrial, and Mechanical Engineering. More women ($N = 156$) than men ($N = 133$) participated in the study.

Survey Design and Dissemination

The survey was designed to collect demographic data and create a database to conduct screening for participant selection in a qualitative study. Yet, a viable opportunity was identified to conduct a quantitative analysis focusing on two questions of the survey (see Figure 1 below). Three versions of each question were used in order to measure involvement appropriately for each organization; therefore, versions not shown below only vary with respect to the organization of membership (i.e. BGOs and MEPS).

***7. Consider the influence of NSBE membership on you. Please indicate the level of influence by selecting one response below.**

No influence Low influence Medium influence High influence Very high influence

***8. Consider the influence of NSBE membership on you. Please indicate the level of influence your membership in NSBE has had on your attainment of each of the following:**

	No influence	Low influence	Medium influence	High influence	Very high influence
1. Analytical skills	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Ingenuity (skill in planning, combining, and adapting to identify problems and find solutions)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Creativity (invention, innovation, thinking outside the box, art)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Communication skills	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Business and management skills	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Leadership	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Ethical standards	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Professionalism	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. The ability to learn new things quickly and the ability to apply knowledge to new problems and new contexts	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. The desire to become a lifelong learner	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 1. Survey Screenshot

The survey was disseminated online via Survey Monkey. Access to participants was obtained using prior relationships with individuals in leadership positions within each organization and with the National Association of Minority Engineering Program Administrators, Inc. (NAMEPA). Dissemination channels included national conferences, listservs, emails, and social media postings. For instance, during the NSBE national conference, handouts advertising the survey were distributed. In addition, NSBE posted a link to the survey on their website and BGOs sent email solicitations at the chapter, regional, and national levels. The survey instrument evaluated the perceived influence of an organization on the development of each of the ten *Engineer of 2020* traits on a five-point Likert Scale (with 1 meaning no

influence, 2 meaning low influence, 3 meaning medium influence, 4 meaning high influence and 5 meaning very high influence).

Data Analysis

Many participants in the study belonged to more than one organization. Therefore, after verifying the data was nonparametric, groupwise comparisons using the Wilcoxon signed-rank test were used to answer the research questions. The Wilcoxon signed-rank test was used to determine if differences in perceived overall influence exist among the three organizations. Additionally, it was used to determine if differences existed in African American engineers' perceptions of the development of *Engineer of 2020* traits resulting from membership in any two of the three organizations. Finally, the test also investigated if membership in any pair of these organizations has a unique influence on the perceived development of one or more of the *Engineer of 2020* traits.

Survey Results

Overall Influence: Research Question 1

As shown in figure 1 (question 7), participants were asked to evaluate the overall level of influence an organization had on them in general. Participants positively rated the influence of involvement in NSBE, BGOs, and MEPs. Each organization's influence was found to be between 3.76 and 3.94 (with 3 meaning medium influence and 4 meaning high influence), but no differences were found when comparing the influence among the three organizations. Table 1 displays the mean of each organization when considering paired comparisons. These results are important because they show that participants in fact consider involvement in these organizations as having at least medium and near high overall influence.

Table 1.

Wilcoxon Signed Rank Test: Mean Data

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Pairwise Comparisons	N	Mean of Overall Influence Rating for Organization 1	Mean of Overall Influence Rating for Organization 2	Mean Difference
BGO – NSBE	66	3.80	3.93	-0.13
MEP – BGO	47	3.89	3.76	0.13
MEP – NSBE	195	3.91	3.94	-0.03

Individual Traits: Research Question 2

As shown in figure 1 (question 8), participants evaluated the level of influence an organization had on their attainment of each of the 10 traits. Table 2 displays the mean rating for each of the ten traits across the three organizations.

Table 2:

Mean Rating of Individual Traits Across Organizations

	NSBE	BGO	MEP
Analytical Skills	2.86	2.59	3.22
Ingenuity	3.44	3.46	3.34
Creativity	3.24	3.36	3.10
Communication Skills	3.85	3.59	3.63
Business and Management Skills	3.55	3.33	3.16
Leadership	3.99	3.81	3.52
High Ethical Standards	3.36	3.47	3.28
Professionalism	3.96	3.59	3.58
“Quick” Learner	3.20	3.33	3.32
Desire to be a Lifelong Learner	3.45	3.06	3.28

The Wilcoxon signed-rank test was used to investigate if differences existed among

participants' perceptions (i.e. ratings) of an organization's influence on the development of each trait. Using an alpha value of 0.05, six traits were found to have significant differences among the organizations: analytical, communication, business and management, leadership, professionalism, and high ethical standards.

Results of the Wilcoxon signed-rank test also revealed which organization participants perceived to most influence each of the six statistically significant traits. Based on an alpha of .05, Table 3 below displays which organization uniquely contributed to the development of each trait.

Table 3.

Organization Influence on Individual Traits

Organization	Trait
NSBE	Professionalism ($p = .030, p = .000$), Business & Management* ($p = .000$), Leadership* ($p = .000$), Communication* ($p = .004$)
BGOs	Ethical Standards** ($p = .011$)
MEPs	Analytical ($p = .001, p = .000$)

Note: One asterisk (*) signifies NSBE has greater influence on the trait than MEPs, and two asterisks (**) signifies BGOs have greater influence on trait than MEPs)

Discussion and Implications

The findings of this study suggest a variety of implications for various stakeholders. Campus program directors, organization leaders, as well as student and alumni members can benefit from the results of this study.

Program Directors/Advisors

Empirical evidence that can be used to advocate support

The most apparent implication of this study is that it provides program directors with empirical data to support the effectiveness of minority support programs and organizations. Program directors can leverage this data in discussions with deans and other administrators to strengthen the argument that such programs, like MEPs, play a direct role in the development of the NAE's *Engineer of 2020* traits, which have been shown to align with outcomes stated in the ABET criterion. This data could be useful when advocating for funding and institutional level support because it quantifies the organizations impact on students.

Enhanced Service Portfolio

Directors often keep a current list (portfolio) of all activities and programs their office offers. The findings of this study help tell a story that will support requests for collaboration and funding support with foundations and corporate partners. This research helps show that non-curricular activities can no longer be defined as social activities, but such activities directly impact student outcomes-specifically skill development. For this reason, program directors can include student activities in their service portfolios.

Integrated Programs

With a clearer understanding of the outcomes of student programs and organizations, program directors and advisors can work to more efficiently integrate and co-support organizations. Seminars, conference events, service opportunities, and other activities can be coordinated to offer all students an integrated exposure to activities and opportunities that will maximize their skill development. This integration could make programming efforts more efficient (i.e., decreasing the amount of spending) because fewer events may be required.

Student Recruitment

Program directors can utilize this information to encourage students to take advantage of programs like NSBE, BGOs, and MEPs. Directors can advertise benefits, supported by research, to encourage student involvement. Additionally, directors now have a data driven reply to a common student question: “Why should I participate?” Directors or program advisors can inform new students about the past student’s perceived membership outcomes, utilizing the data as a recruitment tool.

Organizations

Feedback on Organization’s Impact

The quantified perceptions presented in this study help organizations understand how students and alumni are impacted by their various program offerings. The results of this research provide NSBE, BGOs, and MEPs with direct feedback from students and alumni regarding their experiences in the organizations. This data can be used to show empirical evidence to justify that membership in their organizations does make a difference to the development of professional skills. Also, organizations may use these results to collaborate with other organizations to leverage each other’s strengths.

Evaluation of Organization’s Outcomes

Organizations may choose to reexamine their emphasis or refocus some programming efforts. Organizations can utilize these results to compare their mission statements to student and alumni members’ perceived outcomes. For example, NSBE’s mission is “to increase the number of culturally responsible black engineers who excel academically, succeed professionally, and positively impact the community.” Findings suggest that students perceive NSBE as more of an influencer of professional skills than academic related skills; one could

infer that since students did not perceive NSBE as an influencer of analytical skills, NSBE may decide to create more opportunities for participation in programs to foster analytical and other similar skills. Thus, NSBE would enhance a particular component of its mission statement: “to increase the number of culturally responsible black engineers who excel academically.” Future research will examine specific aspects of membership and involvement in these non- curricular activities that will offer evidence-based suggestions for organization leaders to prioritize programming. This will be especially useful in today’s climate of constrained budgets.

Students

Self-governed Learning

These results provide students with proven sources from which to develop *Engineer of 2020* skills, which are necessary to be successful in the future. Students gain self-awareness of their learning and development. Students gain additional motivation to join and maintain membership in said organizations as they aid in professional development.

With this knowledge, students can purposely develop their own checklists and action steps to obtain the skills they need to be successful practicing engineers. Students are able to self-advocate for developing themselves through informal activities. More so, students can make a more informed decision about how to allocate their limited out of class time to activities.

Increased Job Preparation

Moreover, these results allow students to understand how out-of-class involvement links to important professional competencies. Students may need these experiences to complement their coursework in order to develop the depth and breath of competencies necessary to be prepared for the workforce. Through non-curricular activities, students gain broad and

important non- technical skills (i.e., leadership, communication) and analytical skills that are essential for their success as future engineers. Students who take time to develop and articulate how these skills were developed can improve their professional marketability.

Conclusion and Future Work

In this study, a quantitative analysis of both student and alumni perceptions of how non-curricular activities helped develop *Engineer of 2020* traits was performed. Results show that African American engineers perceive their participation in NSBE, BGOs, and MEPs as supportive of their development of six of the ten *Engineer of 2020* traits: analytical, communication, business and management, leadership, professionalism, and ethical standards. The implications of this work are broad and have applications for multiple audiences: program advisors, organization leaders, and students. Implications for program advisors include integrated programs, student recruitment, and an enhanced service portfolio. Organizations can use these results to obtain feedback and assess program outcomes. For students, implications include increased job preparation and self-directed learning.

Future work will include additional quantitative analysis of the level, type, frequency and continuity of involvement as well as detailed qualitative analysis aimed at gaining in-depth knowledge of the specific contributions each organization makes to the development of the *Engineer of 2020* traits. Our future work will tease out how each organization helps develop the *Engineer of 2020* traits, addressing the specific experiences that members encounter that enable trait development. Both the quantitative and qualitative portions of this analysis can be used to form the basis for future studies seeking to understand the impacts of programming and other retention strategies on student outcomes.

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