The Effect of Clusters of Participation in Engineering Co-curricular Activities on Student Outcomes

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What Affects Student Outcomes More: GPA or participation in co-curricular activities?

Abstract
In this research paper, we examine how grade point average (GPA) and student participation in engineering-related co-curricular activities contribute to social, academic, and professional outcomes at a large public Midwestern R1 engineering college. The outcomes in this study where chosen specifically because we hypothesized that they would be influenced by such participation, and include Bonding Social Capital, Bridging Social Capital, Major Satisfaction, Engineering Identity, and Intent to Persist. Confirmatory Factor Analysis shows excellent construct validity for all scales except for one, which was removed from further analysis. As previously demonstrated, our analysis confirms that participation in co-curricular activities is always related to higher levels on every outcome scale regardless of the type of organization. Furthermore, participants have higher GPAs than non-participants. Linear regression modeling revealed the influence of specific types of organizations and GPA on individual outcomes. A linear regression model that predicts each of the four outcomes was constructed to consider the type of activity and GPA. This analysis shows that all outcomes depend on some combination of type of participation and GPA. Only Bonding Social Capital depends on all types of participation and GPA. Bridging Social Capital is predicted by the participation in the types of organizations whose mission is outward facing, but not on GPA. Engineering Identity depends on GPA and participation in organizations that are related to the engineering enterprise. Only Major Satisfaction is predicted by GPA alone, and not on participation in any of type of organizations. This research shows that even though all the studied outcomes are higher for those who participate in some co-curricular activity, the type of organization and GPA are also influential.

Introduction

Students' experiences in college, both in and out of the classroom, can have a significant impact on their success during college and later in life. For example, results from the National Survey of Student Engagement (NSSE, 2018) consistently show that there is a positive relationship between participation in co-curricular activities and academic performance. Initially, many researchers studied how participation in co-curricular activities resulted in the increase in persistence to graduation [1], [2]. More recently, researchers have shown that such participation is related to positive outcomes across a wide range of dimensions, including social capital and belonging [3], design [4], [5], teamwork [4]–[6], communication [4], [6], [7], ethics [8], and leadership [4], [9]. This paper examines the relationships between participation in a variety of types of co-curricular activities and a number of social, academic, and professional outcomes.

Conceptual Framework

Figure 1 shows a schematic of the conceptual framework guiding this work (Authors, submitted). It is largely based on Astin's Input-Environment-Output theory [10] and Weidman's conceptual framework of Undergraduate Socialization [11], [12]. Astin, Weidman, and others hypothesized that student *Background Characteristics* (e.g, demographics characteristics such as gender, ethnicity, as well as other pre-college personal attributes) effect *Socialization Outcomes* (e.g., eg: post-college aspirations), and that they are mediated by *Collegiate Experiences*. Weidman's conceptual framework identifies two categories of Collegiate Experiences: *Socialization Processes* and *Normative Contexts*. Socialization Processes are those through which students learn community norms and expectations. Normative Contexts are the various academic and social settings that students experience, including academic departments, student residences, and extra- and co-curricular activities. Weidman's model also considers the influence of family and friends he terms *Personal Communities,* and non-familial communities he terms *Occupational Communities,* such as employers and community organizations. Our contributions to this framework are to operationalize certain student characteristics, including the college preparatory activities before entering college and specific socialization processes that students display, and socialization processes, including proactive behaviors displayed by students once the get on campus (Authors, submitted) Through this research, we found that typical engineering-related co-curricular activities fall into four major types: competition and design teams (e.g.: Solar Car Team, Baja Racing), professional societies (e.g.: Tau Beta Pi, American Institute of Chemical Engineers), identity-based organizations (e.g.: Society of Women Engineers, National Society of Black Engineers), and college-run organizations (e.g.: Engineering Student Government, Peer Mentoring Program) (Authors, submitted).

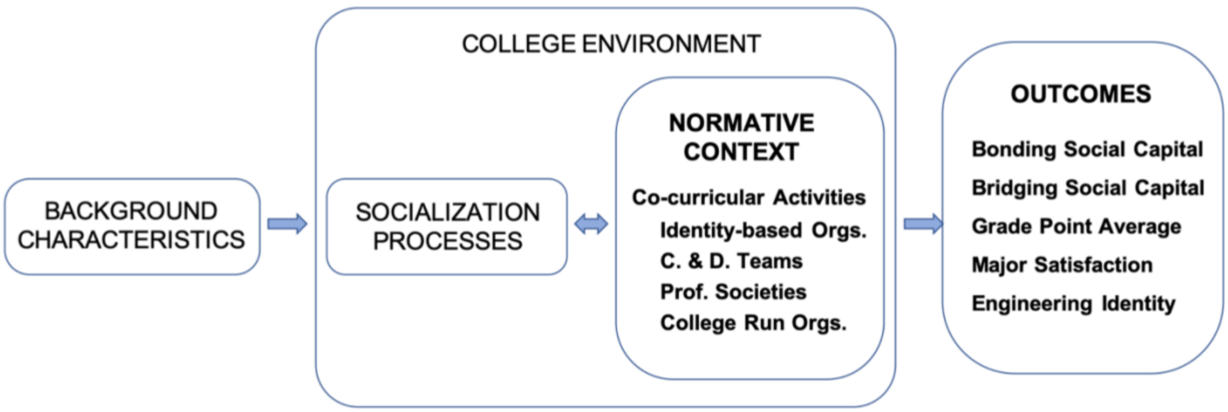

Figure 1: Conceptual framework used in this work. The capitalized text indicates the primary elements of Weidman's model. Bolded text denotes the factors considered in our current research questions.

In this paper, we focus on specific components of the framework, namely the interaction between participation in co-curricular activities and socialization outcomes (bolded in Fig. 1). Both Astin and Weidman consider outcomes from a broad range of categories, including post-college career choices, lifestyle preferences, aspirations, and values, but don't specifically name individual outcomes or dictate how to operationalize them within their frameworks. In this work, we chose to study aspects of social, academic, and professional outcomes, specifically as they pertain to outcomes that we believe may be influenced by participation in co-curricular activities. We took existing instruments from the literature and operationalized them for this context. For social outcomes, we chose to measure social capital, or the productive benefits derived from an individual's social network [13] that we believed could be impacted by participation in co-curricular activities. We also wanted to know how academic outcomes, such as performance, i.e.: grade point average (GPA), and major satisfaction [14] would be affected by such participation. Finally, we wished to understand whether participation in co-curricular activities influenced professional outcomes, including engineering identity [15] and the intention to persist in engineering. [16]

Research Questions

In this paper we examine how student participation in specific co-curricular activities contribute to social, academic, and professional outcomes. Because we took existing outcomes instruments from the literature, a portion of this paper focuses on their operationalization and validation for our context. We also examine the following research questions:

1. Comparing participation in any co-curricular activities to non-participation, are different
    a. social and professional outcomes observed?
    b. Grade Point Averages (GPAs) observed?
2. What are the relationships between the type of participation and GPA on outcomes?

Table 1: Distribution of the demographics and socioeconomic status within the survey sample, sample frame, and national engineering R1 institutions.

	Survey Sample (%) N = 870	**Sampling Frame (%)** N = 4022	**National Sample[a] (%)**
Female	362 (41.6)	1033 (25.7)	(24.0)
URM	81 (9.3)	711 (17.7)	(20.0)
White	459 (52.8)	2202 (54.7)	(63.4)
Asian/American Asian	250 (28.7)	1109 (27.6)	(15.7)
International	58 (6.7)	540 (13.4)	(8.8)
Low Income	116 (13.3)[b]	458 (11.4)[b]	(25.3)[c]
First Gen	106 (12.2)	578 (14.4)	(31.1)

[a] National data from U.S. Department of Education, National Center for Education Statistics, 2015 – 16 National Postsecondary Student Aid Study (NPSAS:16) for graduating seniors from a bachelor's degree program in 2015 – 16 with a major field of study in engineering or engineering technology.

[b] Percentage of students with a family income less than $65,000 based on the survey.

[c] Estimate represents percentage of students with a family income less than $63,000 based on the NCES.

Survey Sample

We invited 4,022 third- and fourth-year undergraduate engineering students at a large public Midwestern R1 university to complete the survey, and received 870 completed responses. Table 1 compares the demographics and socioeconomic status of the survey sample (the completed respondents), the sampling frame (all the students who received the survey), and estimates of the national population of engineering students at Carnegie-classified research institutions obtained from the National Center for Education Statistics (NCES). The survey sample was approximately representative of the sampling frame, except that females were overrepresented consistent with the finding of Porter and Whitcomb [17], and underrepresented minorities (URM) and international students were under represented. Compared to the national average, our institution has a higher proportion of Asian and international students, but a lower proportion of low income and first-generation students.

Table 2: Distribution of the demographics and socioeconomic status for non-participants, all participants, and participation in each type of organization. Statistical significance is indicated between all participants and non-participants, or between participation in each type of organization and non-participants.

	Non-participants (%) **N = 237**	**Participants (%)** **N = 633**	**Identity-based (%)** **N = 166**	**Professional (%)** **N = 276**	**Design/ Competition (%)** **N = 384**	**College-run (%)** **N = 116**
Female	65 (27.4)	297 (46.9) ***	147 (88.6) ***	127 (46.0) ***	161 (41.9) ***	66 (56.9) ***
URM	18 (7.6)	63 (10.0)	29 (17.5) **	20 (7.2)	32 (8.3)	12 (10.3)
White	128 (54.0)	331 (52.3)	82 (49.4)	155 (56.2)	195 (50.8)	63 (54.3)
Asian/American Asian	66 (27.8)	184 (29.1)	38 (22.9)	75 (27.2)	122 (31.8)	27 (23.3)
International	24 (10.1)	34 (5.4) *	6 (3.6) **	11 (4.0) **	14 (3.6) **	8 (6.9)
Low Income	34 (14.3)	82 (13.0)	24 (14.5)	30 (10.9)	54 (14.1)	15 (12.9)
First Gen	25 (10.5)	81 (12.8)	23 (13.9)	26 (9.4)	42 (10.9)	18 (15.5)

* indicates p-value < 0.05, ** indicates p-value < 0.01, and *** indicates p-value < 0.001

Types of Participation

The survey asked students whether they were currently involved or had ever been involved in an engineering-related organization. Students who indicated that they had participated in such an organization were then asked to submit the names of no more than five of which they were most involved. We also asked additional questions about their participation in each listed organization, including how they became interested in joining the group, what their reasons were for joining, and how active they were in the organization. We classified each of these organizations by type--competition and design teams, professional societies, identity-based organizations, and college-run organizations (Authors, submitted). Table 2 shows the demographic breakdown of the respondents for each type of participation. We ran t-tests on each of the demographic groups (e.g.: sex, URM, etc.) and socioeconomic status indicators (e.g.: low income, first generation) between participants and non-participants, as well as between participants in a particular type of organizations and non-participants. There is a statistically significantly higher proportion of women and URM reporting participation in co-curricular activities, especially in identity-based groups. Perhaps unsurprisingly, international students report statistically significantly lower rates of participation. We find no significant differences in participation or non-participation for low-income and first generation students compared to their higher-income and continuing-generation peers, in contrast to other reports [18]–[21].

Outcomes Scale Adaptation

The survey used several scales related to social, academic, and professional outcomes. The two social outcomes scales measure the amount of social capital held by individual students, either within their social circle (Bonding Social Capital- 10 questions) or between social circles (Bridging Social Capital- 10 questions) [13]; the academic outcome scale measures the degree to which students are satisfied with their academic major (Major Satisfaction- 6 questions) [14], and the two professional outcomes scales are related to professional identity, the degree to which they identify as engineers (Engineering Identity- 7 questions) [15] and intend to continue within the profession (Intent to Persist- 4 questions) [16]. The wording of the items was kept the same as the originals as much as possible, except when referring to the College of Engineering. All the scales were on a 7-point Likert scale (0 through 6). Confirmatory Factor Analysis of these scales (Appendix) shows good ($0.80 < \alpha < 0.90$) to excellent ($\alpha > 0.90$) construct validity for all the outcomes except for the Intent to Persist scale, which was removed from further analysis. We also study an additional academic variable, the GPAs of individual students, which were taken from the institutional database.

Analytical Methods

To answer the first question about differences in outcomes between participation in any co-curricular activities and non-participations, we computed the mean value as well as the standard deviation of each outcome of two groups of students, non-participants and all participants. We also conducted t-test to see whether there is significant difference in means of outcome between these two independent groups.

We are also interested in examining the relationships to outcomes between the different subpopulations within the all participants group, namely participants in the specific types of organizations. Because these populations are not necessarily independent, we cannot use a simple t-test and must use a linear model. To examine the relationship between outcomes and types of participation and GPA, we built a series of linear regression models each of which uses involvements in four types of participation and GPA as independent variables, and one individual outcome as dependent variable. We denoted students' outcome by O_k, where k denotes the k-th outcome, and type of students' participation by P_i, where *i* denotes the *i*th type of participation. As each outcome consists of multiple items, we took the average of the Likert scales for the items and defined it as the score of one outcome. Therefore, O_k is a continuous variable that takes any value in the range of 0 and 6. P_i is a binary categorical variable with 1 indicating involvement in a particular type of organization. Rather than using the GPA, we chose to define the variable GPA_{ave} as the average GPA for better interpretation of the intercepts. Thus, the outcome O_k may be modeled using the equation:

$$O_k = \beta_0 + \beta_G \cdot GPA_{ave} + \sum_i \beta_i \cdot P_i$$

where β_0 is the expected outcome for non-participating students having an average GPA, β_G is the change in expected outcome with GPA, and β_i is the change in the expected outcome with participation in the *i*th type of organization. Therefore, the expected outcome for a student with an average GPA involved in one type of co-curricular organization is $\beta_0 + \beta_i$.

Results

Research question 1 asks whether there are different social, professional, and academic outcomes observed for participation in any co-curricular activities compared to non-participation. Research question 1a further parses the question to focus only of the outcomes measured by our survey: bonding social capital, bridging social capital, engineering identity, major satisfaction, and intent

Table 3: Average scores and standard deviations for outcomes (on a 7-point Likert scale) for non-participants, all participants, and participants in each type of organization. Significance compares all participants to non-participants. N is the number in each group, and d is Cohen's effect size.

	N	Social Bridging	d	Social Bonding	d	Engineering Identity	d	Major Satisfaction	d
Non-participants	237	3.7 ±1.1		3.2 ±1.3		4.3 ±1.1		4.3 ±1.3	
All Participants	633	4.3 ±1.0 ***	0.6	3.8 ±1.1 ***	0.5	4.8 ±0.9 ***	0.5	4.6 ±1.2 **	0.3

** indicates p-value < 0.01, and *** indicates p-value < 0.001

Table 4: Average GPA for non-respondents, non-participants, and participants Significance compares all participants to non-participants. N is the number in each group, and d is Cohen's effect size.

	N	GPA	d
Non-respondents	3000[a]	3.31 ± 0.48	
Respondents	998[b]	3.39 ± 0.41***	0.2
Non-participants	237	3.34 ± 0.41	
Participants	633	3.42 ± 0.41*	0.2

* indicates p-value < 0.05, and *** indicates p-value < 0.001

[a] Among 3024 non-respondents, 3000 of them had valid GPA record when we conducted the survey.

[b] We received 998 responses, 870 of which were complete.

Table 5: Linear regression models for various outcomes as a function of type of participation and GPA. R^2 is the goodness-of-fit.

	Social Bridging	Social Bonding	Engineering Identity	Major Satisfaction
R^2_{adj}	**0.068 *** **	**0.085 *** **	**0.057 *** **	**0.039 *** **
Intercept	3.83 ***	3.33 ***	4.44 ***	4.39 ***
Identity-based	0.14	0.22 *	0.06	0.13
Professional	0.36 ***	0.42 ***	0.20 **	0.16
Competition	0.29 ***	0.20 **	0.34 ***	0.08
College-run	0.41 ***	0.54 ***	0.12	0.03
GPA	-0.05	0.29 **	0.27 ***	0.56 ***

* indicates p-value < 0.05, ** indicates p-value < 0.01, and *** indicates p-value < 0.001

to persist. Since the CFA showed that the intent to persist scale does not meet the criteria for construct validity in this context, it was removed from further analysis. Our analysis on the remaining outcomes scales confirms that participation in co-curricular activities is related to higher mean values. Table 3 shows the summary statistics for the mean outcomes for non-participants and all participants. T-tests show that participating is related to statistically significantly higher levels, at least 0.3 (5%), on every outcome scale. Cohen's effect size (d) is defined as the difference between two means divided by a standard deviation for the data, and is a measure of the size of an effect relative to the variability in the population [22]. In this study, three out of the four outcomes have a medium effect size ($d \geq 0.5$), indicating a reasonable effect size. The exception is Major Satisfaction, which has a small effect size ($d \geq 0.2$). Research question 1b asks specifically whether there are different GPAs observed for any participation in co-curricular activities compared to non-participation. Our analysis shows that there are significant differences between the GPAs of the respondents and non-respondents, and all participants and non-participants (Table 4), though the effect size is small ($d \geq 0.2$). Respondents have approximately 0.08 (2%) higher GPAs than non-respondents, and all participants have approximately 0.08 (2%) higher GPAs than non-participants. The fact that these two values are the same is likely a coincidence.

Research question 2 asks about the relationships between the participation in various types of organization and GPA on outcomes. Because students may participate in more than one organization, the subpopulations of students participating in each type of organization is not independent. Furthermore, there are some organizations that have minimum GPA requirements (some professional organizations and the Honors Program, for example). Thus, a series of linear models must be constructed to take these factors into account. The relationships and their significance vary depending on the outcome, as shown in Table 5. The only outcome that can be predicted by both GPA and participation, regardless of type, is Bonding Social Capital. Major Satisfaction is only predicted by GPA, and not by participation in co-curricular organization regardless of type. Bridging Social Capital is not related to GPA, but is by all types of participation except for participation in identity-based organizations. Engineering Identity is also predicted by both GPA and participation in some types of organizations.

Discussion

We show that the outcomes for participation in any co-curricular activities are always higher compared to non-participation, in agreement with published research [4], [9], [23], [24] The fact that Bonding Social Capital is predicted by participation in any type of organization and GPA is unsurprising. Bonding Social Capital is defined as the benefits derived through relationships within an individual's social circle and the literature shows that a common reason to join these groups is to make personal connections [25]. At first glance, the relationship between Bonding Social Capital and GPA may be unexpected, but the literature has several examples where this is true [26], [27]. A possible explanation is that students with strong social ties within in an academic setting, such as a co-curricular organization, are more likely to spend time studying together [27]. Similarly, participation in engineering-related co-curricular activities may act to shape participants' behaviors such that studying and doing well in class becomes the social norm.

That GPA is strongly correlated to Major Satisfaction has been reported in previous research [28] and easy to understand. It seems obvious that a student who is satisfied in their major will likely work harder and perform better in courses than those who are not. Similarly, students who earn good grades seem more likely to be satisfied with their choice of major than those who do not. It is more surprising that major satisfaction is not related to participation in co-curricular activities. Cox and co-workers [29] showed that that engagement is related to major satisfaction, which suggests that participation in co-curricular activities, especially those that are directly tied to disciplinary expertise such as competition teams for example, might lead to an increased appreciation for the discipline. This was not the case here.

Bridging Social Capital, or the weaker bridging ties the can provide additional resources beyond the immediate personal network [26], [30], is not related to GPA but is predicted by all types of participation except for participation in identity-based organizations. Dika [27] showed that an important component in Bridging Social Capital is the quality of the student-faculty relationship. Indeed, it can be argued that the student-faculty relationship is vital in professional societies, competition teams, and college-run organizations. Furthermore, interactions between organizations is also key. Individual competition teams often must share resources like machine rooms and testing equipment; individual professional societies collaborate on various events over the course of the year; college-run organizations often have strong ties across academic units and professional programs. The fact that identity-based organizations do not have a significant relationship with Bridging Social Capital may be because they have a more inward mission to serve their own members.

Engineering Identity is related to both GPA and participation in some types of organizations. This link with GPA has been previously reported [31], and is not surprising. It's straightforward to assume that students who do well in engineering courses would identify more readily as engineers. It is also expected that those organizations with a strong focus on the engineering enterprise, like competition and design teams and professional societies, are also associated with Engineering Identity. Organizations that are less directly associated with engineering practice, like identity-based and college-run organizations, are not associated with Engineering Identity.

Limitations

There are several limitations that limit the generalizability of this work. The first has to do with the nature of the sample. This is a single institution study, and the institution itself is not a typical national engineering school. The number of low income and first-generation students is lower at our institution, but the proportion of Asian and international students is higher. The second limitation has to do with the model fit. The adjusted R-squared (Table 5) are quite low ($0.035 < R_{adj2} < 0.090$), suggesting that there are other factors that predict these outcomes. Indeed, we have not considered the roles of other aspects of our conceptual framework (Fig. 1), such as background characteristics, socialization processes, or other normative contexts. Furthermore, we do not consider the intensity and frequency of participation on outcomes in this paper. Finally, the way in which the organizations were categorized into types may lead to ambiguity. For instance, there are several organizations like the Society of Women Engineers that are both identity-based and professional societies. In this work, we parsed them only into the identity-based type because we found that they had socialization processes more like that type than to the professional society type (Authors, submitted). Also, the college-run organizations, consisting of activities ranging from peer mentoring groups to the Honors Program, is very heterogeneous in nature, which may also lead to some ambiguity.

Conclusions and Future Work

In this work, we examined the relationships between specific types of participation, namely identity-based organizations, competition teams, professional societies, an college-run organizations, and various social, academic, and professional outcomes. Using scales from the literature, we measured Bonding and Bridging Social Capital, GPA, Major Satisfaction, Engineering Identity, and the Intention to Persist in engineering. A major portion of this paper focuses on the operationalization and validation of each of these scales for our context. All exhibited very good to excellent construct validity for all the outcomes except for the Intent to Persist scale, which was removed from further analysis.

Our analysis confirms that participation in co-curricular activities is beneficial on outcome and GPA. Students who participate in any activity see a gain of at least 0.3 (on a 7 point scale) for each outcome, and an increase by 0.08 (on a 4 point scale) in GPA. Linear regression modeling shows that the relationships between types of participation and GPA differ for each of the specific outcomes. All outcomes studied in this work depend on some combination of type of participation and GPA. Only Bonding Social Capital depends only on all types of participation and GPA. Bridging Social Capital is predicted by the participation in the types of organizations whose mission is outward facing, but not on GPA. Engineering Identity depends on GPA and participation in orgs that are related to the engineering enterprise. Only Major Satisfaction is predicted by GPA alone, and not on participation in any of type of organizations.

There are several implications for this work. Students who wish to make friends and strengthen their social bonds can join any type of organization and have those outcomes achieved. Furthermore, their GPAs are likely to be higher. A question that remains to be resolved is if higher GPAs for participants is due to the expectations within the organizations of higher academic achievement, or some other factor. Another implication of this work is that students who wish to enhance their identity as engineers ought to join organizations like competition teams or professional societies. Engineering Identity is also related to higher GPAs, perhaps for similar reasons as for Bonding Social Capital. A final implication is that student who wish to be more satisfied with their major need only achieve higher grades, as opposed to participate in any of the activities studied here. It could be that more discipline-specific activities, such as research with a faculty member with the department, could be related to Major Satisfaction.

Future work will involve digging deeper into other aspects of participation that may affect outcomes, and connecting the results found here with other portions of the framework. The fairly low goodness-of-fit values in all of the linear regression models suggests that there are other factors that contribute to these outcomes. There are additional items related to participation that were not included in these analyses, such as the frequency of participation and total number of participations. Furthermore, other aspects of our conceptual framework, such as background characteristics (e.g.: demographics and college knowledge), socialization processes (e.g.: proactive behaviors), or other normative contexts (e.g.: course taking patterns, participation in non-engineering related organizations) ought to be considered.

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Appendix

Confirmatory Factor Analysis of the outcome scales adapted for this study.

	α	Est.	Std. Err.
Major Satisfaction	0.89		
I often wish I hadn't gotten into my major.		1.198	0.044
I wish I were happier with my choice of an academic major.		1.333	0.049
I am strongly considering changing to another major.		0.839	0.04
Overall, I am happy with the major I have chosen.		0.999	0.034
I feel good about the major I have selected.		1.013	0.034
I would like to talk to someone about changing my major.		0.81	0.04
Engineering Identity	0.89		
My parents see me as an engineer.		0.88	0.039
My classmates see me as an engineer.		0.967	0.035
My peers see me as an engineer.		0.965	0.036
I have had experiences in which I was recognized as an engineer.		0.984	0.04
I am interested in learning more about engineering.		0.909	0.038
I enjoy learning engineering.		0.949	0.034
I find fulfillment in doing engineering.		0.993	0.037
Intent To Persist	0.64		
I intend to complete a major in engineering.		0.38	0.031
I have considered/am considering changing my major to a non-engineering discipline.		1.34	0.056
I have considered/am considering changing my major to a different engineering discipline.		1.31	0.056
I have considered/am considering changing my major to a different engineering discipline.		0.54	0.079
Social Capital - Bonding	0.89		
There are several people in the College of Engineering (e.g., friends faculty, staff) I trust to help solve my problems.		1.039	0.04
There is someone in the College of Engineering I can turn to for advice about making very important decisions.		1.068	0.042
There is no one in the College of Engineering that I feel comfortable talking to about intimate personal problems.		1.009	0.048
When I feel lonely, there are several people in the College of Engineering with whom I can talk.		1.18	0.044

If I needed an emergency loan of $500, I know someone in the College of Engineering who would help.		1.092	0.05
The people I interact with in the College of Engineering would put their reputation on the line for me.		1.029	0.044
The people I interact with in the College of Engineering would be good job references for me.		0.845	0.041
The people I interact with in the College of Engineering would share their last dollar with me.		1.015	0.046
I do not know people in the College of Engineering well enough to get them to do anything important.		1.011	0.046
The people I interact with in the College of Engineering would help me fight an injustice.		0.887	0.04
Social Capital - Bridging	0.92		
Interacting with people in the College of Engineering (e.g., friends faculty, staff) makes me interested in things that happen outside of my town.		0.993	0.037
Interacting with people in the College of Engineering makes me want to try new things.		0.935	0.036
Interacting with people in the College of Engineering makes me interested in what people unlike me are thinking.		0.975	0.038
Talking with people in the College of Engineering makes me curious about other places in the world.		1.04	0.039
Interacting with people in the College of Engineering makes me feel like part of a larger community.		1.037	0.038
Interacting with people in the College of Engineering makes me feel connected to the bigger picture.		1.092	0.039
Interacting with people in the College of Engineering reminds me that everyone in the world is connected.		1.087	0.041
I am willing to spend time to support general College of Engineering community activities.		0.907	0.04
Interacting with people in the College of Engineering gives me new people with whom I can talk.		0.896	0.035
In the College of Engineering, I come in contact with new people all the time.		0.815	0.04

References

[1] G. D. Kuh, “In Their Own Words: What Students Learn Outside the Classroom,” *Am. Educ. Res. J.*, 1993.

[2] M. Wassenaar and T. Major, “Ties that bind,” *Junctures*, vol. 2017, no. 18, pp. 48–52, 2017.

[3] D. R. Simmons, E. G. Creamer, and R. Yu, “Involvement in Out-of-Class Activities : A Mixed Research Synthesis Examining Outcomes with a Focus on Engineering Students,” *J. STEM Educ.*, vol. 18, no. 2, pp. 10–17, 2017.

[4] T. Kinoshita, G. Young, and D. B. Knight, “Learning after learning: Perceptions of engineering alumni on skill development,” *Proc. - Front. Educ. Conf. FIE*, vol. 2015-Febru, no. February, 2015.

[5] L. C. Strauss and P. T. Terenzini, “The Effects of Students’ In- and Out-of-Class Experiences on their Analytical and Group Skills: A Study of Engineering Education,” *Res. High. Educ.*, vol. 48, no. 8, pp. 967–992, Dec. 2007.

[6] G. Young, D. B. Knight, and D. R. Simmons, “Co-curricular experiences link to nontechnical skill development for African-American engineers: Communication, Teamwork, Professionalism, Lifelong Learning, and Reflective Behavior Skills,” in *2014 IEEE Frontiers in Education Conference (FIE) Proceedings*, 2014.

[7] H. K. Ro and D. B. Knight, “Gender Differences in Learning Outcomes from the College Experiences of Engineering Students,” *J. Eng. Educ.*, vol. 105, no. 3, pp. 478–507, 2016.

[8] C. J. Finelli *et al.*, “An Assessment of Engineering Students’ Curricular and Co-Curricular Experiences and Their Ethical Development,” *J. Eng. Educ.*, vol. 101, no. 3, pp. 469–494, Jul. 2012.

[9] D. B. Knight and B. J. Novoselich, “Curricular and Co-curricular Influences on Undergraduate Engineering Student Leadership,” *J. Eng. Educ.*, vol. 106, no. 1, pp. 44–70, 2017.

[10] A. W. Astin, “Student Involvement : A Developmental Theory for Higher Education,” *J. Coll. Stud. Dev.*, vol. 518, 1984.

[11] J. C. Weidman, “Undergraduate socialization: A conceptual approach,” *High. Educ. Handb. theory Res.*, no. Volume 5, pp. 289–322, 1989.

[12] J. C. Weidman, L. Deangelo, and K. A. Bethea, “Understanding Student Identity From a Socialization Perspective,” in *New Directions for Higher Education*, no. 166, Wiley Periodical Inc., 2014, pp. 43–51.

[13] D. Williams, “On and Off the ’Net: Scales for Social Capital in an Online Era,” *J. Comput. Commun.*, vol. 11, no. 2, pp. 593–628, 2006.

[14] M. M. Nauta, “Assessing college students’ Satisfaction with their academic majors,” *J. Career Assess.*, 2007.

[15] A. Godwin, “The development of a measure of engineering identity,” *ASEE Annu. Conf. Expo. Conf. Proc.*, vol. 2016-June, 2016.

[16] N. A. Mamaril, E. L. Usher, C. R. Li, D. R. Economy, and M. S. Kennedy, “Measuring Undergraduate Students’ Engineering Self-Efficacy: A Validation Study,” *J. Eng. Educ.*, vol. 105, no. 2, pp. 366–395, 2016.

[17] S. R. Porter and M. E. Whitcomb, “Non-response in student surveys: The role of demographics, engagement and personality,” *Res. High. Educ.*, vol. 46, no. 2, pp. 127–152, 2005.

[18] C. A. Lundberg, L. A. Schreiner, K. Hovaguimian, and S. Slavin Miller, “First-Generation

Status and Student Race / Ethnicity as Distinct Predictors of Student Involvement and Learning," *NASPA J.*, vol. 44, no. 1, p. 57, 2007.
[19] M. C. Manley Lima, "Commuter Students' Social Integration : The Relationship Between Involvement in Extracurricular Activities and Sense of Belonging," George Washington University, 2014.
[20] E. T. Pascarella, "How College Affects Students: Ten Directions for Future Research," *J. Coll. Stud. Dev.*, vol. 47, no. 5, pp. 508–520, 2006.
[21] G. R. Pike, G. D. Kuh, and R. M. Gonyea, "The Relationship Between Institutional Mission And Students ' Involvement And Educational Outcomes," *Res. High. Educ.*, vol. 44, no. 2, pp. 241–261, 2003.
[22] J. Cohen, *Statistical Power Analysis for the Behavioral Sciences*. Routledge, 1988.
[23] "Engagement insights: Survey findings on the quality of undergraduate education," 2018.
[24] D. R. Simmons and N. J. Hunsu, "Development of a Survey to Explore Out-of-Class Engagement of Engineering Students *," vol. 33, no. 4, pp. 1213–1221, 2017.
[25] P. Holzweiss, R. Rahn, and J. Wickline, "Are All Student Organizations Created Equal? The Differences and Implications of Student Participation in Academic versus Non-Academic Organizations," *Coll. Student Aff. J.*, vol. 27, no. 1, pp. 136–150, 2007.
[26] N. D. Martin, "Social capital, academic achievement, and postgraduation plans at an elite, Private University," *Sociol. Perspect.*, vol. 52, no. 2, pp. 185–210, 2009.
[27] S. L. Dika, "Bonds and Bridges: The Relative Importance of Relations with Peers and Faculty for College Student Achievement," in *2008 Association for Institutional Research Forum*, 2008.
[28] A. Milsom and J. Coughlin, "Examining Person–Environment Fit and Academic Major Satisfaction," *J. Coll. Couns.*, vol. 20, no. 3, pp. 250–262, 2017.
[29] D. W. Cox, A. L. Bjornsen, T. S. Krieshok, and Y. Liu, "Occupational Engagement and Academic Major Satisfaction: Vocational Identity's Mediating Role," *Career Dev. Q.*, vol. 64, no. 2, pp. 169–180, 2016.
[30] R. S. Burt, *Structural Holes*. Cambridge, MA: Harvard University Press., 1992.
[31] M. Scheidt, R. Senkpeil, J. Chen, A. Godwin, and E. Berger, "SAT Does Not Spell Success: How Non-Cognitive Factors Can Explain Variance in the GPA of Undergraduate Engineering and Computer Science Students," *Proc. - Front. Educ. Conf. FIE*, vol. 2018-Octob, pp. 1–5, 2019.