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Development of a Survey to Explore Out-of-Class Engagement of Engineering Students*

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This study describes the development and validation of the Postsecondary Student Engagement (PosSE) Survey, an inventory designed to assess indicators of affective engagement associated with student disposition toward their academic discipline, career and themselves, other students, and faculty. The PosSE Survey was developed to elucidate the relationships between STEM students' out-of-class activity involvement, factors that influence such involvement, and their perceptions of their learning outcomes. Two rounds of reliability analysis and exploratory factor analysis (EFA) were conducted on data from 129 survey respondents. The first analysis examined the internal consistency of the original items developed to assess each construct of the PosSE Survey and validate the instrument. We re-analyzed Cronbach's coefficient alpha of each construct on the instrument after the EFA to examine how the items and related latent constructs were improved in terms of internal consistency reliability. These analyses provided results that helped develop and validate the 27 items and 7 factors of the PosSE Survey. Future work requires wider survey distribution and larger sample sizes so that data can be used to create a more nuanced profile of student engagement, particularly among underrepresented student populations.

Keywords: co-curricular activities; extracurricular activities; engagement; instrument development

1. Introduction

Student engagement encompasses all academic and non-academic aspects of students' learning experiences [1]. Chen and colleagues defined student engagement as the degree to which learners engage with educational activities [2]. It is also portrayed as "the quality of effort students themselves devote to educationally purposeful activities that contribute directly to desired outcomes" [3, p. 555]. Student engagement has been linked with such desirable outcomes as perseverance, academic performance, satisfaction, retention, and graduation rate [2, 4, 5]. Within the classroom, students are deemed engaged depending on the quality of their involvement in such activities as studying, practicing, obtaining feedback, analyzing and solving problems, and interacting with people within their learning community [6].

Although student engagement is often thought of in light of students' involvement in classroom-related activities, research has also shown that the way students engage with co-curricular and extracurricular activities also impacts their entire educational experience [7]. A large body of literature has focused on the impact of student involvement in all aspects of college on a number of desirable educational outcomes. Students' engagement in out-of-class activities has been linked with better cumulative grades [8–10]; improved analytical, group, and leadership skills [11, 12], increased student-faculty interaction [13], ethical development [14], and greater interest in pursuing and remaining in engineering careers [10, 15, 16].

In general, researchers struggle to determine the most appropriate definition of student engagement due to its multifaceted nature. Fredrick, Blumenfeld, and Paris conceptualized three dimensions of engagement: behavioral, emotional, and cognitive [17]. Each type of engagement defines aspects of students' involvement with curricular and extracurricular activities and has significant impact on learning outcomes as well as student retention or dropout from school [7, 18]. Emotional (or affec-

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tive) engagement has been shown to significantly influence students' cognitive and behavioral engagement. When students feel positive affection about school, they are more likely to be motivated to engage with their learning activities, while students who are less emotionally engaged with school are more likely to be less engaged in behaviors that promote positive learning outcomes and could be less cognitively engaged with learning tasks in the classroom [19, 20].

Due to the centrality of students' affective engagement to both behavioral and cognitive engagements, in addition to a range of positive learning outcomes, being able to objectively assess affective engagement has significance for research in education. A number of engagement inventories have been developed. Some inventories measuring different learning and motivation constructs also include sub-scales assessing one or two constructs associated with student engagement. For example, the Motivated Strategies for Learning Questionnaire (MSLQ) contains a few sub-scales measuring aspects of cognitive and behavioral engagement [21, 22], while other inventories broadly measure more constructs associated with student engagement (e.g., National Survey of Student Engagement and the School Engagement Measure) [23, 24]. Most of these instruments do not capture indicators of affective engagement that are associated with students' sense of belonging in school and their relationship to others in school. Having a sense of academic belonging and students' relationship with others in school plays a prominent role in their ability to engage with classroom and out-of-classroom activities [25] and influences students' determination to succeed in school and enhance personal development. We envisage that such an inventory will be a notable contribution to the research on student engagement in educational research.

1.1 Purpose of this study

In this study, we describe the development and validation of an inventory designed to assess indicators of student engagement. The Postsecondary Student Engagement (PosSE) Survey was designed to assess indicators of affective engagement associated with student disposition toward school, other students, and faculty. We developed and administered this survey to ask students about the out-of-school activities they have participated in, reasons that prompted or prevented them from participating in out-of-school activities, and the outcomes they perceive to have resulted from their participation in those activities. The survey also included 27 items that assessed students' sense of affective engagement with school and their learning community. The items in the later section of the questionnaire were designed to measures students' sense of belonging and relationships with others in their learning community, which are important indicators of affective engagement. Additional details on initial survey development are provided elsewhere [26].

2. Methods

In this study, those items on the questionnaire designed to assess indicators of affective engagement were examined using exploratory factor analysis (EFA) to identify the number of factors associated with affective engagement as well as to establish the construct validity of those factors. Conducting EFA demonstrates the construct validity of a sub-scale by reducing the sub-scale to the number of variables that best account for a pattern of correlations among items comprising the scale [27]. We also conducted reliability analysis to determine the internal consistency of each sub-scale. The coefficient of internal consistency reliability, Cronbach's alpha, indicates how consistent a set of test items is in measuring a single dimensional construct [28]. Cronbach's alpha of 0.7 or more is commonly desired [29, 30].

2.1 Data collection and participant selection

The data for this pilot study were collected from a convenience sample of undergraduate and graduate students at a predominately white institution located in a Mid-Atlantic university in the United States. Because we were particularly interested in the participation of groups traditionally underrepresented in STEM fields, we chose an institution that has a significant number of women in their STEM programs. The instrument was administered online through existing listservs at the university, college, and departmental levels. Several instructors were asked to announce the survey during class and to encourage their students to complete the survey. Survey participants were entered into a drawing for gift cards. Students' responses are explored to examine the internal consistency, stability, and construct validity of the PosSE Survey in the analysis reported below.

2.2 Participant description

Participants in this study included 298 undergraduate students drawn from a university in a Mid-Atlantic state of the United States who completed an online survey. A total of 133 participants were retained for this analysis after we deleted cases with missing values on all survey items and the responses of students in non-STEM degree programs. Among the 133 participants, 77 of them are undergraduate students and 56 are graduate students. Our final

Table 1. Characteristics of Sample (n = 133)

Characteristics	Number of students	Percent
Gender		
Male	65	48.9%
Female	65	48.9%
Not reported	3	2.2%
Race		
Asian	21	15.8%
Black	8	6%
Hispanic	11	8.3%
White	87	65.3%
Other races	6	1.9%
Classification		
First year	20	15%
Sophomore	19	14.3%
Junior	16	12%
Senior	14	10.5%
Fifth year and beyond	8	6%
Graduate	56	42.1%
Major		
Science	18	13.5%
Technology	6	4.5%
Engineering	107	80.5%
Mathematics	2	1.5%

sample contains mostly white students (65.3%) and approximately equal numbers of males (48.9%) and females (48.9%). The undergraduate students were mostly equally distributed from first year to senior year, and a few were in the fifth or beyond year (6%). Table 1 shows the students' demographics.

2.3 Data analysis

We deleted the responses of four participants who failed to satisfy the criteria we thought was minimal for participants to be included in analysis: one participant skipped items assessing participants' major, career, and involvement; while three respondents reported that they had not been involved in any out-of-class activity. Thus, we were left with data from 129 participants, which is deemed sufficient for pilot testing using factor analysis [31].

We conducted reliability analysis and exploratory factor analysis on participants' responses using SPSS® statistics software package. All Likert-scale ratings were treated as continuous data in the analysis. Although data arising from Likert-type scales are ordinal, they are treated as continuous variable for the purpose of our analysis [32]. The first analysis was to examine the internal consistency of the original items developed to assess each construct on the PosSE Survey. We conducted EFA using a maximum likelihood (ML) extraction method to reduce the number of items that assess each construct on the instrument as may be necessary, as well as to validate the instrument. Secondly, we re-analyzed the Cronbach's coefficient alpha of each construct on the instrument after the EFA to examine how the items and related latent constructs were improved in internal consistency reliability. These analyses provided results that help develop and validate the items and dimensions of the PosSE Survey in a rigorous way.

Prior to conducting EFA, Kaiser-Meyer-Olkin (KMO) [33] and the Bartlett tests [34] were employed to assess whether the data were amenable to the principal component analysis procedure. The KMO was 0.79, which meets Kaiser's "middling" criteria and suggests the items were adequate for factor analysis. The Bartlett test was significant ($p < 0.05$), indicating that the correlation matrix is not an identity matrix and is factorable [35]. The EFA procedure includes extraction, rotation, and interpretation of the factors. Maximum likelihood was used as an extraction method and oblique rotation method (i.e., direct oblimin) was selected to extract factors for the latent variables because the factors within each latent variable were assumed theoretically to be correlated with each other. Factors with eigenvalues greater than 1 were extracted [32], and items with a factor loading greater than 0.4 were retained [31]. Then the extracted factors were named to construct the dimensions of commitment and involvement about major and career.

3. Results and discussion

3.1 Descriptions and frequencies of survey results

Table 2 shows a description of students' self-reports about their participation in out-of-class activities. More than 40% of respondents were involved in sports, student clubs and organizations, research, and a job, while students participated less (10% or less) in such activities as film, theater, and visual

Table 2. Frequency of Involvement

Activities	Number of students	Percent
Sports	63	48.8%
Student Clubs & Organization	58	45%
Research	54	41.9%
Job	51	39.5%
Engineering Outreach Support	49	38%
Service & Public Service	48	37.2%
Pre-professional	47	36.4%
Professional Experiences	44	34.1%
Culture, Faith, Gender, Identity	41	31.8%
Living-Learning Community	41	31.8%
Design Competition Team	36	27.9%
Music/Dance	30	23.3%
International Experiences	21	16.3%
Government	14	10.9%
Fraternity or Sorority, Services	13	10.1%
Environmental	12	9.3%
Fraternity or Sorority, Social	12	9.3%
Film, Theater, Visual Arts	7	5.4%
Media, Publications and Journalism	7	5.4%
Military	4	3.1%

Table 3. Descriptive of Reasons that Promote and Prevent Involvement in the Activity

Reasons	Mean	S. D.
Promote involvement		
To fulfill my personal interests	5.61	0.60
I agree with the goals of the organization	5.41	0.79
To gain experiences that make me competitive in the job market	5.03	1.11
To create positive impact on campus/community	4.91	1.10
To try something new	4.88	1.11
I was provided information concerning the activities	4.75	1.14
To provide entertainment	4.55	1.30
I could afford the costs/expenses	4.04	1.72
To relieve stress	3.97	1.49
I had the time	3.94	1.46
To follow encouragement from an advisor or faculty member	3.86	1.77
To be on par with other students in terms of involvement in activities	3.65	1.47
To break down barriers of any kind (i.e., religion, race, Gender, sexual orientation)	3.22	2.28
My parents influence	2.58	1.48
Prevent involvement		
Lack of time, scheduling issue	4.19	1.54
Lack the knowledge about the opportunities	3.41	1.50
Cost (time and money) of joining was too high	3.39	1.64
Limit to number of participants; a competitive process to join	3.01	1.63
Lengthy, difficult membership process	3.00	1.49
Introverted personality	2.97	1.53
Don't contribute to what I want to learn	2.85	1.66
Lack of motivation	2.78	1.43
Didn't feel supported by faculty advisor	2.70	1.94
Family or personal matters	2.69	2.27
Social inertia	2.60	1.80
Possibility of negative impact	2.51	1.40
I am not a "joiner"	2.40	1.56
Race/ethnicity issues	2.04	1.59
Gender issue	2.00	1.52

arts; environmental; fraternity or sorority (social); media publications and journalism; and military. It likely that research fell near the top of the list because a number of graduate students responded to the survey. Sports, engineering outreach support, student clubs and organizations, and living-learning community were the top 4 activities for undergraduate respondents.

Respondents were asked to rate on a scale of 1 to 6, with 1 being "strongly disagree" and 6 being "strongly agree," whether they agreed that the listed reasons had encouraged or discouraged their involvement in each of the out-of-class activities listed on the survey. Table 3 shows descriptive statistics of students' agreement with the list of reasons thought to promote or prevent their involvement in the out-of-classroom activities, with a higher mean indicating more agreement or less disagreement. Personal interest and goal alignments topped the list of promoters, while time and scheduling topped the list of inhibitors.

Table 4 shows descriptive statistics of the positive and negative outcomes students reported that they seem to derive from their involvement in the out-of-class activities. Our finding indicates that many participate in out-of-class activities because it gives them a sense of personal development. Respondents also rated a number of outcomes highly (Mean > 5). Perceived wasted time, consistent with the list of inhibitors, tops the list of negative outcomes reported.

3.2 Reliability and validity analysis

3.2.1 Initial Reliability Analysis

The original PosSE Survey consisted of 27 items designed to assess 8 constructs: Major Affective, Career Commitment, Perceived Fit with Career, Major Identification, Proactive Personality, Program Belonging, Major Satisfaction, and Peer Involvement. Four of these items were reverse coded to keep the consistent meanings of all items. EFA was conducted to explore how each item grouped into constructs. After constructs were extracted, we calculated an internal consistency reliability coefficient, Cronbach's alpha, for each construct. The initial reliability coefficients are presented in Table 5. Reliability coefficients for the constructs were above 0.7 (commonly regarded as a cut-off value of Cronbach's coefficient alpha for a good level of reliability [29, 30]) for all but one construct. A closer examination of items on Peer Involvement (with a Cronbach alpha of 0.649) revealed that item "I explain course materials to one or more students (e.g., tutoring)" was poorly correlated with the other items related to the con-

Table 4. Descriptive of Outcomes of the Activity Involvement

Outcomes	Mean	S.D.
Positive outcomes		
Personal development	5.26	0.79
Communication skills	5.09	0.79
Social engagement	5.07	0.84
Satisfaction with the college experience	5.05	0.97
Social development	5.04	0.92
Professional development	5.02	1.03
Sense of belonging to college	4.97	1.00
Leadership skills	4.96	1.08
Intellectual development	4.95	1.11
Opportunity to be independent	4.89	1.03
Academic engagement	4.74	1.17
Cross-cultural awareness	4.02	1.34
Civic development	3.94	1.25
Negative outcomes		
Consumed my time therefore my free time was reduced	4.15	1.28
Consumed my time therefore my schedule was less flexible	4.12	1.22
Increased expense	3.02	1.58
Academic timeline extended	2.44	1.40
Decreased academic engagement	2.41	1.28
Decreased my GPA in college	2.27	1.31
Declined personal health	2.09	1.18
Damaged interpersonal relationships	2.02	1.07
Decreased social engagement	1.89	1.17
Social development negatively impacted	1.71	0.88
Personal development negatively impacted	1.62	0.85

Table 5. Original Items, Constructs, and Reliability

Item	Construct	Cronbach coeff. α
I regret having entered in my major. (Reversed) I am enthusiastic about my major.	Major Affective	0.740
I think I will be very happy to spend the rest of my career in my current academic discipline. I do not feel a strong sense of "belonging" to my academic discipline. (Reversed) I do not feel "emotionally attached" to my academic discipline. (Reversed) I do not feel like "part of the family" in my academic discipline. (Reversed)	Career Commitment	0.779
My eventual career will directly relate to a job in my academic discipline. In the future, I will not have a career that requires me to have skills related to my academic discipline. (Reversed)	Perceived Fit With Career	0.716
Being good at my major is an important part of who I am. Success in my major at school is very valuable to me. It matters to me how well I do in my major at school.	Major Identification	0.750
I am constantly on the lookout for new ways to improve my life. If I see something I don't like, I fix it. I love being a champion for my ideas, even against others' opposition. I excel at identifying opportunities. If I believe in an idea, no obstacle will prevent me from making it happen.	Proactive Personality	0.777
I feel like a real part of my current program. I am treated with as much respect as other students in my program. The instructors in my program respect me.	Program Belonging	0.709
I am satisfied with the faculty in my major. I don't intend to change my major from current major to another major. Overall, I am happy with the major I've chosen.	Major satisfaction	0.788
I discuss academic issues with peers. I discuss social issues with peers. I explain course materials to one or more students (e.g., tutoring). I discuss career issues with peers. I discuss cultural issues with peers.	Peer Involvement	0.649

struct. The internal reliability coefficient for the scale increased to 0.747 after deleting this item. We also observed that while both Major Affective and Perceived Fit with Career had acceptable reliability coefficients ($\alpha = 0.727$ and $\alpha = 0.713$, respectively), they only had two items associated with them. In order to strengthen constructs reliability, it is recommended to have more than three items for each construct [36]. In the future, we will develop additional items to measure these constructs.

3.2.2 *Exploratory factor analysis and reliability*

After deleting items with low reliabilities, we conducted EFA to examine the preliminary structure of the remaining 26 items. The items were subjected to four steps: extraction, rotation, interpretation, and rewording. The rewording was done by a three-member expert panel comprising a statistician with seven years of experience developing surveys, a higher education scholar with substantive research experience in organizational, curricular, instructional, and co-curricular practices in engineering, and a director of assessment in a college of engineering. The panel's areas of expertise included cognitive development, survey methodology, and writing and administering surveys. Table 6 shows the revised and former names of constructs (names are in parentheses).

In the first step, the number of factors to extract depended upon the eigenvalues, scree plot, and conceptual meaning of the items identified with each factor. We wanted the fewest number of factors that explained the largest amount of variation. The analysis indicated that seven factors best explained the observed covariation matrix and accounted for 69.4% of the variance within the data set. We selected an oblique solution (i.e., direct oblimin) in the rotation step since we envisaged that our factors were theoretically correlated, although we were not sure how correlated they were at the time. A factor loading of 0.40 or above is considered to be meaningful [31]. All the items showed clear and strong fit with each factor. Since no cross-loadings (a loading on more than one factor) existed for items, all items

Table 6. Item Factor Analysis Results

Item	Factor loading	Factor/ Construct Revised Name (Former Name)	Cronbach's coeff. α
Overall, I am happy with the major I've chosen.	0.707	Major Satisfaction	0.869
I don't intend to change my major from current major to another major.	0.657		
I am enthusiastic about my major.	0.574		
I think I will be very happy to spend the rest of my career in my current major.	0.550		
I regret having entered in my major. (Reversed)	0.522		
I do not feel like "part of the family" in my academic discipline. (Reversed)	0.853	Academic Discipline Belonging	0.822
I do not feel "emotionally attached" to my academic discipline. (Reversed)	0.782		
I do not feel a strong sense of "belonging" to my academic discipline. (Reversed)	0.711		
I feel like a real part of my current academic discipline.	0.475		
In the future, I will not have a career that requires me to have skills related to my academic discipline. (Reversed)	0.598	Academic Discipline to	
Career Link (Perceived Fit with Career)	0.716		
My eventual career will directly relate to a job in my academic discipline.	0.457		
Success in my major at school is very valuable to me.	0.993	Major Identification	0.750
It matters to me how well I do in my major at school.	0.707		
Being good at my major is an important part of who I am.	0.533		
I excel at identifying opportunities.	0.821	Achievement Striving	
(Proactive Personality)	0.777		
If I see something I don't like, I fix it.	0.671		
If I believe in an idea, no obstacle will prevent me from making it happen.	0.583		
I love being a champion for my ideas, even against others' opposition.	0.540		
I am constantly on the lookout for new ways to improve my life.	0.494		
I discuss career issues with peers.	0.832	Peer Interaction (Peer Involvement)	0.747
I discuss academic issues with peers.	0.747		
I discuss social issues with peers.	0.514		
I discuss cultural issues with peers.	0.427		
The faculty in my program respect me.	0.850	Positive Faculty Relationship (Faculty Interactions)	0.778
I am satisfied with the faculty in my major.	0.601		
I am treated with as much respect by faculty as other students in my program.	0.586		

were retained in the survey. We also revised the names of two factors. According to the conceptual items and constructs, the EFA results indicated that the items loaded on Academic Discipline to Career Link, Major Identification, Achievement Striving, and Peer Interaction were similar to or the same as those associated in the survey.

The items associated with two pairs of constructs (Major Affective and Major Satisfaction, and Major Commitment and Program Belonging) could not be statistically distinguished from each other. After reviewing and discussing the conceptual latent structure of the items and related constructs, the identified latent constructs were revised and renamed to ensure the brevity and clarity of the indicated items. Most items originally related to Major Affective and Major Satisfaction, renamed Major Satisfaction, were loaded on a single factor; and most items originally associated with Major Commitment and Program Belonging, renamed Academic Discipline Belonging, were loaded on another single factor. Finally, three items concerning faculty and instructors were loaded together on a new factor named Positive Faculty Relationship.

The last step of the EFA is to interpret the rotation pattern coefficients and provide a meaningful understanding of the common features among the relevant items. All of the revised constructs and associated items were examined for clarity, relevancy, and content validity. The reliability or internal consistency of each revised construct was determined by computing the coefficient alpha. Table 6 shows the number of items retained, the factor loading of each item, and the internal reliability coefficient of each factor after the EFA procedure.

Major Satisfaction captured participants' perceptions about their overall satisfaction with, and emotional connection to, their major. Two items on the factor, ''Overall, I am happy with the major I've chosen'' and ''I don't intend to change my major from current major to another major'' also sought to capture participants' commitment to continuing in the chosen major, suggesting that one aspect of satisfaction includes choosing and continuing in the major. *Academic Discipline Belonging* captured participants' perceptions about their sense of belonging in their academic discipline. Academic discipline belonging is construed as perceptions of acceptance, fit within the academic discipline, or inclusion in the program or department setting [37]. Example of items on the sub-scale include: ''I do not feel 'emotionally attached' to my academic discipline (Reversed).'' *Academic Discipline to Career Link* captured participants' perceptions about how they feel their chosen major fits into their future career. *Major Identification* captured participants' perceptions about their sense of identification with their chosen major. *Achievement Striving* captured participants' perceptions of their actions being relatively unconstrained by situational forces [38] and included items specifically related to proactive behaviors, such as ''If I believe in an idea, no obstacle will prevent me from making it happen.'' *Peer Interaction*, captured participants' perceptions about their involvement and interactions with peers. Such interactions included whether they actively discuss career, academic, social, and cultural issues with peers. Lastly, *Positive Faculty Relationship* captured participants' view of the way they are treated by, and if they generally are satisfied with, their faculty or instructors in their program.

We revised the wording of a few items on a number of constructs in order to improve their clarity and fit. The wording 'academic discipline' of item on *Major Satisfaction*—''I think I will be very happy to spend the rest of my career in my current academic discipline''—was revised to 'major.' The wording 'program' in an item on *Academic Discipline Belonging*—''I feel like a real part of my current program''—was revised to 'academic discipline'. Lastly, we added 'by faculty' in the item ''I am treated with as much respect as other students in my program'' to better reflect *Positive Faculty Relationship.* All other items on each construct were retained. Only two items were loaded onto *Academic Discipline to Career Link* construct. We will make effort to include additional items in the future in order to strengthen the internal reliability of this construct. Furthermore, we will re-examine the psychometric properties of the construct in the future.

4. Limitations and future work

The result of this validation study is limited by the number of participants who responded to the survey, and the lack of population diversity that would have tested the robustness of instrument and its suitability to a diverse student groups. The study was based only on a sample mostly comprising engineering students from one institution, which limits the generalizability of our findings. The next phase of the validation of this instrument will include administering the survey to a larger student population from additional three institutions—all of which have a more diverse student body. We expect that this effort will result in increased sample size and a student population that broadens the number of STEM majors represented in the sample. We hope to target traditional underrepresented student groups in STEM education, such as ethnic minorities and women in STEM programs.

Periodic reassessment and ongoing modification are essential to ensure that all the constructs of the PosSE Survey remain relevant and applicable. These revisions will involve updating the content of the questionnaire and conducting further psychometric studies to establish evidence for the validity and reliability of the instrument. We will explore the structure of the 26-items on the PosSE Survey using a larger sample that will include more students majoring in science, technology, and math along with engineering students. In our future effort, we will increase the population to sample from, as well as the survey distribution pathways in order to improve number of responses. With a larger sample size, we will randomly split the sample in our future analysis into two sub-samples. One of the sub-samples will be for ongoing development of the instrument and item selection and the other sub-sample to replicate the results and provide further valuable information [39]. We will also conduct exploratory factor and confirmatory factor analyses on the sub-samples to explore and establish the psychometric properties of subscales on the instrument.

5. Conclusion

This study provides mounting evidence of validity and reliability for the PosSE Survey. We discussed the development of items for the PosSE Survey and the validation of subscales in the section of the survey that addresses affective variables that influence students' involvement in classroom and out-of-class activities. Reliability coefficients (Cronbach's coefficient α) for all constructs were high, ranging from 0.72 to 0.87. We believe the PosSE Survey can help elucidate the relationships among STEM students' out-of-class activity involvement, factors that influence such involvement, and their relationships in their learning community. Such data would allow higher education administrators, faculty, and researchers to gain objective information from a validated instrument that can inform evidence-based policies and programs. The information that the PosSE Survey can provide may contribute to a nuanced understanding of the important role of STEM students' out-of-class involvement.

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References

1. K. L. Krause and H. Coates, Students' engagement in first-year university, *Assessment and Evaluation in Higher Education*, **33**(5), 2008, pp. 493–505.
2. P. D. Chen, R. Gonyea and G. Kuh, Learning at a distance: Engaged or not, *Journal of Online Education*, **4**(3), 2008. Available at http://innovateonline.info/ index.php?view= article&id= 438&action=login
3. S. Hu and G. D. Kuh, Being (dis)engaged in educationally purposeful activities: The influences of student and institution characteristics, *Research in Higher Education*, **43**(5), 2002, pp. 555–575.
4. V. Tinto, Leaving college: Rethinking the causes and cures of student attrition (2nd ed.), University of Chicago Press, Chicago, 1993.
5. E. T. Pascarella and P. T. Terenzini, *How college affects students: A third decade of research*, Jossey-Bass, San Francisco, 2005.
6. G. D. Kuh, What we're learning about student engagement from NSSE, *Change*, **35**(March/April), 2003, pp. 24–31.
7. M. Stuart, C. Lido, J. Morgan, L. Solomon and S. May, The impact of engagement with extracurricular activities on the student experience and graduate outcomes for widening participation populations, *Active Learning in Higher Education*, **12**(3), 2011, pp. 203–215.
8. S. Brint and A. M. Cantwell, Undergraduate time use and academic outcomes: Results from the University of California Undergraduate Experience Survey 2006, *Teachers College Record*, **112**(9), 2010, pp. 2441–2470.
9. R. M. Carini, G. D. Kuh and S. P. Klein, Student engagement and student learning: Testing the linkages, *Research in Higher Education*, **47**(1), 2006, pp. 1–32.
10. K. Meyers, C. F. Pieronek and L. H. McWilliams, Engineering student involvement: Comparison of two dissimilar institutions, *Proceedings of the 119th ASEE Annual Conference and Exposition*, San Antonio, TX, 2012, Paper ID #6036.
11. 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, *Research in Higher Education*, **48**(8), 2007, pp. 967– 992.
12. D. R. Simmons, G. D. Young, S. G. Adams and J. P. Martin, Non-curricular activities help African American students and alumni develop engineer of 2020 traits: A quantitative look, *Proceedings of the ASEE Annual Conference and Exposition*, Indianapolis, IN, 2014, Paper ID #22870.
13. G. R. Pike, G. D. Kuh and A. C. McCormick, An investigation of the contingent relationships between learning community participation and student engagement, *Research in Higher Education*, **52**(3), 2011, pp. 300–322.
14. B. A. Burt, D. C. Carpenter, M. A. Holsapple, C. J. Finelli, R. M. Bielby, J. A. Sutkus and T. S. Harding, Out-of-classroom experiences: Bridging the disconnect between the classroom, the engineering workforce, and ethical development, *International Journal of Engineering Education*, **29**(3), 2013, pp. 714–725.
15. R. Yu and D. R. Simmons, Synthesis of engineering undergraduate students' out of class involvement, *Proceedings of the ASEE Annual Conference and Exposition*, Seattle, WA, 2015, Paper ID #24787.
16. B. N. Geisinger and D. R. Raman, Why they leave: Understanding student attrition from engineering majors, *International Journal of Engineering Education*, **29**(4), 2013, pp. 914–925.
17. J. A. Fredricks, P. Blumenfeld and A. Paris, School engagement: Potential of the concept, state of the evidence, *Review of Educational Research*, **74**(1), 2004, 59–109.
18. E. Masson, The positive effects of extracurricular activities on students, *Essai*, **9**(27), 2011, pp. 84–87.
19. C. Good, A. Rattan and C. S. Dweck, Why do women opt out? Sense of belonging and women's representation in mathematics, *Journal of Personality and Social Psychology*, **102**(4), 2012, pp. 700–717.
20. K. F. Osterman, Students' need for belonging in the school community, *Review of Educational Research*, **70**(3), 2002, pp. 323–367.
21. T. G. Duncan and W. J. McKeachie, The making of the motivated strategies for learning questionnaire, *Educational Psychologist*, **40**(2), 2005, pp. 117–128.
22. P. R. Pintrich, D. A. F. Smith, T. García and W. J.

McKeachie, Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ), *Educational and Psychological Measurement*, **53**(3), 1993, pp. 801–813.
23. J. A. Fredericks and W. McColskey, The measurement of student engagement: A comparative analysis of various methods and student self-report instruments, in S. L. Christenson, A. L. Reschly and C. Wylie (eds.), *Handbook of research on student engagement*, Springer, New York, 2012, pp. 763–782.
24. J. Fredricks, W. McColskey, J. Meli, J. Mordica, B. Montrosse and K. Mooney, *Measuring student engagement in upper elementary through high school: A description of 21 instruments.* Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Washington, DC, 2010. Available at http://ies.ed.gov/ncee/edlabs/ regions/southeast/pdf/rel_2011098.pdf
25. R. M. Marra, K. A. Rodgers, D. Shen and B. Bogue, Leaving engineering: A multi-year single institution study, *Journal of Engineering Education*, **101**(1), 2012, pp. 6–27.
26. Authors 2015b
27. L. R. Fabrigar, D. T. Wegener, R. C. MacCallum and E. J. Strahan, Evaluating the use of exploratory factor analysis in psychological research, *Psychological Methods*, **4**(3), 1999, pp. 272–299.
28. L. J. Cronbach, Coefficient alpha and the internal structure of tests, *Psychometrika*, **16**(3), 1951, pp. 297–334.
29. C. E. Lance, M. M. Butts and L. C. Michels, The sources of four commonly reported cutoff criteria: What did they really say? *Organizational Research Methods*, **9**(2), 2006, pp. 202–220.
30. R. K. Henson, Understanding internal consistency reliability estimates: A conceptual primer on coefficient alpha, *Measurement and Evaluation in Counseling and Development*, **34**(3), 2001, pp. 177–189.
31. F. J. Floyd and K. F. Widaman, Factor analysis in the development and refinement of clinical assessment instruments, *Psychological Assessment*, **7**(3), 1995, pp. 286–299.
32. U. Olsson, Maximum likelihood estimation of the polychoric correlation coefficient, *Psychometrika*, **44**(4), 1979, 443–460.
33. H. Kaiser, An index of factorial simplicity, *Psychometrika*, **39**(1), 1974, pp. 31–36.
34. M. S. Bartlett, A note on the multiplying factors for various chi square approximations, *Journal of the Royal Statistical Society*, **16**(2), 1954, pp. 296–298.
35. B. G. Tabachnik and L. S. Fidell, *Using multivariate statistics*, Harper Collins, New York, 1996.
36. R. E. Schumacker and R. G. Lomax, *A beginner's guide to structural equation modeling*, Lawrence Erlbaum Associates, Mahwah, NJ, 2010.
37. T. Floyd-Smith, D. Wilson, D. C. Jones, M. Plett, R. A. Bates and N. M. Veilleux, Investigation of belonging for engineering and science undergraduates by year in school, *Proceedings of the 119th ASEE Annual Conference and Exposition*, San Antonio, TX, 2012, Paper ID #5111.
38. T. S. Bateman and J. M. Crant, The proactive component of organizational behavior: A measure and correlates, *Journal of Organizational Behavior*, **14**(2), 1993, pp. 103–118.
39. R. DeVellis, *Scale development: Theory and application* (3rd ed.), Sage, Los Angeles, CA, 2012.

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