Increasing Impact of the Hidden Curriculum: Exploring Student Outcomes from Out-of-Class Activities

Dr. Denise Rutledge Simmons P.E., Virginia Tech

Denise R. Simmons, Ph.D., PE, LEED-AP, is an assistant professor in the Myers-Lawson School of Construction and in the Department of Civil & Environmental Engineering, and an affiliate faculty of the Department of Engineering Education at Virginia Tech. She holds a B.S., M.S., and Ph.D. in civil engineering and a graduate certificate in engineering education – all from Clemson University. She has over 10 years of experience working for energy companies and as a project management consultant. Her research contributes to the advancement of labor and personnel issues in engineering broadly and specifically in the construction industry through two research areas: untangling the complex relationship between activities people become involved in — operationalized as engagement — and the technical and professional outcomes gained — operationalized as competencies. The broader impact of this work lies in achieving and sustaining productive, diverse and inclusive project organizations composed of engaged, competent people. Dr. Simmons' research is supported by awards from NSF, including a CAREER award. She oversees the Simmons Research Lab (www.denisersimmons.com), which is home to a dynamic, interdisciplinary mix of undergraduate and graduate students and a post-doctoral researcher from various colleges and departments at Virginia Tech who work together to explore engineering and construction human centered issues with an emphasis on understanding difference and disparity.

Dr. Cassandra J. Groen, Virginia Tech

Dr. Cassandra Groen is a post-doctoral researcher in the Department of Engineering Education and the Myers-Lawson School of Construction at Virginia Tech. Her primary research interests include professional identity formation in undergraduate civil engineering students, grounded theory methods, and theory development. Her current work includes the exploration of professional identity formation in civil engineering students who experience disabilities and the ways in which this identity is influenced by students' academic relationships, events, and experiences. Dr. Groen holds B.S. and M.S. degrees in Civil Engineering from the South Dakota School of Mines & Technology.

Increasing Impact of the Hidden Curriculum: Exploring Engineering Student Participation in Out-of-Class Activities

Abstract

Existing literature has shown that out-of-class activities provide undergraduate students with significant learning experiences that positively impact their academic and career pathways. However, despite these positive impacts, undergraduate engineering students are less likely to take advantage of such experiences than their non-engineering counterparts. This lack of participation in out-of-class activities is problematic for the retention of a talented and diverse engineering workforce; student participation in out-of-class activities has been shown to promote persistence toward graduation and entrance into the engineering workforce, particularly for women and other underrepresented groups in engineering.

In this paper, we provide a brief overview of work conducted to-date as part of a project funded by the National Science Foundation titled, “Investigating Co-Curricular Participation of Students Underrepresented in Engineering.” The purpose of this mixed methods study is to explore the influence of out-of-class activity participation on underrepresented students’ persistence, learning outcomes, and workforce entry. Here, we present findings from two quantitative studies that utilize the Postsecondary Student Engagement (PosSE) Survey to 1) examine the popularity of specific out-of-class activities and outcomes; and 2) identify the incentives for and barriers to participation. To highlight programmatic implications of this work, we then introduce the Building Undergraduate Interventions for Learning and Development (BUILD) Model, which can serve as a design framework for the modification and implementation of out-of-class interventions intended for undergraduate engineering students. We conclude this paper with a discussion of areas for continued work to increase the impact of out-of-class activities as a hidden curriculum.

Introduction

Over the past two decades, government, industry, and academia have emphasized the need to raise the number of STEM graduates and diversify the predominately white male profession [1-3]. Though great strides have been made to increase the number of underrepresented students in engineering, the demonstrable gap in their educational attainment and workforce entry stubbornly persists [4-7]. Prior work in engineering education has dedicated a great deal of attention to understanding why this gap persists, often linking student attrition to factors such as pre-college mentorship, parental influence, and student engagement in in- and out-of-class activities [5, 8].

Research examining the impacts of student participation in out-of-class activities has shown promise in promoting the retention and matriculation of college students into the engineering workforce. In higher education, broadly, out-of-class activities have been identified as a key provider of significant learning experiences that positively influence undergraduate students’ academic and career pathways. Students who actively engage in educationally-purposeful activities outside of the classroom, in addition to in-class activities, are more likely than their disengaged peers to persist toward graduation [9-12], realize gains in cognitive and intellectual

development [13], and improve practical competence and skill transfer [14, 15]. Moreover, student involvement in co-curricular activities, such as participation in student organizations [10], living-learning communities [16], service learning experiences [17], voluntary design teams [18], undergraduate research [19], internships [20] and community service [21] has been shown to increase students' satisfaction with their college experience, academic success, life-long learning and the rates by which they might persist. Similar outcomes have also been associated with out-of-class activity participation among engineering students. Research examining student participation in undergraduate research experiences [22-24], engineering living-learning communities [25, 26], religious-based communities [27], and engineering service-learning programs [28, 29] are more likely to pursue a graduate degree or enter the engineering workforce, maintain a greater belonging to the engineering field, and experience increased growth in professional and professional skills.

However, despite these positive impacts, undergraduate engineering students are less likely to take advantage of such experiences than their non-engineering counterparts and spend significantly more time on academic coursework [30]. While this may reflect a traditional tendency to focus on technical competencies in engineering education, current thinking among engineering professionals, as evidenced in engineering education standards, aligns with more general trends in undergraduate education that emphasize non-technical skills such as collaboration and critical thinking [31-33].

While we know that participation in out-of-class activities yield a variety of individual student outcomes (e.g., improved sense of belonging, increased professional skill competence, etc.), few studies examine the simultaneous influence of a variety of out-of-class activities on student retention in engineering, both collectively and across demographics and disciplines. Therefore, a current project sponsored by the National Science Foundation as a CAREER award, on which the first author serves as principal investigator (PI), is exploring the influence of out-of-class activity participation on students' persistence, learning outcomes, and workforce entry. Titled, "Investigating Co-Curricular Participation of Students Underrepresented in Engineering," this study seeks to gain an understanding as to 1) how engineering students decide to participate or not participate in out-of-class activities; 2) how these students perceive the impact of various types of out-of-class activities on their engagement in school and development of technical and professional competencies; and 3) how each type of activity may differentially impact academic and career outcomes. This project is unique in its focus on various types of out-of-class experiences and is shaped by specific calls for further research on the influence of out-of-class involvement on persistence, learning and workforce entry by engineering education researchers. Such research is essential to informing innovative, evidence-based out-of-class experiences and institutional policies and practices that support the diverse pathways that students take to becoming engineers.

In this paper, we provide a brief overview of work conducted to-date as part of this larger project. We focus our discussion here on findings from two quantitative studies that utilize the Postsecondary Student Engagement (PosSE) Survey to 1) examine the popularity of specific out-of-class activities and outcomes; and 2) identify the incentives for and barriers to participation. To highlight programmatic implications of this work, we introduce the Building Undergraduate Interventions for Learning and Development (BUILD) Model, which can serve as a design

framework for the modification and implementation of out-of-class interventions intended for undergraduate engineering students. We conclude this paper with a discussion of areas for continued work to increase the impact of out-of-class activities as a hidden curriculum.

The Postsecondary Student Engagement (PosSE) Survey

The Postsecondary Student Engagement (PosSE) Survey is a tool used to assess student engagement in out-of-class activities and captures four primary characteristics of student engagement: 1) the type and number out-of-class activities in which students participate; 2) the frequency by which they participate in those activities; 3) outcomes and barriers to participation; and 4) students' perceived levels of engagement while participating. Unlike the National Survey of College Student Engagement (NSSE), which focuses engagement measures based on cognitive and behavioral engagement indicators as depicted in Figure 1[34], the PosSE Survey primarily utilizes affective and cognitive engagement indicators to measure engagement [35]. Affective engagement is a relatively underutilized dimension for engagement measures in engineering education, despite its inherent influence on both cognitive and behavioral engagement [36]. As such, the PosSE Survey's focus on affective engagement makes it a significant contributor to student engagement measures in engineering education.

The development of the PosSE Survey was conducted in three phases. In the first phase (i.e., initial development), survey items were created using the combined approaches of a review of relevant literature and instruments, a Q-Study, and expert panel. Items were adapted from identified existing and relevant instruments, administered to a development sample, and evaluated and optimized for scale length (see 35, 37 and 38 for full descriptions of the development process). Once initial items were generated, think-aloud sessions were conducted with undergraduate students to determine face validity [38]. During the second phase of instrument development, a pilot testing of the survey was conducted with data collected from 133 participants. An Exploratory Factor Analysis (EFA) was used to reduce the number and refine the content of items as well as establish a preliminary structure [35]. As a result, the survey contained a total of 26 items belonging to seven identified factors: 1) major satisfaction, 2) academic discipline belonging, 3) academic discipline to career link, 4) major valuing, 5) achievement striving, 6) peer interaction, and 7) positive faculty relationship. Currently, the third phase of development is being conducted to further refine and validate the instrument.

For the quantitative studies described in this paper, the PosSE Survey has served as the primary form of data collection, with each presented study focusing on a different aspect of survey results. These findings will then be combined in later phases of the larger project to gain an understanding of the influence of participation in out-of-class activities on student retention, learning, and workforce entry within the STEM fields and particularly for underrepresented groups in STEM. These studies are further discussed in the following sections.

Figure 1: Measures of Engagement in NSSE and the PosSE Survey

Study 1: Overall Popularity and Intensity of Out-of-Class Activities [40]

In this exploratory, quantitative study, we sought to develop a more nuanced and complex understanding of undergraduate engineering students' perceptions of engagement in out-of-class activities by achieving three research aims: 1) gain an understanding of which types of activities were most beneficial (i.e., yielded the most self-identified outcomes) for students; 2) understand levels of student involvement required to achieve these self-identified outcomes; 3) explore existing trends regarding items 1 and 2 as reflected through specific student groups (i.e., disaggregated student demographic characteristics (i.e., race/ethnicity and gender).

While students participate in a variety of out-of-class activities, we utilized a *top activity* as a way to scope and answer these questions. A *top activity* was defined as the activity in which a student reported attaining the most self-identified outcomes. We then narrowed our research focus to examine students' top out-of-class activities to understand the type of activities which students perceived they received the most benefits and the level of engagement in that activity. Using this approach, we could examine the relationships among a student's chosen top out-of-class activity and their level of activity with respect to their reported demographics (e.g., gender and race/ethnicity).

Overview of Methods

Participants completed the Postsecondary Student Engagement (PosSE) Survey to explore out-of-class activities and associated outcomes and level of activity. Of the 845 total surveys completed by engineering students at three R1 institutions, 645 of those students were purposively sampled for this study to intentionally focus research efforts on gender and racial/ethnic differences. Responses were quantitatively analyzed using frequency tables, diverging bar charts, and calculated odds ratios. A full description of the methods utilized in this study, including data collection, sampling techniques and analytical procedures can be found in [40].

Summary of Findings

The first aim of the study was to gain an understanding of which types of activities were most beneficial (i.e., yielded the most self-identified outcomes) for undergraduate engineering students. Overall, the five top out-of-class activities reported by students included job; sports; design competition teams; culture, faith, gender, and identity; and professional experiences (shown in Figure 2). Three of these top activities - job; sports; and culture, faith, and gender identity - are not explicitly related to engineering curricula, indicating that some engineering students in this sample have strong interests outside of engineering and may potentially value experiences not directly connected to the engineering curriculum. However, the two remaining most-reported top activities, design competition teams and professional experiences, maintain a more direct connection to the engineering field, potentially reflecting the need that students may feel to focus solely on engineering-related activities during their undergraduate experience [30]. Aligning with these findings, activities traditionally associated with the humanities such as film, theater, and visual arts and media, publication, and journalism, were least reported as a students' top out-of-class activity. These findings support calls from engineering education researchers that promote the integration of engineering and humanities cultures to further enhance student skills desired by engineering industry [41].

Figure 2: Distribution of top out-of-class activities for STEM students

The second aim of this study was to understand student involvement required to achieve self-identified outcomes. In other words, how much time, money, and other resources are required to experience the benefits associated with participating in a particular out-of-class activity. The majority of participants identified their level of participation in their top out-of-class activity as highly active (67.2%) or moderately active (28.7%). Music and dance, military, and social fraternity and sorority were among the top activities requiring the most involvement; however, very few students (4.5%, 3.4% and 5.7%, respectively) reported these as their top out-of-class activity. Of survey participants, 86% reported their top activity as one that requires lower levels of involvement. These findings align with prior research suggesting that some students may struggle with the consequences of a jam-packed curriculum [30], and those who do dedicate high levels of involvement to their activity tend to dedicate their efforts toward activities that can be directly associated with their engineering degree.

The third research aim of this study was to examine top activity choice and associated levels of involvement as exhibited through specific demographic characteristics such as gender and race/ethnicity. While no significant differences were identified based on demographic characteristics regarding top activity involvement, significant differences were found regarding top activity choice. When examining top activity choice based on gender, men were more likely to report activities such as *job* or *sports* as their top activity, whereas women were more likely to report participation in a *living-learning community* as their top activity. With regard to race and ethnicity, White students were more likely to report *design competition teams* as their top activity, while engineering students from underrepresented groups were more likely to report *engineering outreach support* as their top activity. While we have not explicitly inquired about the reasons why engineering students from underrepresented groups are more likely report these types of activities as their top activities, prior research suggests that, in many of these cases,

students from underrepresented groups tend to involve themselves with top activities that increase their sense of belonging in a field otherwise dominated by White men [42].

General Conclusions

While the results of this survey revealed overall trends of engineering students' top activity choice and level of involvement, both across engineering majors and within specific demographic characteristics, they also identified key areas that warrant further inquiry. Specifically, more work is necessary to further explore reasons for student activity choice, particularly regarding the types of barriers and outcomes (both positive and negative) that may influence participation and retention, respectively. As observed in this study, some students, particularly those from underrepresented groups, may participate in out-of-class activities as a means to increase their sense of belonging within the field. Based on prior work, it may be postulated that engagement in such activities may be limited due to high work-loads often associated with traditional engineering curricula. This inability to participate in activities that increase sense of belonging could potentially hinder student retention and ultimately, persistence. A similar barrier may be experienced by students who are interested in participating in humanities-based activities that are not directly-tied to engineering. However, students also reported these as "highly active" activities, meaning that they may require large amounts of resources (e.g., time) that maintain the potential to lead to negative outcomes such as increase expenses, reduce free time, and extending the academic timeline. Identifying such barriers and outcomes and their influences on student activity choice may then be used to inform the design of out-of-class activities and other programs intended for engineering students.

Study 2: Incentives of and Barriers to Participation in Out-of-Class Activities for Engineering Students [43]

As described in the preceding section, the previous study identified primary trends across engineering disciplines that identified popular out-of-class activities and perceived outcomes associated with varied levels of out-of-class activity involvement. However, it was also identified that specific barriers to student participation and the types of outcomes resulting from participation warranted further investigation. To build on this prior work, the following study sought to create a profile of engineering student engagement that could further explore and articulate the potential challenges and outcomes experienced by students as they chose to - or to not - participated in out-of-class activities. In particular, this profile included four components: 1) activity prevalence, 2) level of engagement, 3) incentives and barriers to participation, and 4) outcome type.

Overview of Methods

As with the prior study, the PosSE survey was distributed to undergraduate engineering students across predominantly white institutions across the U.S. A total of 1421 undergraduate engineering students responded to the survey, with 816 students submitting completed responses to be used for analysis. Descriptive statistics were calculated for reason and outcomes of their out-of-class involvement. A series of comparison tests, including *t-tests* and ANOVAs were run to examine differences in out-of-class involvement as well as reasons and outcomes among

different student characteristic groups. A full description of data collection and analysis is included in [43].

Summary of Findings

Aligning with the previous study, the two most prevalent out-of-class activities participated in by undergraduate engineering students was taking part in some form of sport or possessing an on- or off-campus job. Students reported spending 7-9 hours per week and being highly involved in their chosen out-of-class activities. Most often, students chose to participate in a specific out-of-class activity because they wanted to fulfill a personal interest, gain experience, or agreed with an organization's goals. In contrast, students often chose not to participate in out-of-class activities due to lack of time, scheduling issues, cost, and a lack of knowledge about a program. These reasons for and against participation in out-of-class activities also align with the outcomes students experienced as a result of participation. Personal and professional development were most often reported as a positive outcomes of participation, whereas reduced free time and a more rigid schedule were identified as negative.

General Conclusions

The findings from this study point to a myriad of organizational and programmatic strategies that can be used to improve and promote undergraduate engineering student participation in out-of-class activities. In particular, the alignment between students' reasons for participation (e.g., personal interest), barriers to participation (i.e., lack of time and scheduling issues, cost, and lack of knowledge), and negative outcomes (i.e., reduced free time and a more rigid schedule) confirmed our initial proposition that while students may be interested in participating in certain out-of-class activities, that participation may be hindered due to the greater workload demands associated with traditional engineering curricula. Prior work corroborates these findings [8, 30, 44], which point to programmatic and organizational changes that may be made to undergraduate engineering curricula such as integrating in- and out-of-class learning within undergraduate engineering curricula and balancing enriching out-of-class experiences with traditional coursework.

Implications of Current Research: An Introduction to the BUILD Model (Publication In-Progress)

As demonstrated in the two previous studies, gaining a better understanding of engineering student engagement in out-of-class activities can help guide actions of program administrators and educators to restructure and promote activities to improve engagement and enhance student learning both inside and outside of the classroom. In this section, we introduce the Building Undergraduate Interventions for Learning and Development (BUILD) Model, a framework. The BUILD model is based on existing frameworks, models, and effective practices for the design of learning environments and interventions in out-of-class activities. Prior research has provided the necessary insight into specific elements of learning environment[45], institutional elements [46], and best practices [47, 48] that can be combined to create a comprehensive framework useful to educators for both designing new and modifying existing out-of-class interventions for undergraduate engineering students. The complete BUILD Model is shown in Figure 3.

Figure 3: The BUILD Model

The BUILD model outlines three main components for educators to consider in the design of out-of-class interventions for undergraduate engineering students. These components include: 1) the learning environment, 2) structure, and 3) institutional support. The learning environment in which students engage serves as the central component for educators to consider when designing or developing an intervention. This component contains the following elements: 1) intended outcomes, 2) the learning experience, 3) assessment, and 4) access to the learning experience. Structure refers to the elements that enable, support, and provide structure to the learning environment and the learning experience such as personnel (e.g., faculty and staff), resources (e.g., financial resources and supplies), and facilities. The elements of structure include: 1) personnel and 2) the resources and facilities necessary for the learning environment. The final component, institutional support, identifies the need for appropriate support from multiple stakeholders located at various levels of the institution. The elements of institutional support include: 1) support from leadership, 2) involvement from multiple stakeholders, and 3) alignment of incentives for those involved, such as faculty. These components, as well as their inherent elements, highlight the considerations for necessary for the effective and sustainable design and implementation of out-of-class interventions.

While the BUILD model is still in its early phases of development, we are currently exploring the variety of application techniques for the wide range out-of-class activities in which students may participate. As such, strategies for developing new intervention design as well as intervention modification are currently being created and expanded to other contexts. Future work will be conducted to refine and further operationalize the BUILD Model to both promote student engagement in out-of-class activities and improve their experiences as a result of that participation.

Areas for Ongoing and Future Work

The outcomes, previously identified in this paper, that college students experience, as a result of out-of-class activity participation are particularly important for individuals belonging to groups traditionally underrepresented in engineering such as women and other minority groups [49-51].

As such, the larger NSF CAREER project, on which the studies presented herein are based, has been specifically designed to investigate student participation in out-of-class activities and outcomes as experienced by student populations that vary based on demographic (e.g., gender, race/ethnicity, generational status, veteran status, non-traditional and transfer student status, disability status, and LGBTQ identification, etc.) and institutional (e.g., major, university type) characteristics.

While we have gained a baseline understanding of the types of activities in which students participate, their reasons for participation, and associated outcomes for undergraduate engineering students, we have also slowly begun to identify further nuance among these characteristics based on gender and race [40] and major [43]. We are currently in the process of expanding this work to examine out-of-class participation for specific demographic groups, such as Black and African American men [52], and under specific environmental factors, such as institutional type. From this continued research, we can further build on and contribute to the growing knowledge base

Despite this research progress, however, we have yet to deeply explore the influence of students' demographic and environmental characteristics on out-of-class participation. This is particularly the case for students who belong to underrepresented groups that are often aggregated or overlooked within engineering education research. These student groups include LGBTQ students, students who experience disability, student veterans, non-traditional students, and first-generation students. Future work will also examine these groups at their intersections to understand how a combination of characteristics can influence a students' out-of-class participation, and ultimately, their persistence and retention in the engineering field.

Acknowledgements

The authors would like to gratefully acknowledge the National Science Foundation for supporting this work under grant EEC-1351156. Any opinions, findings, conclusions, or recommendations expressed here are those of the authors and do not necessarily reflect the views of the National Science Foundation. Also, the authors acknowledge the contributions of Amy Hermundstad Nave to the development and description of the BUILD model.

References

- [1] Chubin, D. E., May, G. S., and Babco, E. L. (2005). Diversifying the engineering workforce. *Journal of Engineering Education*, 94(1), 73–86. <https://doi.org/10.1002/j.2168-9830.2005.tb00830.x>
- [2] National Academy of Engineering. (2011). *Expanding underrepresented minority participation: America's science and technology talent at the crossroads*. Washington, DC: National Academies Press.
- [3] President's Council of Advisors on Science and Technology. (2012). *Engage and excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics*. Washington, DC: Executive Office of the President.

- [4] National Science Foundation, National Center for Science and Engineering Statistics. (2017). *Women, minorities, and persons with disabilities in science and engineering: 2017*. Arlington, VA: Author.
- [5] Ohland, M. W., Sheppard, S. D., Lichtenstein, G., Eris, O., Chachra, D., & Layton, R. A. (2008). Persistence, engagement, and migration in engineering programs. *Journal of Engineering Education*, 97(3), 259–278. <https://doi.org/10.1002/j.2168-9830.2008.tb00978.x>.
- [6] Sax, L. J., Kanny, M. A., Jacobs, J. A., Whang, H., Weintraub, D. S., & Hroch, A. (2016). Understanding the changing dynamics of the gender gap in undergraduate engineering majors: 1971–2011. *Research in Higher Education*, 57(5), 570–600. <https://doi.org/10.1007/s11162-015-9396-5>.
- [7] Yoder, B. L. (2016). *Engineering by the numbers*. Washington, DC: ASEE. Retrieved from <https://www.asee.org/papers-and-publications/publications/college-profiles/15EngineeringbytheNumbersPart1.pdf>.
- [8] Eris, O., Chachra, D., Chen, H. L., Sheppard, S., Ludlow, L., Rosca, C., Bailey, T, and Toye, G. (2010). “Outcomes of a longitudinal administration of the persistence in engineering survey.” *Journal of Engineering Education*, vol. 99 no. 4, pp. 371–395.
- [9] Astin, A. W. (1993). *What matters in college? Four critical years revisited*. San Francisco, CA: Jossey Bass.
- [10] Pascarella, E. T., & Terenzini, P. T. (2005). *How college affects students: A third decade of research* (Vol. 2). San Francisco, CA: Jossey-Bass.
- [11] Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition* (2nd ed.). University of Chicago Press, Chicago.
- [12] Tinto, V. (2000). Looking at the university through different lenses. *About Campus*, 4(6), 2-3.
- [13] Magolda, M. B. B. (1992). Cocurricular influences on college students' intellectual development. *Journal of College Student Development*, 33(3), 203-213.
- [14] Kuh, G. D. (1995). The other curriculum: Out-of-class experiences associated with student learning and personal development. *Journal of Higher Education*, 66(2), 123–155. <http://www.jstor.org/stable/2943909>.
- [15] Dalrymple, O., & Evangelou, D. (2006, July). *The role of extracurricular activities in the education of engineers*. Paper presented at the 9th International Conference on Engineering Education, San Juan, Puerto Rico.
- [16] Stassen, M. L. A. (2003). Student outcomes: The impact of varying living-learning community models. *Research in Higher Education*, 44(5), 581-613.
- [17] Astin, A. W. & Sax, L. J. (1998). How Undergraduates are Affected by Service Participation. *Journal of College Student Development*, 39 (3): 251-263.
- [18] Khorbotly, S., & Al-Olimat, K. (2010, October). *Engineering student-design competition teams: Capstone or extracurricular?* Paper presented at the Frontiers in Education Conference (FIE), 2010 IEEE, Washington D.C.
- [19] Gregerman, S. R., Hathaway, R. S., & Nagda, B. A. (2002). The relationship of undergraduate research participation to graduate and professional education pursuit: An empirical study. *Journal of College Student Development*, 43(5), 614 - 631.
- [20] Di Lorenzo-Aiss, J., & Mathisen, R. E. (1996). Marketing higher education: Models of marketing internship programs as tools for the recruitment and retention of undergraduate marketing majors. *Journal of Marketing for Higher Education*, 7(1), 71-84.
- [21] Coyle, E. J., Jamieson, L. H., & Oakes, W. C. (2005). EPICS: Engineering projects in community service. *International Journal of Engineering Education*, 21(1), 139-150.

- [22] Zydney, A. L., Bennett, J. S., Shahid, A., & Bauer, K. W. (2002). Impact of undergraduate research experience in engineering. *Journal of Engineering Education*, 91(2), 151–157. <https://doi.org/10.1002/j.2168-9830.2002.tb00687.x>.
- [23] Allendoerfer, C., & Yellin, J. M. (2011). *Investigating best practices in the research mentoring of underrepresented minority students in engineering: The impact of informal interactions*. Paper presented at the American Society for Engineering Education Annual Conference and Exposition, Vancouver, Canada. <https://peer.asee.org/18197>.
- [24] Hunter, A. B., Laursen, S. L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education*, 91(1), 36-74.
- [25] Micomonaco, J. P. (2011). *Living-learning communities as a potential intervention to increase the retention of first-year engineers*. Paper presented at the 118th ASEE Annual Conference and Exposition, Vancouver, B.C. Canada.
- [26] Soldner, M., Rowan-Kenyon, H., Inkelas, K. K., Garvey, J., & Robbins, C. (2012). Supporting students' intentions to persist in STEM disciplines: The role of living-learning programs among other social-cognitive factors. *Journal of Higher Education*, 83(3), 311–336. <https://doi.org/10.1353/jhe.2012.0017>
- [27] Allendoerfer, C., Wilson, D., Bates, R., Crawford, J., Jones, D., Floyd-Smith, T., Plett, M., Scott, E. & Veilleux, N. (2012). Strategic pathways for success: The influence of outside community on academic engagement. *Journal of Engineering Education*, 101(3), 512–538. <https://doi.org/10.1002/j.2168-9830.2012.tb00060.x>.
- [28] Ropers-Huilman, B., Carwile, L., & Lima, M. (2005). Service-learning in engineering: a valuable pedagogy for meeting learning objectives. *European Journal of Engineering Education*, 30(2), 155-165.
- [29] Carberry, A. R., Lee, H., & Swan, C. W. (2013). Student perceptions of engineering service experiences as a source of learning technical and professional skills. *International Journal for Service Learning in Engineering*, 8(1), 1-17.
- [30] Lichtenstein et al., 2010 Lichtenstein, G., McCormick, A. C., Sheppard, S. D., & Puma, J. (2010). Comparing the undergraduate experience of engineers to all other majors: Significant differences are programmatic. *Journal of Engineering Education*, 99(4), 305–317. <https://doi.org/10.1002/j.2168-9830.2010.tb01065.x>.
- [31] Association of American Colleges and Universities. (2011). *The LEAP vision for learning: Outcomes, practices, impact, and employers' views*. Washington, DC: Association of American Colleges and Universities.
- [32] ABET. (2016). *Criteria for accrediting engineering programs, 2016-2017*. Baltimore, MD: ABET. Retrieved from <http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2016-2017/>.
- [33] National Academy of Engineering. (2004). *The Engineer of 2020: Visions of Engineering in the New Century*. Washington, DC: The National Academies Press.
- [34] National Survey of Student Engagement (NSSE) (2006). *The NSSE 2006 Codebook*. Bloomington, IN: Indiana University Center for Postsecondary Research and Planning.
- [35] Simmons, D. R. & Ye, Y., Hunsu, N. J. & Adesope, O. O. (2017). Development of a Survey to Explore Out-of-Class Engagement of Engineering Students. *International Journal of Engineering Education*, 33(4), 1213-1221.

- [36] Lashari, T. A., Alias, M., Akasah, Z. A., & Kesot, m. J. (2012). An Affective-Cognitive Teaching and Learning Framework in Engineering Education. *ASEAN. Journal of Engineering Education*, 1(1), 11-24.
- [37] Simmons, D. R. & Yu, R. (2015). *Conducting a Q Study to Refine and Develop New Measures of Engineering Student Co-Curricular Involvement*. Research in Engineering Education Symposium. Dublin, Ireland.
- [38] Simmons, D. R., Tendhar, C., Yu, R. Vance, E. & Amelink, C., (2015). *Developing the Postsecondary Student Engagement Survey (PosSES) to Measure Undergraduate Engineering Students' Out of Class Involvement*. Paper presented at 2015 ASEE Annual Conference and Exposition (Engineering Research Methods Division), Seattle, WA. <https://peer.asee.org/23845>, DOI: 10.18260/p.23845.
- [39] Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74(1), 59–109.
- [40] Simmons, D. R., Van Mullekom, J. and Ohland, M. (under review). The Popularity and Intensity of Undergraduate Out-of- Class Activities. *Journal of Engineering Education*.
- [41] Brint, S., Cantwell, A. M., & Hanneman, R. A. (2008). The two cultures of undergraduate academic engagement. *Research in Higher Education*, 19(5), 383–402. <https://doi.org/10.1007/s11162-008-9090-y>.
- [42] Tonso, 2006 Tonso, K. L. (2006). Teams that work: Campus culture, engineer identity, and social interactions. *Journal of Engineering Education*, 95(1), 25–37. <https://doi.org/10.1002/j.2168-9830.2006.tb00875.x>.
- [43] Simmons, D. R., Ye, Y., Ohland, M. & Garahan, K. (2017). Understanding Students' Incentives for and Barriers to Out-of-Class Participation: A Profile of Civil Engineering Student Engagement. *Journal of Professional Issues in Engineering Education and Practice*, 144(2), 04017015.
- [44] Holland, J. M., Major, D. A., Morganson, V. J., & Orvis, K. A. (2011). Capitalizing on opportunity outside the classroom: Exploring supports and barriers to the professional development activities of computer science and engineering majors. *Journal of Women and Minorities in Science and Engineering*, 17(2), 173-192.
- [45] Ambrose, S.A., Lovett, M.C., Bridges, M.W., DiPietro, M., & Norman, M.K. (2010). *How learning works: Seven research-based principles for smart teaching*. (First edition. ed., The jossey-Bass higher and adult education series). San Francisco, CA: Jossey-Bass.
- [46] Association of American Universities Undergraduate STEM Initiative. (2013). *Framework for Systemic Change in Undergraduate STEM Teaching and Learning*.
- [47] Dyer-Barr, R. (2014). Research to practice: Identifying best practices for STEM intervention programs for URMs. *Quality Approaches in Higher Education*, 5(1), 19–25. Retrieved from <http://asq.org/edu/2014/09/research-to-practice-identifying-best-practices-for-stem-intervention-programs-forurms.pdf>.
- [48] Parkinson, A. (2007), Engineering Study Abroad Programs: Formats, Challenges, Best Practices, *Online Journal for Global Engineering Education*, Vol. 2, No. 2.
- [49] Chachra, D., Chen, H. L., Kilgore, D., & Sheppard, S. (2009, October). *Outside the classroom: Gender differences in extracurricular activities of engineering students*. Paper presented at the Frontiers in Education Conference, San Antonio, TX.
- [50] Ro, H. K. (2011). *An investigation of engineering students' post-graduation plans inside or outside of engineering*. (Doctoral dissertation). Retrieved from ProQuest Dissertation and Theses. (UMI No. 3483734).

- [51] Lee, W. C., & Matusovich, H. M. (2015), *Minority/multicultural engineering program impact: A student perspective of co-curricular support*. Paper presented at the American Society for Engineering Education Annual Conference & Exposition, Seattle, WA.
<https://peer.asee.org/24494>.
- [52] Simmons, D. R. (2017). *What Should Your Students Join?: Pathways for African American Engineering Students' Development of 21st Century Competencies*. National Association of Multicultural Engineering Program Advocates (NAMEPA). Blacksburg, Virginia.