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Measuring the Impact of Experiential Learning

Dr. John H. Callewaert, University of Michigan

John Callewaert is Director of Strategic Projects in the Office of the Associate Dean for Undergraduate Education, College of Engineering, University of Michigan. He previously served as a program director with the University of Michigan's Graham Sustainability Institute, Director of the University of Michigan-Flint's Office of Research, and the Director of the Institute for Community and Environment at Colby-Sawyer College. He completed doctoral study in Resource, Policy and Behavior at the University of Michigan. His undergraduate degree is in Agricultural Engineering Technology from Michigan State University.

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Abstract

This is a research paper submitted to the Educational Research and Methods Division.

Numerous institutions are focusing on expanding experiential learning opportunities (e.g. client-based projects, international service trips, team competitions, etc.) for engineering students. Kolb [1] defines experiential learning as an iterative process involving conceptualization, active experimentation, concrete experience, and reflective observation. Experiential learning has also been identified as an important pedagogical feature of current engineering education leaders in the recent MIT report *The Global State of the Art in Engineering Education* [2]. Many believe experiential learning provides more real-world learning environments and opportunities to build skill sets that may not necessarily be provided in the classroom such as leadership, problem solving, and teamwork. However, as noted by Chan [3], while experiential learning has been increasingly explored and adopted, few have researched the appropriate assessment methods that can be aligned with the learning outcomes of experiential learning.

This paper provides an analysis of survey responses to a set of experiential learning student outcomes questions from 1500 undergraduate engineering students at the University of Michigan Ann Arbor (U-M). Responses are primarily from questions included on U-M's version of the Student Experience in the Research University (SERU) Consortium survey. The SERU Consortium is a group of leading research-intensive universities who collaborate on a range of activities including the generation of institutional, comparative, and longitudinal data on the student experience in research universities [4]. In addition to the SERU questions, several other questions were asked about the specific student experience at U-M.

In order to assess the impact of experiential learning, responses from students who had participated in one or more Michigan Engineering experiential learning opportunity such as a student competition team or a design project were compared with students who did not participate. Only activities that were intentionally designed as an experiential learning opportunity were included in the analysis.

Several key findings - all with a statistically significant difference ($p<.05$) – were identified:

- Experiential learning participants reported higher participation in other engaged learning experiences (e.g., learning communities, leadership programs, etc.) compared to non-participants.
- Participants reported higher levels of participation and leadership in student organizations.
- Participants reported less difficulty with learning about campus activities and getting involved.
- Participants reported higher levels of growth on a variety of outcomes (conducting research, leadership, comprehending academic material, understanding their field of study).
- Most interestingly, program participants reported lower ability upon entry but experienced higher levels of growth in a wide range of skills such as teamwork, writing, critical thinking, leadership and communication. This resulted in comparable or higher current levels of ability compared to non-participants.

Introduction

Numerous institutions are focusing on expanding experiential learning opportunities (e.g. client-based projects, international service trips, team competitions, etc.) for engineering students. Kolb [1] defines experiential learning as an iterative process involving conceptualization, active experimentation, concrete experience, and reflective observation. Experiential learning has also been identified as an important pedagogical feature of current engineering education leaders in the recent MIT report *The Global State of the Art in Engineering Education* [2]. Many believe experiential learning provides more real-world learning environments and opportunities to build skill sets that may not necessarily be provided in the classroom such as leadership, problem solving, and teamwork. However, as noted by Chan [3], while experiential learning has been increasingly explored and adopted, few have researched the appropriate assessment methods that can be aligned with the learning outcomes of experiential learning.

In terms of assessing experiential learning, some such as Jiusto and DiBiasio [5] have examined how such programs promote greater self-directed learners. Killen has examined the impact of experiential learning on engineering student learning retention and managing technological innovation[6]. Others have examined the impact of experiential learning in engineering courses, laboratories and project management environments[7], [8], or student research experiences [9], [10] or particular engineering disciplines [11], [12]. However, these assessments have focused on very specific or unique academic program opportunities that may not exist at other institutions. The objective of this paper is to take a program level view of experiential learning and measuring student outcomes using an existing survey instrument.

This objective connects to some of the early work sponsored in the 1970s by the American Society for Engineering Education (ASEE) that examined skills gained by students through experiential learning opportunities at several institutions. The work focused on a comparative analysis of programs and involved interviews with students, administrators, alumni, faculty, and clients. The study concluded that the programs examined developed a set of learning outcomes – such as communication - not generally achieved in traditional courses [13] (page 127). However, the work raised important questions about how experiential learning environments may stretch traditional assessment procedures beyond their credibility, for example, in the areas of interpersonal awareness, ethics, and self-confidence, [13] (page 125) thus the need for different approaches to measurement and assessment.

If experiential learning has become an important pedagogical feature of engineering education, a key challenge then is to develop an approach for measuring the impact of experiential learning that is not limited to a particular activity or course. This can provide insights into the impact and contributions of experiential learning programs throughout a student experience.

The Student Experience in the Research University Survey

One approach for analyzing the impact of experiential learning at the program level is to use the Student Experience in the Research University (SERU) survey. SERU is an online undergraduate survey that offers a systematic environmental scan of the student experience within major research-intensive universities. SERU grew out of an idea developed by John Douglass and Richard Flacks in the late 1990s to create a University of California-wide survey that focused on the academic and civic engagement of undergraduate students[14]. It employs a modular design in order to include a greater number of items and to decrease individual response times. It has a set of core questions administered to every respondent—for example, questions on time use, evaluation of a student's major and satisfaction—as well as five unique modules of additional questions that are randomly assigned. SERU is primarily focused on informing academic department program reviews, though it is also used for campus-wide for voluntary accreditation, assessment of campus climate, analysis of admission policies, or to examine particular student identity and sense of belonging questions [15], [16]. SERU has grown beyond the University of California system and is used at nearly 30 research universities in North America. The SERU consortium is focused on long-term collaboration among peer institutions and generating longitudinal data that provides a meaningful benchmark to help gauge changes in student demographics, behavior patterns, and attitudes and to analyze impact of curricular and other institutional reforms. An advantage of SERU is that while it utilizes a decentralized approach in data analysis, all members of the consortium reciprocally share their databases with each other [17], [18].

Focus Programs

The objective of this study was to use SERU data from U-M via the "University of Michigan Asks You" (UMAY) survey [19] to determine the impact of several experiential learning programs available to undergraduate engineering students. Multiple programs were included but only those offerings that involved a substantial time commitment were included in the analysis. For example, a short-term experience involving only a day or two was not included, but a design team project covering a semester or more was included. Similarly, a drop in visit to learn more about an opportunity was not included but a training program involving skill development was included. Below is a summary of the types of experiences included:

- Study abroad
- Honors
- Teaching assistant
- Design project
- Creative project
- Team competition
- Research project

Students received credit for some of the experiences but not all. Most involved an experience that was not required as part of a major degree requirement.

Methods

The primary analytical approach involved comparing the mean SERU/UMAY responses from U-M College of Engineering experiential learning program participants (program participants) with responses from students who had not participated in experiential learning programs (non-participants) and checking for statistical significance (t-test). The selected SERU/UMAY questions covered a wide range of experiential and engaged learning opportunities and activities as well as a set of self-reported growth questions for key competencies such as creativity, teamwork, and communication.

The first step involved gathering program participant data from the U-M College of Engineering experiential learning programs. Since the most recent SERU/UMAY survey responses available were from 2017, program participant data was collected from 2013-2017. This would ensure that almost every experiential learning program participant who was involved between 2013 and 2017 would have been invited to complete the SERU/UMAY survey as the University invites every undergraduate student to take the survey. Unless a student had left U-M, they would have received the survey invitation as a first year student, sophomore, junior, or senior. SERU/UMAY survey response rates for U-M range from 20-30% and that generates 5,000-8,000 responses each year. Figure 1 below provides the response rates for 2017 that show that the U-M College of Engineering response rate was very similar to the overall U-M response rate, and that while the program participant response rate was slightly higher than the non-participant response rate, they were all quite similar.

Figure 1: 2017 SERU/UMAY Response Rates

Survey Population	Respondents	Response Rate
U-M	7,351	26.7%
College of Engineering	1,541	25.7%
Program Participants	858	28.4%
Non-Participants	683	23.0%

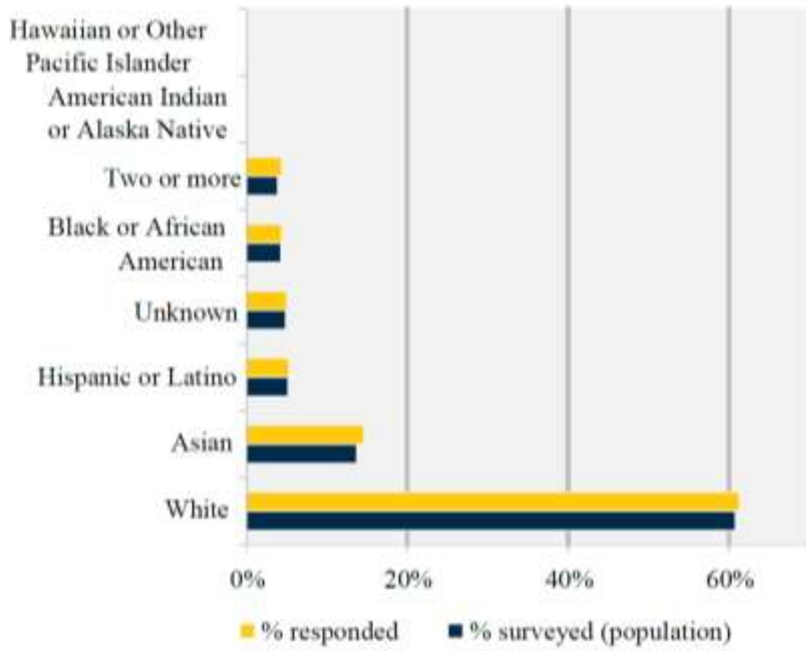
In addition, the response rates for each of the included experiential learning programs (27.9% to 34.9%) were similar to the overall U-M College of Engineering response rate that suggests that the results are representative of U-M College of Engineering students. The population of eligible respondents among program participants (n=3023) and non-participants (n=2973) was nearly equivalent. As shown in Figure 2 below, class level representation was fairly similar between the two groups with slightly more non-participants in the first year, sophomore and junior cohorts and slightly more program participants in the senior cohorts.

Figure 2: Class Level Percentages

Class Level	Program Participants	Non-Participants
First Year	5.0%	9.7%
Sophomore	19.7%	26.9%
Junior	22.4%	24.2%
Continuing Senior	36.2%	25.2%
Graduating Senior	16.7%	14.1%

At the University level, steps are taken to examine if SERU/UMAY responses are representative of U-M demographics. As shown in Figure 3, SERU/UMAY responses for 2017 were generally representative of institutional demographics.

Figure 3: Domestic Respondents by Race/Ethnicity



Results

An initial comparison of program participants and non-participants shows that program participants were more involved in a wide range of educational experiences than non-participants. As shown in Figure 4, all the differences are statistically significant and areas where participants were much more involved than non-participants were in areas such as study abroad, internships, and research or creative projects. In particular, program participants were 47% more likely to participate in research or creative projects outside of course requirements than non-participants. There may appear to be overlap in some of these experiences but there is not. For example, if a non-participant listed honors or study abroad, these experiences were gained through opportunities outside the College of Engineering. This could be through another honors or study abroad program at U-M or even outside the University but would not include those opportunities sponsored by the U-M College of Engineering. By using student ID numbers to sort program participant and non-program participants, the two groups were kept distinct.

Figure 4: Experiential Learning Program Participants and Non- Participants Comparison for Other Educational Experiences

	Program Participant Mean	Non-participant Mean	Difference*	Program Participant n	Non-participant n
Learning community	0.18	0.13	0.05	818	638
Living-learning program	0.18	0.10	0.08	820	642
Capstone or thesis project(s)	0.22	0.16	0.06	820	642
Academic service learning or community-based learning experience	0.17	0.12	0.05	817	640
Research or creative project outside of regular course requirements	0.50	0.34	0.16	818	641
Credit bearing internship, practicum, or field experience	0.16	0.07	0.09	816	641
Non-credit bearing internship, practicum, or field experience	0.46	0.36	0.10	819	637
Honors program	0.10	0.04	0.06	818	641
Leadership program	0.14	0.09	0.05	817	639
On campus academic experiences with an international/global focus	0.18	0.06	0.12	818	642
Study abroad academically-focused time outside of the U.S. for credit	0.33	0.03	0.30	819	641

Scale: 1= Yes, 0= No
*Denotes a statistically significant difference at p<.05
Program Participant mean is greater than Non-participant mean

In terms of academic engagement (Figure 5), program participants also reported higher levels than their non-participants peers in areas such as working with faculty on research or other non-course related activities, pursuing independent studies, and greater satisfaction with educational enrichment programs.

Figure 5: Academic Engagement among Experiential Learning Program Participants and Non- Participants

	Program Participant Mean	Non-participant Mean	Difference*	Program Participant n	Non-participant n
How frequently - Worked with faculty on an activity other than coursework[a]	2.08	1.68	0.40	848	678
Currently doing or have done - At least one independent study course[b]	0.15	0.10	0.05	815	642
Currently doing or have done - Assist faculty in conducting research[c]	0.36	0.28	0.08	814	635
How satisfied - Educational enrichment programs[d]	4.59	4.43	0.16	788	614

[a]Scale: 1= never, 2= one time, 3= two times, 4= three or more times
[b]Scale: 1= Yes, 0= No
[c]Scale: 1= Yes, 0= No
[d]Scale: 1= very dissatisfied, 2= dissatisfied, 3= somewhat dissatisfied, 4= somewhat satisfied, 5= satisfied, 6= very satisfied
*Denotes a statistically significant difference at p<.05
Program Participant mean is greater than Non-participant mean

Another area where results for program participants were consistently higher than non-program participants was in the areas of student organization engagement. In addition to participation, program participants were more likely to report engagement related to leadership such as chairing a meeting and delegating tasks to others (Figure 6) and were 36% more likely to be an officer in a student organization than non-participants.

Figure 6: Student Organization Engagement among Experiential Learning Program Participants and Non- Participants

	Program Participant Mean	Non-participant Mean	Difference*	Program Participant n	Non-participant n
How many hours - Participating in student clubs or organizations[a]	2.78	2.29	0.49	825	641
Ever participated in a student organization[b]	0.87	0.71	0.16	795	623
Are you or have you been an officer of a student organization[b]	0.57	0.42	0.15	686	441
How often in student org - Chaired a meeting[c]	2.07	1.67	0.40	686	440
How often in student org - Planned an event[c]	2.22	2.00	0.22	688	440
How often in student org - Promoted or marketed an event[c]	2.21	2.04	0.17	686	437
How often in student org - Led or facilitated a discussion[c]	2.27	1.95	0.32	686	439
How often in student org - Recruited new members for the organization/club[c]	2.35	2.12	0.23	689	440
How often in student org - Partnered with community org/organized outreach event[c]	1.82	1.69	0.13	687	441
How often in student org - Developed a budget[c]	1.73	1.53	0.20	688	441
How often in student org - Delegated tasks to others[c]	2.48	2.06	0.42	688	441

[a]Scale: 1= none, 2= 1-5 hrs, 3= 6-10 hrs, 4= 11-15 hrs, 5= 16-20 hrs, 6= 21-25 hrs, 7= 26-30 hrs, 8= More than 30 hrs
[b]Scale: 1= Yes, 0= No
[c]Scale: 1= never, 2= 1-2 times, 3= 3-5 times, 4= more than 5 times
*Denotes a statistically significant difference at p<.05
Program Participant mean is greater than Non-participant mean

One area that generated different results concerned student reported levels of proficiency and ability for a set of skills such as critical thinking, leadership, understanding international perspectives, and research. In this question module, students were asked to rate their skills when they started at U-M against their skill level now. Figure 7 only provides statistically significant differences, but in general, program participants rated their entry proficiency levels lower than non-participants. However, in several areas program participants reported greater growth in proficiencies from when they started to now. These included analytical and critical thinking, leadership, taking and giving a presentation, and teamwork. In terms of leadership, program participants reported a mean skill growth of 25% in leadership whereas non-participants reported a mean skill growth of 14%.

It is important to note that these scores were all from the same period (2017). The results do not compare student responses from when they started with 2017. This means students are reflecting back to their skill levels when they started. This could demonstrate more growth among program participants than non-participants. An alternative explanation that is that program participants develop greater awareness of these proficiencies through the experiential learning opportunities and are perhaps more self-critical of their entry skill levels than non-participants. Additional investigation would be needed to confirm if this is true or not.

Figure 7: Levels of Proficiency and Ability

	Program Participant	Non-participant		Program Participant	Non-participant
	Mean	Mean	Difference*	n	n
When you started here - Analytical & critical thinking skills	3.95	4.09	-0.14	788	616
Now - Analytical & critical thinking skills	4.90	4.81	0.09	785	616
When you started here - Ability to read and comprehend academic material	3.68	3.81	-0.13	787	616
When you started here - Understanding your field of study	2.83	3.00	-0.17	785	616
When you started here - Quantitative skills	3.98	4.15	-0.17	786	614
When you started here - Ability to understand international perspectives	3.41	3.58	-0.17	779	612
When you started here - Leadership skills	3.59	3.81	-0.22	778	612
Now- Leadership skills	4.47	4.33	0.14	778	612
When you started here - Ability to prepare and make a presentation	3.62	3.79	-0.17	778	612
Now- Ability to prepare and make a presentation	4.67	4.54	0.13	778	612
When you started here - Ability to design, conduct, evaluate research	2.97	3.11	-0.14	778	612
When you started here - Interpersonal and teamwork skills	3.84	3.99	-0.15	778	612
Now- Interpersonal and teamwork skills	4.81	4.65	0.16	778	612

Scale: 1= very poor, 2= poor, 3= fair, 4= good, 5= very good, 6= excellent
*Denotes a statistically significant difference at p<.05
Program Participant mean is greater than Non-participant mean
Program Participant mean is less than Non-participant mean

A student growth module that is not part of SERU but was included as part of UMAY involved an analysis of U-M engaged learning activities (creativity, intercultural engagement, social/civic responsibility, collaboration, and self-agency). As with most of the results shared above, program participants reported more growth than did non-participants (see Figure 8 below). For example, program participants reported a 7% higher rate of growth in collaboration, communication and teamwork.

Figure 8: Self-reported Levels of Growth in Outcomes Related to Engaged Learning

	Program Participant	Non-participant		Program Participant	Non-participant
	Mean	Mean	Difference*	n	n
Rate your growth -Creativity - the ability to understand creative processes and your own capacity to create new works and ideas	2.75	2.62	0.13	746	594
Rate your growth -Intercultural engagement - ability to understand the role of values and culture in driving decisions	3.01	2.84	0.17	744	593
Rate your growth -Social/civic responsibility - ability to understand impacts of actions, and reason across the perspectives	2.88	2.77	0.11	744	593
Rate your growth -Collaboration, communication, and teamwork - the ability to communicate with many audiences; to appreciate and	3.30	3.09	0.21	746	592
Rate your growth -Self-agency, the ability to innovate and to understand and manage risks	3.08	2.94	0.14	744	590

Scale: 1= very little or none, 2= little, 3 = some, 4= very much
*Denotes a statistically significant difference at p<.05
Program Participant mean is greater than Non-participant mean

Finally, two areas which may be connected to program participants' higher levels of engagement and self-assessment concern questions about the level of difficulty students experience navigating campus structures (Figure 9) and their sense of belonging (Figure 10). Program participants reported less difficulty assessing information, getting involved and finding ways to get involved in clubs and organizations. Similarly, program participants reported a greater sense of feeling valued and belonging than non-participants. There may be a positive interaction between these two areas and involvement in experiential and engaged learning opportunities. It is not difficult to imagine a student who is more involved in these opportunities reporting that they are have less difficulty navigating campus structures and that they belong.

Figure 9: Navigating Campus Structure

	Program Participant	**Non-participant**		**Program Participant**	**Non-participant**
	Mean	Mean	Difference*	n	n
Level of difficulty - Accessing information about academic opportunities	3.72	3.48	0.24	735	569
Level of difficulty - Getting involved in campus programs outside of the classroom	3.50	3.25	0.25	675	532
Level of difficulty - Finding ways to get involved in student clubs & organizations	3.80	3.53	0.27	744	571

Scale: 1=very difficult, 2= difficult, 3= neutral, 4= easy, 5= very easy
*Denotes a statistically significant difference at p<.05
Program Participant mean is greater than Non-participant mean

Figure 10: Sense of Belonging

	Program Participant	**Non-participant**		**Program Participant**	**Non-participant**
	Mean	Mean	Difference*	n	n
Agree or disagree - I feel valued as an individual at this campus	4.28	4.13	0.15	778	611
Agree or disagree- I feel that I belong at this University	4.74	4.58	0.16	777	611

Scale: 1= strongly disagree, 2= disagree, 3= somewhat disagree, 4= somewhat agree, 5= agree, 6= strongly agree
*Denotes a statistically significant difference at p<.05
Program Participant mean is greater than Non-participant mean

Conclusion

This paper has offered an approach for measuring the impact of experiential learning opportunities at the program level. Rather than examining the impact of such opportunities within a particular course or experience, institutional results from the Student Experience in the Research University (SERU) survey were used to compare the self-reported information from two undergraduate engineering groups – experiential learning program participants and non-participants at the University of Michigan. Results show that program participants report higher levels of key competencies, growth, participation, engagement, and sense of belonging. One area where program participants reported lower levels was their self-assessment of a range of skills when they started compared to the present. This could demonstrate greater growth over time than non-participants or a more-critical self-assessment by program participants of their entry-level abilities.

At the U-M College of Engineering, the results from these analyses are already being used to convey the value of experiential learning. This includes a new experiential learning marketing campaign directed at incoming and current students. Results are also being used to inform an experiential learning credentialing requirement that the College if currently discussing.

An important overall contribution of this work to engineering education practice is providing a data-driven assessment of programs that normally rely on anecdotal information or simply the number of participants in a particular program. Given that most of the results were from the common SERU survey tool, there is also the possibility of comparing student responses across schools. This could be very useful to institutions that are seeking to understand or improve their position among peers or to determine the value of experiential learning programs.

It is important to note that all of the results used in this analysis come from student self-reported survey responses. An important next step in the work is to develop ways to compare these results to other indicators of student engagement and growth through more objective measures such as an assessment of student work or competency assessments. Other future work which could expand the analysis discussed in this paper include an analysis of years of involvement and number of involvements for program participants as well as pre-involvement variables such as similar experiences before college and demographic variables.

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