2021 ASEE ANNUAL CONFERENCE
Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time
Paper ID #33693

Sustainable Bridges from Campus to Campus: The Creation and Conduct of Online Synchronous Summer Bridge Programs in 2020

Dr. Catherine L. Cohan, Pennsylvania State University

Catherine Cohan, Ph.D. has been a research psychologist for over 20 years. Her areas of expertise include engineering education, retention of underrepresented students, measurement, and assessment. She is currently an Assistant Research Professor and coordinates the Sustainable Bridges NSF IUSE project (Peter Butler, PI). Previously, she was the project coordinator the the Toys'n MORE NSF STEP project (Renata Engel, PI).

Dr. Lauren A. Griggs, Pennsylvania State University

Dr. Griggs received her B.S. in Engineering Science, with a concentration in Nanomedicine from The University of Virginia in 2012. As a doctoral student in the Department of Biomedical Engineering at Virginia Commonwealth University, Dr. Griggs was awarded the Ruth L. Kirschstein National Research Service Award Individual Predoctoral Fellowship through the National Institute of Health. As the Program Coordinator for the VCU Louis Stokes Alliance for Minority Participation program, she worked to increase the number of underrepresented minority students earning baccalaureate degrees and matriculating to graduate school. As a postdoctoral scholars at Vanderbilt University, Dr. Griggs explored novel techniques to investigate the intersection of diabetes and breast cancer progression. Dr. Griggs is now an Assistant Teaching Professor, Director of the Multicultural Engineering Program and Director of the Clark Scholars Program at Penn State University. In this role, Dr. Griggs drives initiatives to improve the recruitment and retention of underrepresented groups pursuing degrees in engineering and strives to foster a welcoming environment that celebrates culture and inclusion. Her passion lies in working directly with students, serving as an advisor, inspiring others through meaningful career discussions and helping others to gain confidence as well as succeed in their chosen degree fields.

Dr. Ryan Scott Hassler, Pennsylvania State University

Associate Teaching Professor of Mathematics

Research Interests: First Year Engineering Student Success, summer bridge programs Mathematics retention of underrepresented minority students Conceptual Understanding, mathematical situation models Hybrid learning, instructional technology Early Algebra, textbook analysis

MS Applied Statistics PhD Mathematics & Science Education

Mark William Johnson, Pennsylvania State University, Altoona Campus

Mark W. Johnson is Professor of Mathematics with primary research areas in Algebraic Topology and Category Theory, as well as an ongoing interest in preparing future engineers, especially those from under-represented groups, for the mathematical challenges inherent in their chosen degree.

Dr. Michael Kagan, Pennsylvania State University, Ogontz Campus

Michael (Mike) Kagan is an associate professor of physics at Penn State Abington. He received a Ph.D. in Physics from the Pennsylvania State University. Dr. Kagan's research interests are diverse and include Quantum Gravity and Cosmology, Physical Applications of Graph Theory, as well as Physics Education. Dr. Kagan has over twenty years of experience teaching math, physics and astronomy at middle, high school and university level. For the last several years, he has implemented Investigative Science Learning Environment (ISLE) in his classes. Dr. Kagan has been an AP Physics Reader (grader) and a coach for the National Physics Team.

Dr. Peter J. Butler, Pennsylvania State University
Dr. Tonya L. Peeples, Pennsylvania State University

Professor Tonya Peeples joined the Penn State College of Engineering in August of 2018, as the Inaugural Associate Dean for Equity and Inclusion and Professor of Chemical Engineering. Prior to joining Penn State she worked at the University of Iowa and in her 23 years at UI, served to advance diversity and promote opportunities for all students to pursue education and careers in Science Technology Engineering and Mathematics (STEM). As an individual researcher, an administrator and as a leader in the state and national community, Dr. Peeples has made an impact on improving access to STEM careers through personal commitment, local partnerships, institutional leadership and effective collaboration. Dr. Peeples is biochemical engineering researcher and served as Associate Director of the UI Center for Biocatalysis and Bioprocessing and on the coordinating committee for the National Institutes of Health (NIH) training grant in biotechnology. As a Professor, she has mentored a diverse group of high school, undergraduate and graduate students including three high school students, 64 undergraduate and 13 graduate students, and three postdoctoral fellows. Several of her graduate and undergraduate student researchers have won local, regional and national awards for their work. Dr. Peeples is influencing faculty and institutional leaders through leadership in the Aspire Alliance, an NSF INCLUDES collaborative effort. On her academic leadership roles she has implemented search committee training on implicit bias and best practices for recruiting diverse faculty. As a leader in the University Center for Exemplary Mentoring funded by the Alfred P. Sloan Foundation, she trains faculty in mentoring minority students. These activities are ”game changers” in helping engineering programs enhance enrollment growth and increasing numbers of women and minority students, faculty and staff. She has established collaborations to extend a welcoming environment to all students. She has received numerous awards for service to the local state and national STEM communities, including Outstanding Service Award from the American Institute of Chemical Engineers (AIChE) Minority Affairs Committee, the Collegiate Service Award from the UI CoE, the Michael J. Brody Award for Faculty Excellence in Service, the UI Diversity Catalyst Award. In 2015 she was the recipient of the Pioneers of Diversity Award from AIChE. In 2016 she was a fellow of the Executive Leadership in Academic Technology and Engineering and Sciences (ELATES) program. She is a fellow of the American Institute of Medical and Biological Engineering.

Sustainable bridges from campus to campus: The creation and conduct of online synchronous summer bridge programs in 2020 (NSF IUSE #1525367)

Abstract

Purpose: The purpose of the *Sustainable Bridges from Campus to Campus* project (NSF IUSE #1525367, known locally as *Engineering Ahead*) is to establish summer bridge programs that serve Engineering students at regional campuses of The Pennsylvania State University. In 2016, residential summer bridge programs for incoming Engineering students were started at the Abington, Altoona, and Berks campuses patterned after a successful long-standing bridge program at the Penn State University Park campus. Recruitment focuses on enrolling racially underrepresented domestic students (i.e., African American, Hispanic American, Native American, Pacific Islander), women, and first-generation students in Engineering into the bridge programs. The project also supports an established summer bridge program for racially underrepresented incoming Engineering students at the flagship University Park campus. In 2020 (Year 5 of the project) because of the COVID-19 pandemic and restrictions on in-person gathering, the *Engineering Ahead* residential bridge programs were converted to online synchronous summer bridge programs. This paper presents data on recruitment, enrollment, retention, and students' perceptions of belonging and mattering over time.

Goals: The overarching goal of this project is to increase retention and graduation among racially underrepresented Engineering students, with a focus on students who start their Penn State education at a regional campus. Since their inception, the *Engineering Ahead* summer bridge programs try to increase retention and graduation through three strategies: intensive math review (pre-calculus, calculus), community building, and professional development. Central topics and questions for this paper are how we conducted online bridges, what was offered, student enrollment and retention, what we learned from the process, can social integration among students be achieved virtually, and what were student perceptions of the online bridge experience?

Method: Accepted incoming Engineering students (summer and fall 2020) at the Abington, Altoona, Berks, and University Park campuses were encouraged to apply via letter, email, and presentations at accepted student programs to an online summer bridge program to support success in math and science during the first year. Eighty-six incoming students enrolled in the four online bridge programs for incoming first-year Engineering students.

Results: We reliably assessed students' sense of belonging and perceived college mattering using standardized measures. Repeated measures analyses showed that there was a significant increase over the 4-week bridge programs of students' sense of belonging and perceived mattering.

Conclusions: An important component of summer bridge programs is fostering a sense of community and interpersonal bonds among the students. Results showed that students enrolled in online bridge programs reported significant increases in their sense of belonging and perceived college mattering over four weeks. It appears we captured some of the benefits of summer bridge programs even though they were not residential.

Sustainable bridges from campus to campus:
The creation and conduct of online synchronous summer bridge programs in 2020
(NSF IUSE #1525367)

The purpose of the *Sustainable Bridges from Campus to Campus* project (NSF IUSE #1525367, known locally as *Engineering Ahead*) is to establish summer bridge programs that serve Engineering students at regional campuses of The Pennsylvania State University. In 2016, residential summer bridge programs for incoming Engineering students were started at the Abington, Altoona, and Berks regional campuses. Recruitment focuses on enrolling racially underrepresented domestic students (i.e., African American, Hispanic American, Native American, Pacific Islander), women, and first-generation students in Engineering into the bridge programs. (Penn State defines first-generation students are those whose parents did not attend college.) The project also supports an established summer bridge program for racially underrepresented incoming Engineering students at the flagship University Park campus. In 2020 (Year 5 of the project), the COVID-19 pandemic restricted in-person gathering. Rather than cancel the summer programs, the *Engineering Ahead* residential bridge programs were converted to online synchronous summer bridge programs. Because community building happens naturally in residential bridge programs, we wondered whether or not it would develop in bridge programs that were administered online and synchronously. We operationalized "community building" as the development over time of a *sense of belonging* and perceived *mattering*. This paper presents data on change overtime during the summer bridge programs in students' perceptions of a sense of belonging and mattering.

The transition to college often involves leaving the established bonds of family and friends to enter a new social environment in which the student may not know anyone and no one knows them. In addition to academic preparation, summer bridge programs can integrate new students into the college community by building relationships with other new students, faculty, and staff and mitigate feelings of being untethered, alone, or disconnected. To examine the development of social integration for incoming engineering students, we assessed sense of belonging and perceived mattering. The construct "sense of belonging" has been examined as a factor related to persistence and retention in college. In a college student population, "sense of belonging" can be defined as "subjective sense of affiliation and identification with the university community," (p. 228), "interpersonal relatedness," (p 229), and the opposite of loneliness (Hoffman, Richmond, Morrow & Salomone, 2002-2003). The construct "perceived mattering" is defined here as "relationships to specific others (e.g., faculty, counselors/advisors, other students)" that engender "the feeling that others are dependent on us, are interested in us, are concerned with our fate, care about us, and appreciate us" (Tovar, Simon, & Lee, 2009; 158, 159).

Procedure and Participants

Incoming engineering students at the Penn State Abington, Altoona, Berks, and University Park campuses were invited to apply for a math-intensive online synchronous summer bridge program via email, regular mail, and presentations at admitted-student programs. The bridge programs also focused on professional development, community building, and campus resources. The online bridge programs at the regional campuses were four weeks long. The

University Park bridge program was six weeks long. The programs were full-time and ran from 9am to 4pm or 5pm with some evening activities. On Friday at the end of each week, students were asked to complete online surveys that contained perceived mattering and sense of belonging scales. Students who successfully completed the bridge program received a $500 scholarship. A total of 84 students participated. Enrollment in each program was as follows: Abington 22, Altoona 9, Berks 22, University Park 31. Table 1 shows the demographic characteristics of the Cohort 5 participants. Seventy-three percent are male. Forty-seven percent are racially underrepresented. Thirty-seven percent of the bridge students are first-generation college students.

Table 1. Background Characteristics for Cohort 5 Bridge Students

	Bridge Students	
Variables	N	%
Gender		
Male	61	73
Female	23	27
Ethnicity		
African American	19	23
Asian	11	13
Hispanic	19	23
Native American/Pacific Islander	1	1
White	34	41
First-Generation College Student	31	37

Note: Total *N* = 84 (n = 53 regional campus bridge students, n = 31 flagship campus bridge students).

Results

Results involving longitudinal data were presented separately for the 4-week summer bridges and the 6-week summer bridge. Tables 2 and 3 show the weekly College Mattering Inventory scores for the 4- and 6-week bridge programs. Visual inspection of the means showed increases over time in the total score and the subscale scores. Tables 4 and 5 show the weekly Sense of Belonging Scale scores for the 4- and 6-week bridge programs. Visual inspection of the means showed increases over time in the total score and the subscale scores with a positive meaning and a decrease over time in the subscale with a negative meaning.

To examine the associations among the total scores and subscale scores, Tables 6 and 7 show the Cronbach's alpha reliability measurements and the within-scale intracorrelations for the College Mattering Inventory and the Sense of Belonging Scale at Week 1. The total scale scores and the subscales were reliable for the most part. Several of the subscales had marginal reliability with alpha coefficients less than 80. However, for the purposes of this paper, we focused on the total scale scores and not the subscale scores for the substantive analyses examining change over

time. The subscales correlated as expected such that scales with a positive valence were significantly positively correlated and scales with a negative valence were significantly correlated to the positively valenced subscales in a negative direction. Table 8 shows the intercorrelations for the College Mattering Inventory and the Sense of Belonging Scale. Most of the variables for each scale were associated in logical ways with the other scale. The two total scale scores were correlated .68, moderately high. Put another way, the two total scale scores shared 46% of their variance indicating that the constructs tap into similar ideas but are not redundant with each other. It is not immediately clear why the Mattering to Instructors subscale was unrelated to any of the Sense of Belonging scales.

Table 2. Weekly College Mattering Inventory Scores During Virtual 4-Week Summer Bridge Programs 2020

			Week							
			1		2		3		4	
			n = 47		n = 43		n = 37		n = 26	
Construct	**# Items**	**Range**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Total Mattering Scale	29	29-145	102.1	15.6	101.2	19.8	103.8	18.8	110.4	17.4
General College Mattering	8	8-40	24.9	5.5	5.7	7.0	26.0	6.1	29.4	5.0
Mattering vs Marginality	6	6-30	22.3	5.8	6.0	9.0	22.4	6.5	22.5	6.7
Mattering to Counselors	5	5-25	17.3	4.5	17.5	4.7	17.2	5.2	19.0	408
Mattering to Instructors	4	4-20	11.0	1.4	10.2	2.3	11.2	1.3	11.2	1.4
Mattering to Students	3	3-15	7.6	1.9	7.9	2.5	8.9	2.3	9.5	3.0
Perception of Value	3	3-15	12.2	2.0	11.6	2.2	11.8	2.4	12.5	1.8
Note: Total N = 53. Scale = 1-5.										

Table 3. Weekly College Mattering Inventory Scores During Virtual 6-Week 2020 Summer Bridge Programs

			Week											
			1		2		3		4		5		6	
			n = 26		n = 28		n = 28		n = 28		n = 25		n = 26	
Construct	**# Items**	**Range**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Total Mattering Scale	29	29-145	113.3	12.9	113.7	14.2	116.3	14.5	121.0	14.8	121.1	15.7	122.5	16.9
General College Mattering	8	8-40	30.1	5.1	30.2	4.9	30.5	4.7	32.8	4.9	32.0	5.2	33.9	5.1
Mattering vs Marginality	6	6-30	22.8	4.8	22.5	5.2	23.4	4.9	24.3	4.5	23.9	5.2	23.2	6.6
Mattering to Counselors	5	5-25	19.9	2.9	20.4	2.9	21.0	3.2	21.7	3.2	21.6	3.7	22.7	3.1
Mattering to Instructors	4	4-20	11.6	1.0	11.3	1.9	11.4	1.6	11.2	1.7	11.6	1.2	10.6	2.1
Mattering to Students	3	3-15	9.0	2.8	9.1	2.6	10.0	2.8	10.6	2.3	11.3	2.6	11.4	3.0
Perception of Value	3	3-15	13.1	1.7	13.3	1.8	13.3	2.0	13.2	2.0	13.4	1.8	13.7	2.0
Note: Total N = 31.														

Table 4. Weekly Sense of Belonging Scores During Virtual 4-Week 2020 Summer Bridge Programs

			Week							
			1		2		3		4	
			n = 46		n = 43		n = 37		n = 26	
Construct	**# Items**	**Range**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Total Sense of Belonging Score	26	1-5	3.3	.4	3.4	.5	3.4	.6	3.6	.6
Peer Support	8	1-5	2.9	.7	3.1	.8	3.3	.9	3.4	.9
Faculty Support	6	1-5	3.7	.8	3.8	.8	3.8	.9	3.9	1.0
Classroom Comfort	4	1-5	3.6	1.1	3.8	1.0	3.7	1.0	3.9	1.1
Isolation	4	1-5	2.8	.9	2.6	.9	2.5	1.1	2.6	1.1
Empathic Faculty Understanding	4	1-5	3.7	.7	3.8	.7	3.8	.8	4.0	.9
Note: Total N = 53.										

Table 5. Weekly Sense of Belonging Scores During Virtual 6-Week 2020 Summer Bridge Programs

			Week											
			1		2		3		4		5		6	
			n = 26		n = 28		n = 28		n = 28		n = 25		n = 25	
Construct	**# Items**	**Range**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Total Sense of Belonging Score	26	1-5	3.4	.4	3.5	.4	3.6	.5	3.7	.5	3.7	.4	3.9	.5
Peer Support	8	1-5	3.5	.8	3.4	.9	3.5	.8	3.7	.8	3.8	.8	4.1	.9
Faculty Support	6	1-5	3.7	.7	3.8	.8	4.0	.7	4.2	.7	4.2	.8	4.4	.7
Classroom Comfort	4	1-5	3.3	1.1	3.6	1.0	3.6	1.1	3.8	1.1	3.9	1.1	4.1	1.1
Isolation	4	1-5	2.5	1.0	2.5	1.0	2.4	1.0	2.2	.9	2.2	1.0	2.1	1.1
Empathic Faculty Understanding	4	1-5	4.0	.6	4.3	.5	4.3	.5	4.3	.6	4.4	.6	4.5	.6
Note: Total N = 30.														

Table 6. Reliability and Intracorrelations for the College Mattering Inventory (Week 1)

Scale	α	1	2	3	4	5	6	7
1. Total Score	.89	--	.82***	.72***	.81***	.28*	.46***	.64***
2. General College Mattering	.81		--	.35**	***.69	.17	.44***	.41***
3. Mattering vs. Marginality	.87			--	.39**	.20	.14	.44***
4. Mattering to Counselors	.82				--	.17	.22	.46***
5. Mattering to Instructors	.77					--	.21	.16
6. Mattering to Students	.68						--	.20
7. Perception of Value	.63							--

Note: N = 73. *** p < .001. ** p < .01. * p < .05.

Table 7. Reliability and Intracorrelations for the Sense of Belonging Scale (Week 1)

Scale	α	1	2	3	4	5	6
1. Total Score	.74	--	.70***	.80***	.71***	-.51***	.70***
2. Peer Support	.84		--	.34**	.25*	-.67***	.39**
3. Faculty Support	.79			--	.67***	-.51***	.46***
4. Classroom Comfort	.92				--	-.48***	.32**
5. Isolation	.77					--	-.25*
6. Empathic Faculty Understanding	.70						--

Note: N = 72. *** p < .001. ** p < .01. * p < .05.

Table 8. Correlations Between the Sense of Belonging and Perceived Mattering Scales (Week 1)

	Sense of Belonging Scales					
Mattering Scales	Total Score	Peer Support	Faculty Support	Classroom Comfort	Isolation	Empathic Faculty Understanding
Total Score	.68***	.57***	.57***	.38**	-.50***	.57***
General College Mattering	.45***	.52***	.24*	.00	-.22	.45***
Mattering vs. Marginality	.52***	.37**	.54***	.48***	-.53***	.33**
Mattering to Counselors	.54***	.38**	.44***	.32**	-.33**	.52***
Mattering to Instructors	.10	.10	.04	.05	-.10	.19
Mattering to Students	.46***	.56***	.25*	.20	-.34*	.26*
Perception of Value	.42***	.32**	.43***	.22	-.31**	.33**

Note: N = 72.

We conducted repeated measures analyses of the total scale score for sense of belonging and for perceived mattering to answer the substantive question of whether students reported increases over the course of their virtual bridge programs. To maximize the sample size and statistical power, we examined the change over time for four weeks for all of the programs together. For each analysis, we examined change in total scale scores as a function of time (within-subjects variable) and which bridge program (between-subjects variable). For the Sense of Belonging Scale, **there was a significant main effect of Time [F(3,120) = 9.35, p < .001)] indicating that students' scores changed significantly over four weeks**. The Summer Bridge between-subjects factor was not significant [F(3,40) = 1.31, ns], indicating that sense of belonging scores were similar across the different bridge programs. The Time x Bridge Program interaction was not significant [F(9, 120) =1.63, ns], indicating that changes in sense of belonging over time did not differ by which summer bridge the students attended. Post-hoc analysis of the estimated marginal means showed that **sense of belonging ratings at Week 4 were significantly higher than at Week 1 (3.70 vs. 3.41, p < .001), Week 2 (3.70 vs 3.47, p < .001), and Week 3 (3.70 vs 3.5, p < .05)**. Sense of belonging at Weeks 1, 2, and 3 did not differ from each other. Figure 1 illustrates the pattern of results for students' sense of belonging.

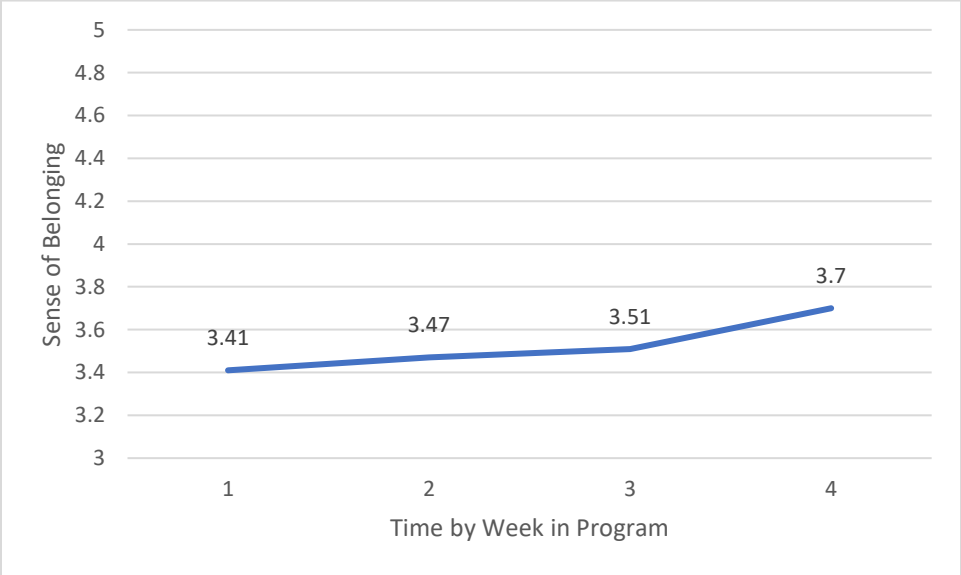

Figure 1. Sense of Belonging Over 4 Weeks During Online Bridge Programs

Next we examined perceived college mattering over four weeks for the bridge students. Similar to the sense of belonging scale, **there was a significant main effect of Time [F(3,117) = 8.96, p < .001)] indicating that students' mattering scores changed significantly over four weeks**. The Summer Bridge between-subjects factor was also significant [F(3,39) = 4.11, p , .05], indicating that perceived college mattering scores differed across the bridge programs. The Time x Bridge Program interaction was not significant [F(9, 117) =1.41, ns], indicating that changes in perceived mattering over time did not differ by which summer bridge the students attended. Post-hoc analysis of the estimated marginal means for the Time factor showed that **mattering ratings at Weeks 3 and 4 were significantly higher than at Time 1 and Week 4 was higher than Week 2**. Mattering at Weeks 1 and 2 and Weeks 2 and 3 did not differ from each other. Figure 2 illustrates the results for perceived college mattering. Post hoc analysis of the Bridge factor showed that the University Park students reported significantly higher

perceived mattering than the Abington students. Figure 3 shows the main effect for Bridge program.

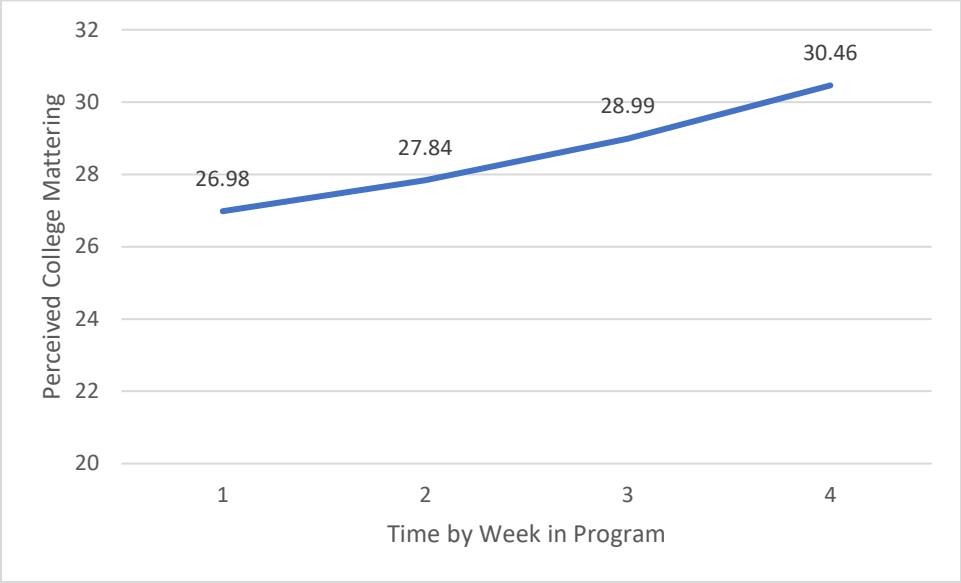

Figure 2. Perceived College Mattering Over 4 Weeks During Online Summer Bridge Programs

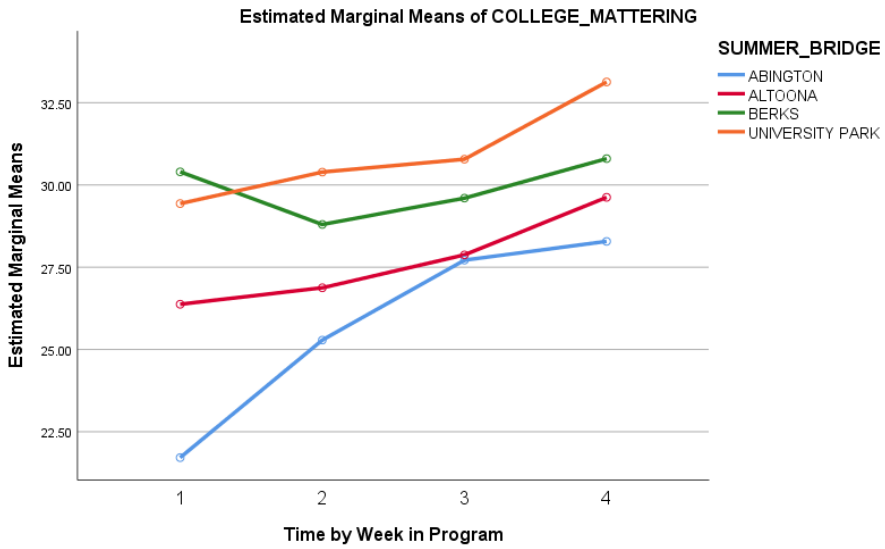

Figure 3. Perceived Mattering and the Main Effect of Bridge Program During Online Summer Bridge Programs

Discussion and Conclusions

In 2020 the *Engineering Ahead* project quickly retooled math-intensive in-person bridge programs at four campuses in The Pennsylvania State University system to offer them virtually and synchronously over either four or six weeks. An important component of summer bridge programs is fostering a sense of community and interpersonal bonds among the students. The purpose of this paper was to examine whether students' perceived mattering and sense of belonging changed over time during the course of the bridge programs. "The common agenda and similar struggles further encouraged student/peer interactions and helped to create meaning bonds between students that are characterized by support rather than mere social unions." (p. 252) Hoffman et al (2002-2003) made this observation about learning communities, however it also aptly describes students' residential summer bridge experience. We wondered if an online summer bridge context would also engender meaningful bonds. Results showed that students enrolled in online bridge programs reported significant increases in their sense of belonging and perceived college mattering over four weeks. It appears we captured some of the benefits of summer bridge programs even though they were not residential. Further analysis will examine whether students' sense of belonging and perceived mattering had longer term benefits in terms of academic performance during the fall semester or retention after the first and second semesters. As a point of comparison, future research should include the assessment of sense of belonging and mattering among students who do not participate in a summer bridge program.

Acknowledgements

We are grateful to the National Science Foundation for supporting the Sustainable Bridges project. Please note that any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation. We would also like to express gratitude for these additional financial and in-kind support: the Penn State Office of the Vice Provost for Educational Equity, Accudyne Systems, the Albert and Suzanne Lord Endowment at Penn State Abington, ArcelorMittal, the Barbara Bogue Enrichment Endowment for Women in Engineering, the Guion Bluford Alumni Leadership Endowment for the Multicultural Engineering Program, Bosch Rexroth, the Getz Endowment at Penn State Altoona, Lockheed Martin, the Lucier Endowment, the Lubrizol Endowment, the Multicultural Engineering Program (MEP) Support Endowment, the National Society for Black Engineers Program Endowment, and the Pifer Endowment at Penn State Berks.

References

Hoffman, M., Richmond, J., Morrow, J., & Salamone, K. (2002-2003). Investigating "Sense of Belonging" in first-year college students. *Journal of College Student Retention, 4*, 227-256.

Tovar, E., Simon, M. A., & Lee, H. B. (2009). Development and validation of the College Mattering Inventory with diverse urban college students. *Measurement and Evaluation in Counseling and Development, 42*, 154-178.