ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #37719

Engineering Strong Bridges: Review of College Bridge Programs

Dr. Diane L Peters P.E., Kettering University

Dr. Peters is an Associate Professor of Mechanical Engineering at Kettering University.

Engineering Strong Bridges: Review of College Bridge Programs

Abstract

In an effort to promote the retention and success of undergraduate students, many universities have established bridge programs. These programs are intended to help students who are talented, but need extra preparation to transition successfully from high school and perform at a college level, and have the goal of ensuring that students will be able to succeed and persist in their programs. The programs vary in size, length, structure, and specific focus, and there are many published papers describing individual programs at different universities and presenting evaluation data that has been collected. However, there is a lack of work comparing these programs or synthesizing the research on them. This paper presents a literature review on bridge programs, with a specific focus on engineering bridge programs. Some of the characteristics that are compared are the length of the programs, their structure, and the topics included. Assessment data that has been collected is also noted, as is the degree to which programs have used that assessment data to inform their programs. The comparisons include both key similarities and major differences between bridge programs, and indicate what best practices are known as well as where there are gaps in knowledge related to bridge programs.

Introduction

Students' college readiness varies, with some students well prepared to succeed and others far less prepared. Those less prepared students are not necessarily less intelligent, but may have faced challenges or lack of opportunities in their high school education. In order to address their gaps in preparedness, some schools have established programs to better prepare those students for their freshman year, with the goal of equipping them for long-term success in college. These programs are often called "bridge" programs, as they bridge the gap between high school and college. Such programs vary tremendously in length, content, and structure, with no universally agreed-upon standard for what they should look like.

Many such programs have been reported in the literature, with some of the papers being primarily descriptive and others containing some type of rationale or evaluation for the programs described. Despite the large number of papers published on such programs, several works [1, 2, 3] refer to a lack of research or literature on the topic, including some that were published after a large number of other papers had appeared. This suggests that there may be a lack of awareness of the scale and scope of literature on the topic. This review paper, therefore, can help to fill in this gap in awareness by presenting a broad overview of many different bridge programs, as well as setting forth some of the key common features and differences seen among them.

Methods

In conducting this literature review, it was necessary to set some parameters for what would be considered. The following characteristics were required of all papers that were to be included:

1. Only programs addressing the readiness of incoming college freshmen are included. Bridge programs that prepare undergraduates for graduate school, programs aimed exclusively at transfer students, programs focusing on the transition from freshman year to sophomore year, or those programs for students who had not yet completed high school are not included in this work.
2. Only programs at colleges and universities within the United States are considered. Pre-college and university experiences may vary greatly across countries and cultures, and therefore the inclusion of international institutions could make it difficult to make meaningful comparisons.
3. The programs could be hosted by any type of educational institution, including but not limited to community colleges and four-year universities, as long as the program itself fits into the definition set forth in item 1.

These criteria necessitated some judgment calls as to whether a paper should be included or not, particularly in the case of a pre-college program that was designed to motivate high school students to matriculate into a university's STEM programs, e.g. [4]. When such a judgment call needed to be made, the program was examined to determine whether it was primarily aimed at college readiness in order to determine whether that paper should be included. Similarly, programs that were conducted during the regular school year, such as [5] were not included. The publication dates of the papers chosen ranged from 1995 to 2022, with the majority published between 2010 and 2020; the distribution of years of publication of these papers is shown in Figure 1. They were published in a variety of different venues, including theses, conferences, and journals, with many of the conference papers drawn from the American Society for Engineering Education (ASEE) conferences. In some cases, multiple papers were published on the same program; while the program itself was included only once in the summaries given in the Findings section, all relevant papers were included in this review and its conclusions.

Findings

The papers examined in this review varied tremendously in the type of information included, based on their focus and purpose. Some contained detailed descriptions of programs, including structure, content, cohort size, and schedule. Others focused only on specific elements of the bridge program in question, and described it in detail while leaving out other information that did not contribute to its specific purpose. Yet others focused on the evaluation of a program, or on in-depth information on the experiences of participants. Therefore, any numerical information on how many programs reported a certain feature or aspect are indicative of general trends only, and do not present a complete or detailed picture of the range of programs in existence. Having said that, it can be seen that bridge programs vary in length and content, with the shortest ones found in the literature lasting only one week [6, 7] with a very singular focus on math preparation, and

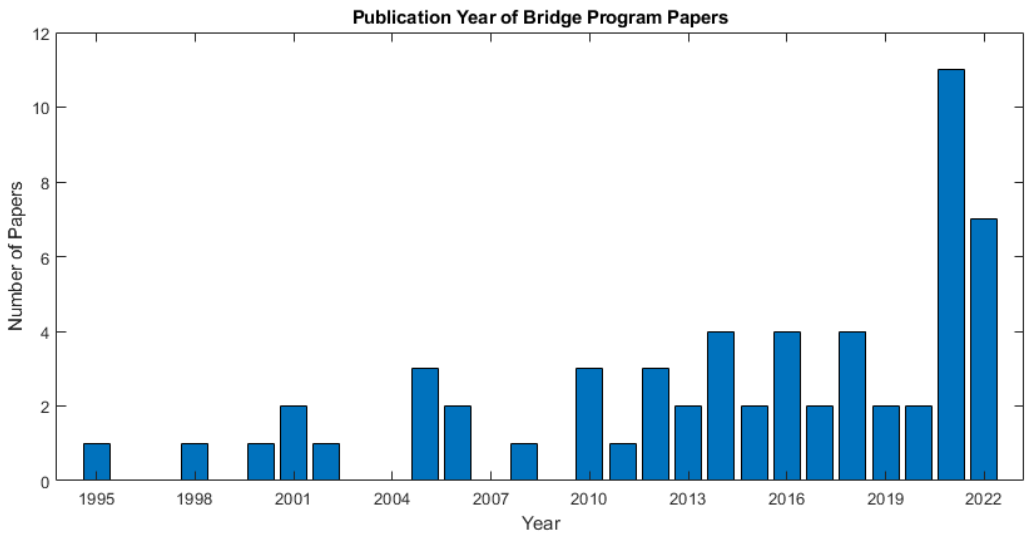

Figure 1: Publication Years of Bridge Program Papers Included in Review

the longest lasting seven weeks [8] and including multiple courses as well as advising and community-building elements. As shown in Table 1, there are also programs that run for two weeks, four week programs, five week programs, and most commonly, six week programs. No programs longer than seven weeks were reported in the literature.

Table 1: Bridge Program Length

Program Length (weeks)	Number of Programs	References
1	2	[6, 7]
2	5	[9, 10, 11, 12, 13, 14]
4	5	[15, 16, 17, 18, 19, 20]
5	2	[21, 22]
6	8	[23, 24, 3, 25, 26, 27, 28, 29, 30]
7	1	[8]

The size of the cohorts also varied among the programs and institutions. The smallest programs had 20 students or fewer (e.g., [29, 12], while the largest programs enrolled over 100 students each year (e.g., [8, 6]). The most common size of programs was between 20 and 40 students per year; this could have been due to the specific student population or due to issues of scaling, and was not commonly discussed in the literature.

In many cases, no underlying principle or framework was cited as the basis for the programs. However, some programs (e.g., [13]) did indicate that they had an underlying framework. Those that did so cited the work of Tinto on student retention theory [31, 32, 33].

Academic Content of Programs

The academic content of the programs varied, although basic writing and math skills were very common elements of many programs. In addition to academics, the majority of programs included some workshops on college knowledge and/or success preparation as well as some community-building or social events. In some cases, students could receive credit for their academic work in the program (e.g., [22]); in many other cases, the academic elements were intended to be review or remedial, and did not carry any credit (e.g., [9, 16]). In one case, it was specifically stated that the lack of credit was an advantage, as it removed some of the pressure. The academic content also included specific items relevant to the needs identified by the various institutions, which were a function of the academic programs at the institutions as well as the student body and its needs, and have varied over time. These included a strong focus on biology preparation in one case [10, 11], computer programming skills [1, 12], integrated science, physics, or chemistry [3, 28, 24], introduction to engineering [34], and CAD [12]. An overview of the content is given in Table 2, showing the most common components in some typical programs. In this summary, the term "Communications" includes reading, writing, public speaking or presentations, or other forms of communicating that students may encounter. The term "Science" includes traditional science courses such as biology, chemistry, or physics, as well as any type of integrated science courses, and "Computer" includes CAD courses, computer programming, or any type of computer applications course. The abbreviation "FYE" denotes Freshman Year Experience.

Table 2: Bridge Program Academic Content

References	Math	Communications	Science	Computer	Other
[35, 16]		X			
[22, 13]	X	X			
[27]		X			
[3, 25]	X	X			Problem-solving
[28]	X		X		
[26, 6, 7, 29, 23, 17]	X				
[15, 21, 18, 9, 36]	X				
[8]	X	X			FYE
[10, 11]			X		
[34]					Intro. to Eng.
[12]	X		X	X	
[24]	X	X	X		
[37]	X	X	X		FYE
[38]	X		X	X	
[14]		X			Innovation
[39]	X				Eng. Design

While one goal of many of these programs was to improve students' scores on math placement exams, some researchers [26] suggested that this may not be the best approach; they suggested that if foundational abilities were not strengthened, then this could lead to students struggling in a

higher level math class as a result of that placement. Therefore, in their bridge program they created a modeling-based mathematics course, with specific focus areas based on student difficulties they had seen in their pre-calculus and calculus courses. Other programs took different approaches to mathematics, with the bridge program detailed by Eblen-Zayas and Russell [29] making extensive use of the ALEKS adaptive learning software in the online part of their hybrid program. Similarly, [30] made use of ALEKS along with the Wright State model for mathematics [40] in their program. This software package [41, 42] includes multiple different modules, and is used by some universities for placement in mathematics classes as well as for student review and self-study; multiple studies exist that examine its use and efficacy, e.g. [43, 44], demonstrating its wide acceptance and use in higher education.

Prior to the COVID-19 pandemic, the majority of these programs were in person, with only one online program [17] and one hybrid program [29]. It was found by Reisel et al. [45] that online programs are less effective than on-campus programs; however, as that finding is from 2012, it pre-dates the recent pandemic-driven growth and improvement in virtual programs of all kinds. A number of programs that were established during the COVID-19 pandemic were virtual, and many transitioned from in-person to virtual, among them [19, 20, 30, 46, 47, 48]. As this transition is recent, long-term data on success is not yet available; such data will also naturally have limitations, as the hurried nature of some transitions and the larger societal impacts of the pandemic present additional variables that impact the efficacy of bridge programs.

Social, Relationship, Advising, and Professional Components of Programs

In one bridge program, described in [10], there was a strong focus on building connections with faculty. This included having lunch with faculty members and learning how to email faculty, in order to increase students' comfort in contacting professors. Other programs included elements of connecting bridge participants to current students, which could be done through the use of undergraduate student mentors for the participants (e.g., [34]). Additional elements of interest were the inclusion of industry tours and resume-writing [12] and the integration of bridge programs with other elements of the student experience, such as first-year seminars and themed learning communities [49]. Additionally, one program [50] integrated social media to help students develop connections to the campus community. That program was described in 2014; while a number of years have passed since then, there is still work being done on student use of social media and their interaction with it (e.g., [51, 52, 53]). A full accounting of this literature is outside of the scope of this paper. A summary of some typical components of programs is given in Table 3. In this summary, the term "Advising" covers any interactions with staff advisors or with peers, as well as any type of advising done by faculty or alumni of the school. The term "Social" includes recreational activities as well as cohort-building and team-building activities. "Professional Skills" includes any interactions designed to build students' knowledge of industry or their preparation for it, such as tours or resume-writing, and "College Knowledge" encompasses any non-class related activities designed to prepare students for success as college students. Note that some activities, as described in papers, may be ambiguous, as there can be overlap between Advising and College Knowledge, for example. It is also noted that programs may include components that were not noted in the papers, as they were not a focus of that particular paper or because the author(s) felt it was an obvious part of any such program.

Table 3: Bridge Program Non-Academic Content

References	Advising	Social	Professional Skills	College Knowledge
[35, 16]	X	X		X
[22]		X		X
[27]	X	X		X
[3, 25, 21, 24]		X	X	
[29, 8, 46]	X	X		
[10, 11]	X	X		
[34, 23, 36, 19, 20]		X		
[12, 13]			X	X
[37]		X	X	X
[39]	X	X		
[38]	X	X	X	
[14, 30]	X	X	X	X

Impact of Programs

Multiple studies have assessed the impact of bridge programs, either in general or as applied to a particular program, with many of the assessments focused specifically on mathematics content [54, 55]. Other assessments were focused either on overall student success or on the students' perceptions of their effect. The impact of these programs, as documented in the literature, has varied. Cooper, Ashley, and Brownell [10] found that, while bridge participants did not report stronger connections with peers than did other freshmen, they did report stronger connections with faculty. Several researchers found that there were positive effects from bridge programs, with a number of researchers reporting that bridge students had a higher likelihood of graduation [56, 57, 13]. However, one such study did note that there was not a statistically significant impact on students' GPA due to the program [13]. It was noted in one paper, which focused on a small number of student experiences (six students) [58], that students had increased motivation as a result of bridge program participation. A similar study [59] found that participants valued the ability to experience college work and to enter college in a safe, welcoming environment, thereby increasing their self-confidence and self-esteem. In light of this value of the program, some bridge programs specifically focused on promoting this sense of belonging, e.g., [60]. For another program [2], it was reported that students experienced positive impacts on their academic self-efficacy, sense of belonging, academic and social skills.

One recent work [61] reported on a meta-analysis of bridge programs. This recent and comprehensive study shows that such programs have a moderate impact on student success, although it is noted by the authors of that work that the majority of the studies included in their meta-analysis were conducted at large, Ph.D.-granting institutions, and that this is a limitation of the results. In contrast to these results, [62] found no statistically significant differences between bridge participants and non-participants. Similarly, [63] found that for the particular bridge program they studied, there was little impact, and contended that student retention is a complicated issue that cannot be addressed by a single program. In the same vein, [64] argue based on their case study that summer bridge programs are likely to have indirect impacts on

students; this would make their impact harder to measure effectively.

While these programs are typically intended specifically for under-prepared students of all demographics, there are a number of papers that specifically evaluate their impact on under-represented populations within engineering. This could include women or racial minorities [65, 66]; in those cases where racial minorities are specifically considered, the institution could be a minority-serving institution, such as in [37], or a primarily white institution (PWI) as in [65]. While assessment data on student academic performance is mixed, as with the overall picture on assessment, the literature does indicate that students tend to feel a greater sense of belonging, which impacts their overall college experience.

Discussion and Conclusion

Despite the statement in several papers that there is "scant literature" on bridge programs, there are actually many papers published on the topic, covering a wide variety of different aspects of the programs. As shown in the Findings, the content of bridge programs often includes some kind of mathematics. This suggests that, while mathematics is a very important subject for college success in STEM fields, it is one in which students are often under-prepared. Writing skills are another very frequent component, indicating that this is another area where students tend to be under-prepared. Other subjects may or may not be included, depending on the university's perception of student needs; when they are included, some form of science is typically among them. Many programs also include some type of social aspect, designed to increase students' sense of belonging, and some form of mentoring or coaching. However, due to the differing focus of the papers, it is not always easy to see the general trends on program structure, content, and efficacy. The review provided here gives an overview of what is known, and what types of questions remain to be answered.

One gap that seems to exist in bridge programs is career preparation; while this may not be significant at some schools, it could be an issue at those colleges and universities that have a significant emphasis on co-op or internship experiences, particularly if they are integrated into the curriculum at an early stage of students' education. Another gap in the literature is in the comparison of virtual, hybrid, and fully online programs. The growth of virtual programs necessitated by the COVID-19 pandemic may begin to fill this gap, but long-term data will not be available until the programs have been running for several years, and will present the limitation that any differences in the programs' results could be due to the larger societal impacts of the pandemic. However, in time it is expected that the data will become more clear, and the relative advantages and disadvantages of virtual and hybrid bridge programs will become more clear.

Yet another gap deals with the financial aspects of bridge programs. As many under-prepared students can be expected to come from less affluent backgrounds, the expense of an additional program could be a significant barrier to them. Some papers contained passing references to scholarships or other financial aspects of the programs, but a full understanding of how much programs may cost participants, and what financial assistance is available to the participants, is lacking.

In the future, a review should also be conducted on bridge programs that do not fit within the criteria set forth in this paper. This could include those that focus on students who have completed their freshman year and are transitioning into their specific majors, e.g., [67], those that focus on transfer students, and those that fall more into the category of pre-college programs. Similarities and differences of these programs to those covered in this review would provide a clearer picture of the full range of programs that exist to bring students into STEM fields, ease their transition into and through college, and support their success.

References

[1] A. Kezar, "Summer bridge programs: Supporting all students. eric digest." 2000.

[2] T. L. Strayhorn, "Bridging the pipeline: Increasing underrepresented students' preparation for college through a summer bridge program," *American Behavioral Scientist*, vol. 55, no. 2, pp. 142–159, 2011.

[3] D. L. Tomasko, J. S. Ridgway, S. V. Olesik, R. J. Waller, M. M. McGee, L. A. Barclay, and J. Upton, "Impact of summer bridge programs on STEM retention at the Ohio State University," in *Proceedings of the 2013 ASEE North-Central Section Conference, Washington, DC: American Society for Engineering Education*, 2013, pp. 1–13.

[4] G. Recktenwald and J. Hook, "Evolution of an invention education summer camp as a bridge from high school to college STEM (evaluation)," in *2022 ASEE Annual Conference & Exposition*. Minneapolis, MN: ASEE Conferences, August 2022, https://peer.asee.org/41254.

[5] M. J. Grimm, "Work in progress-an engineering bridge program-the foundation for success for academically at-risk students," in *Proceedings Frontiers in Education 35th Annual Conference*. IEEE, 2005, pp. S2C–8.

[6] D. Budny, "Mathematics bridge program," in *Proceedings Frontiers in Education 1995 25th Annual Conference. Engineering Education for the 21st Century*, vol. 1. IEEE, 1995, pp. 2a4–11.

[7] H. A. S. Aysa Galbraith, Leslie Bartsch Massey and B. Crisel, "Preparing engineering students for the fall semester through a summer math bridge program," in *2021 ASEE Virtual Annual Conference Content Access*. Virtual Conference: ASEE Conferences, July 2021, https://peer.asee.org/38400.

[8] S. Lonn, S. J. Aguilar, and S. D. Teasley, "Investigating student motivation in the context of a learning analytics intervention during a summer bridge program," *Computers in Human Behavior*, vol. 47, pp. 90–97, 2015.

[9] J. M. Raines, "Firststep: A preliminary review of the effects of a summer bridge program on pre-college STEM majors," *Journal of STEM Education: Innovations and Research*, vol. 13, no. 1, 2012.

[10] K. M. Cooper, M. Ashley, and S. E. Brownell, "A bridge to active learning: A summer bridge program helps students maximize their active-learning experiences and the active-learning experiences of others," *CBE—Life Sciences Education*, vol. 16, no. 1, p. ar17, 2017.

[11] ——, "Breaking down barriers: A bridge program helps first-year biology students connect with faculty," *Journal of College Science Teaching*, vol. 47, no. 4, 2018.

[12] R. Nazempour, H. Darabi, P. C. Nelson, R. A. Revelo, Y. Siow, and J. Abiade, "Execution details and assessment results of a summer bridge program for engineering freshmen," in *2019 ASEE Annual Conference & Exposition*, 2019.

[13] C. Greer, C. Chi, and N. Hylton-Patterson, "An empirical evaluation of a summer bridge program on college graduation at a small liberal arts college," *Journal of College Student Retention: Research, Theory & Practice*, p. 1521025120960035, 2020.

[14] K. Schubert, X. D. Solorzano, L. Massey, C. Gattis, J. Popp, C. Cao, T. Carter, and D. Muralidhara, "A successful 2-week innovation- and student success-focused bridge program for first-year students," in *2022 ASEE Annual Conference & Exposition*. Minneapolis, MN: ASEE Conferences, August 2022, https://peer.asee.org/42080.

[15] C. G. Ami, "The effects of a four-week summer bridge program." 2001.

[16] J. R. Sablan and W. G. Tierney, "Evaluating college-ready writing and college knowledge in a summer bridge program," in *The Educational Forum*, vol. 80, no. 1. Taylor & Francis, 2016, pp. 3–20.

[17] J. L. Frost and J. Dreher, "Impact of online summer mathematics bridge program on placement scores and pass rates," *Universal Journal of Educational Research*, vol. 5, no. 6, pp. 1039–1044, 2017.

[18] L. Cancado, J. Reisel, and C. Walker, "Impacts of a summer bridge program in engineering on student retention and graduation," *Journal of STEM Education*, vol. 19, no. 2, 2018.

[19] C. L. Cohan, L. A. Griggs, R. S. Hassler, M. W. Johnson, M. Kagan, P. J. Butler, and T. L. Peeples, "Sustainable bridges from campus to campus: The creation and conduct of online synchronous summer bridge programs in 2020," in *2021 ASEE Virtual Annual Conference Content Access*. Virtual Conference: ASEE Conferences, July 2021, https://peer.asee.org/37793.

[20] C. Cohan, L. Griggs, R. Hassler, M. Johnson, M. Kagan, A. Freeman, P. Butler, and T. Peeples, "Sustainable bridges from campus to campus: Summer bridge program implementation across four campuses," in *2022 ASEE Annual Conference & Exposition*. Minneapolis, MN: ASEE Conferences, August 2022, https://peer.asee.org/42032.

[21] K. Boykin, D. Raju, J. Bonner, J. Gleason, and L. Bowen, "Engineering math based bridge program for student preparation," in *International Conference on Education, Training and Informatics: ICETI*, 2010, pp. 6–9.

[22] A. Suzuki, A. Amrein-Beardsley, and N. Perry, "A summer bridge program for underprepared first-year students: Confidence, community, and re-enrollment," *Journal of the First-Year Experience & Students in Transition*, vol. 24, no. 2, pp. 85–106, 2012.

[23] C. White, M. Curtis, and C. Martin, "Pre-freshman accelerated curriculum in engineering (PACE) summer bridge program," in *2001 Annual Conference*, 2001, pp. 6–790.

[24] A. Persaud and A. Freeman, "A model for underrepresented minority student success in engineering: The pref summer bridge program," in *2005 Annual Conference*, 2005, pp. 10–57.

[25] D. L. Tomasko, J. S. Ridgway, R. J. Waller, and S. V. Olesik, "Association of summer bridge program outcomes with STEM retention of targeted demographic groups." *Journal of College Science Teaching*, vol. 45, no. 4, 2016.

[26] H. M. Doerr, J. B. Ärlebäck, and A. Costello Staniec, "Design and effectiveness of modeling-based mathematics in a summer bridge program," *Journal of Engineering Education*, vol. 103, no. 1, pp. 92–114, 2014.

[27] P. Lopez, "Student perceptions of a summer bridge program for underrepresented students," *Journal of Applied Research in the Community College*, vol. 23, no. 1, pp. 27–39, 2016.

[28] S. Liu, "Entering the STEM pipeline: Exploring the impacts of a summer bridge program on students' readiness," *Journal of College Student Development*, vol. 59, no. 5, pp. 635–640, 2018.

[29] M. Eblen-Zayas and J. Russell, "Making an online summer bridge program high touch," *Journal of College Student Development*, vol. 60, no. 1, pp. 104–109, 2019.

[30] L. M. Allison Quiroga P.E., Christopher Dalton and C. Jeffries, "Transitioning to a virtual engineering summer bridge program: Planning and implementation (experience)," in *2021 ASEE Virtual Annual Conference Content Access*. Virtual Conference: ASEE Conferences, July 2021, https://peer.asee.org/37938.

[31] V. Tinto, *College student retention: Formula for student success*. Greenwood publishing group, 2005.

[32] ——, "Research and practice of student retention: What next?" *Journal of college student retention: Research, Theory & Practice*, vol. 8, no. 1, pp. 1–19, 2006.

[33] ——, "From theory to action: Exploring the institutional conditions for student retention," in *Higher education: Handbook of theory and research*. Springer, 2010, pp. 51–89.

[34] M. A. Reyes, M. R. Anderson-Rowland, and M. A. McCartney, "Freshman introductory engineering seminar course: Coupled with bridge program equals academic success and retention," in *FIE'98. 28th Annual Frontiers in Education Conference. Moving from'Teacher-Centered'to'Learner-Centered'Education. Conference Proceedings (Cat. No. 98CH36214)*, vol. 1. IEEE, 1998, pp. 505–510.

[35] J. R. Sablan, "The challenge of summer bridge programs," *American Behavioral Scientist*, vol. 58, no. 8, pp. 1035–1050, 2014.

[36] C. Caldwell and R. Hughes, "An engineering summer bridge program utilizing a safe space to increase math efficacy," in *2021 ASEE Virtual Annual Conference Content Access*. Virtual Conference: ASEE Conferences, July 2021, https://peer.asee.org/38368.

[37] U. J. Chikwem, J. O. Chikwem, D. J. Swinton, and C. D. Chikwem, "Lincoln's excellent academic program in science summer bridge program: 2005-2009," vol. 9, 2020.

[38] A. Villalta-Cerdas and F. Yildiz, "Creating significant learning experiences in an engineering technology bridge course: a backward design approach," in *2022 ASEE Annual Conference & Exposition*. Minneapolis, MN: ASEE Conferences, August 2022, https://peer.asee.org/41970.

[39] M. H. Cummings, M. Darbeheshti, S. Ivey, C. Stewart, D. Russomanno, D. King, K. Goodman, J. Campbell, T. Altman, M. Jacobson, and G. Simon, "Summer bridge programming for incoming first-year students at three public urban research universities," in *2022 ASEE Annual Conference & Exposition*. Minneapolis, MN: ASEE Conferences, August 2022, https://peer.asee.org/41415.

[40] N. Klingbeil, R. Mercer, K. Rattan, M. Raymer, and D. Reynolds, "Redefining engineering mathematics education at Wright State University," in *2006 Annual Conference & Exposition*, 2006, pp. 11–1073.

[41] W. Canfield, "ALEKS: A web-based intelligent tutoring system," *Mathematics and Computer Education*, vol. 35, no. 2, p. 152, 2001.

[42] D. L. Johnson, "ALEKS math assessment," *LEARNING AND LEADING WITH TECHNOLOGY*, vol. 33, no. 5, p. 53, 2006.

[43] T. Woods, "Analysis of ALEKS mathematics placement test data," 2017.

[44] B. Yilmaz, *Effects of adaptive learning technologies on math achievement: A quantitative study of ALEKS math software*. University of Missouri-Kansas City, 2017.

[45] J. R. Reisel, M. Jablonski, H. Hosseini, and E. Munson, "Assessment of factors impacting success for incoming college engineering students in a summer bridge program," *International Journal of Mathematical Education in Science and Technology*, vol. 43, no. 4, pp. 421–433, 2012.

[46] R. T. Doris Espiritu and B. O'Connell, "Building bridges into engineering and computer science: Outcomes, impacts and lessons learned," in *2022 ASEE Annual Conference & Exposition*. Minneapolis, MN: ASEE Conferences, August 2022, https://peer.asee.org/41965.

[47] A. L. Cesar, "The effects of a remote pre-freshman summer bridge program: An action research study," Ph.D. dissertation, Capella University, 2021.

[48] M. A. Gonzales, E. Hall, K. X. Mulligan, and J. Oliver, "Remoting into STEM summer bridge programs," in *Teaching and Learning for Social Justice and Equity in Higher Education*. Springer, 2022, pp. 107–133.

[49] L. P. Chism and G. Williams, "Implementation of first-year seminars, the summer academy bridge program, and themed learning communities," *Metropolitan Universities*, vol. 19, no. 2, pp. 8–17, 2008.

[50] D. L. Hottell, A. M. Martinez-Aleman, and H. T. Rowan-Kenyon, "Summer bridge program 2.0: Using social media to develop students' campus capital," *Change: The Magazine of Higher Learning*, vol. 46, no. 5, pp. 34–38, 2014.

[51] W. W. Lau, "Effects of social media usage and social media multitasking on the academic performance of university students," *Computers in human behavior*, vol. 68, pp. 286–291, 2017.

[52] A. D. Woods, M. Taylor, and B. Dumas, "Social media usage by millennial college students: The development of the digital-age student leader," *Academy of Educational Leadership Journal*, vol. 23, no. 1, pp. 1–7, 2019.

[53] M. Kolhar, R. N. A. Kazi, and A. Alameen, "Effect of social media use on learning, social interactions, and sleep duration among university students," *Saudi Journal of Biological Sciences*, vol. 28, no. 4, pp. 2216–2222, 2021.

[54] H. Diefes-Dux, "Does a successful mathematics bridge program make for successful students?" in *2002 Annual Conference*, 2002, pp. 7–441.

[55] S. A. Lesik, K. G. Santoro, and E. A. DePeau, "Evaluating the effectiveness of a mathematics bridge program using propensity scores," *Journal of Applied Research in Higher Education*, 2015.

[56] T. E. Murphy, M. Gaughan, R. Hume, and S. G. Moore Jr, "College graduation rates for minority students in a selective technical university: Will participation in a summer bridge program contribute to success?" *Educational evaluation and policy analysis*, vol. 32, no. 1, pp. 70–83, 2010.

[57] J. Wachen, J. Pretlow, and K. G. Dixon, "Building college readiness: Exploring the effectiveness of the UNC academic summer bridge program," *Journal of College Student Retention: Research, Theory & Practice*, vol. 20, no. 1, pp. 116–138, 2018.

[58] W. C. Lee, C. S. Wade, and C. T. Amelink, "Examining the transition to engineering: A multi-case study of six diverse summer bridge program participants," in *2014 ASEE Annual Conference & Exposition*, 2014, pp. 24–561.

[59] M. Turner, C. McCallum, and J. Benson, "Beyond the bridge: Exploring the experiences of a summer bridge program through student voices," *Journal of College Orientation, Transition, and Retention*, vol. 28, no. 1, 2021.

[60] B. B. Megan McSpedon, Margaret E. Beier and M. Wolf, "Differential effects of bridge program participation on perceived belonging and peer support for STEM degree seekers during the COVID-19 pandemic," in *2021 ASEE Virtual Annual Conference Content Access*. Virtual Conference: ASEE Conferences, July 2021, https://peer.asee.org/36981.

[61] B. C. Bradford, M. E. Beier, and F. L. Oswald, "A meta-analysis of university STEM summer bridge program effectiveness," *CBE—Life Sciences Education*, vol. 20, no. 2, p. ar21, 2021.

[62] G. A. Cross, "Academic performance among first-year college freshmen following participation in a summer bridge program," 2022.

[63] H. Wathington, J. Pretlow, and E. Barnett, "A good start? the impact of Texas' developmental summer bridge program on student success," *The Journal of Higher Education*, vol. 87, no. 2, pp. 150–177, 2016.

[64] N. L. Cabrera, D. D. Miner, and J. F. Milem, "Can a summer bridge program impact first-year persistence and performance?: A case study of the new start summer program," *Research in Higher Education*, vol. 54, no. 5, pp. 481–498, 2013.

[65] S. R. Allen, *The Impact of Summer Bridge Programs on Progress and Retention into the Second Year among African American Students at a Predominantly White Institution*. Widener University, 2021.

[66] D. Ghazzawi, D. Pattison, and C. Horn, "Persistence of underrepresented minorities in STEM fields: Are summer bridge programs sufficient?" in *Frontiers in Education*, vol. 6. Frontiers, 2021, p. 224.

[67] M. L. Alexander, B. M. W. Bailey, R. R. Mogiligidda, M. Hosur, D. Hicks, and M. Preuss, "WIP: Hands-on learning in a summer bridge program targeting underclassmen and transfer students at an HSI," in *2021 ASEE Virtual Annual Conference Content Access*. Virtual Conference: ASEE Conferences, July 2021, https://peer.asee.org/38063.