INCREASING CONFIDENCE AND PREPAREDNESS OF INCOMING STUDENTS THROUGH A SUMMER BRIDGE PROGRAM

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Abstract – *The transition from high school to postsecondary studies entails many challenges for students. Thus, postsecondary institutions have developed Summer Bridge Programs (SBP) to support students in this transition by improving academic and psychosocial preparedness while boosting general confidence and attitude toward the university or college.*
The EMBER program in the Faculty of Engineering at McMaster University aims to help students entering Engineering programs succeed academically and socially. The program is divided into three parts: self-paced online learning modules, synchronous online tutorials, and four-day in-person workshops.
This paper explores students' experiences and self-reported levels of confidence and preparedness. Three anonymous surveys were administered to students participating in EMBER. The initial results show that students' self-reported confidence and preparedness levels increased after attending EMBER. Most students valued all parts of the experience. Future research will focus on assessing the extent to which the EMBER program improves academic outcomes.

Keywords: Summer Bridge Program, First year, Student experience.

1. INTRODUCTION

Starting postsecondary studies entails several challenges for students. Both academic and social aspects of the new learning environment can be quite different from high school. Also, the extent students feel prepared impacts their experiences during the first and subsequent years. Thus, several postsecondary institutions have developed Summer Bridge Programs (SBP) to help students for a smooth transition to postsecondary education. SBPs focus on the development of both academic and social skills. These programs run, generally, in the summer months before classes start in the Fall and involve orientation to the new college or university life, academic advising, training skills for postsecondary success, and also accelerated coursework [1].

Institutions that offer STEM programs have also implemented different SBPs, which have shown an effect not only on students' experiences during their first year [2], but on other areas as well [3], [4]. A meta-analysis of 16 STEM SBPs showed that program participation had a medium-sized effect on first-year overall grade point average and first-year university retention [5]. As [6] state, the longest tradition of bridging education is to be found mainly in the educational system in the United States, SBPs have reached undergraduate students widely across the country. Thus, most empirical studies assessing the effect of SBP refer to the US context.

Following the trend, some institutions in Canada offer SBPs. Each program is unique, as they vary in duration (one week, four weeks or more), academic focus (self-directed/own pace, chemistry, math, physics, or computer programming), whether they involve social activities (activities with faculty members, upper-year students), fees to students, and eligibility of students to participate in them (all students, or underrepresented students). For example, Radford University launched a one-week residential summer camp for female high school-age students who want to pursue STEM field careers [7]. The University of Toronto has a program called STEM Scholars Program [8], a 6-8 week residential SBP open to high achieving Black students entering undergraduate STEM studies. Queens University has a self-guided set of modules in mathematics, chemistry, physics, and programming (the QEng Prep program [9]) that help students review key concepts and reinforce self-checked questions in the modules. The University of Waterloo designed an online, skills-based course to refresh high school math with an orientation day, so students can also connect with classmates. Other institutions focus on course credits to help students to reduce their load in the Fall semester, like the SBP offered by the University of Regina [10], which consists of a self-paced English course with social activities, tutoring and residence life experiences. Similarly, Engineering students accepted at the University of Waterloo can choose, depending on their English language test score, between two Bridge to Academic Success in English programs [11] the intensive 7-week summer session (iBASE) or an 8-month session (BASE).

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Finally, the University of Alberta has the B2E Program (Bridge2ENGG) [12], which is a program with three levels: (i) foundations to first-year Engineering, (ii) academic essentials and (iii) an ENGG Camp that ties academic and soft skills.

This paper aims to describe the SBP offered by the Faculty of Engineering at McMaster University since 2020, EMBER, and study whether the program helps students increase their self-reported confidence and preparedness. To this end, we collected data from EMBER students in the 2022 cohort by administering at three different times throughout the program (N1= 102, N2 = 53, N3 = 29). Initial results show that after attending the program, the proportion of students that do not feel confident and/or prepared in different aspects decreased. Also, there is an increase in the proportion of students that feel confident and/or prepared. Finally, most students valued all parts of the experience.

2. EMBER PROGRAM

EMBER is McMaster University's program for incoming students engineering the Faculty of Engineering. As some of the programs described in the previous section, EMBER aims to help students' academic and social success. Students enrolled in EMBER learn and reinforce foundational math, physics, chemistry, and computing concepts. Furthermore, they connect with other incoming students, upper-year students, staff, faculty members, and clubs in engineering. All students enrolled in the Faculty of Engineering can register in any module they choose at no cost to them. The program was promoted to students through email, social media, and during the University's Spring Open House event. The program is entirely voluntary, and there is no pre-assessment or requirement other than being a first-year student in the Faculty of Engineering.

The EMBER program is divided into three parts: (i) online learning modules, (ii) live courses and Fireball Academy activities, and (iii) CONNECT. Students can attend one, two or all the parts independently. In the first part, students can learn at their own pace by accessing the modules for math, physics, chemistry, and computing. The second part consists of two weeks of live courses in math, physics, chemistry, and computing, as well as an introduction to academic advising, clubs, teams, and other faculty resources (Fireball Academy activities). The last part is designed to give students hands-on experience of McMaster's approach. Students can connect with classmates and professors in diverse workshops, participate in a design-a-thon to develop problem-solving skills and learn how to work effectively in teams.

2.1. Academic skills

To foster students' academic skills, EMBER provides self-directed learning materials. Students enrolled in the EMBER modules can access the online content through McMaster's learning management system (AvenueToLearn). Each module is divided into organized sections containing videos, quizzes, and summative tests to help students evaluate their level of comprehension. In the second part of EMBER, students can attend synchronous online course tutorials that are organized for two weeks.

2.2. Social Activities

Social activities take place in the second and third parts of EMBER. In live synchronous online sessions, students are provided with information about clubs, teams and faculty resources during the Fireball Academy events. Students can participate in non-academic activities during the in-person CONNECT, such as a campus tour/scavenger hunt and a greet and meet session.

2.3. Students' wellness and equity, diversity, and inclusion

EDI and students' mental health have special attention in the offered sessions. The program incorporates valuable information on students' well-being, mental health, and academic and social activities. Some sessions in the program focus on stress and time management, and EDI.

Since it was launched in 2020, the year 2022 was the first time EMBER took place with in-person activities.

3. METHODOLOGY

3.1. Participants

This study had obtained ethics approval by the time of recruiting participants. All students enrolled in EMBER 2022 were considered in this study and invited to participate through an announcement on McMaster's learning management system. Recruited participants were asked to answer three anonymous surveys posted on the website: one before EMBER (pre-EMBER), another after the 2-week synchronous sessions (post-EMBER), and the last one after the CONNECT part of EMBER (post-CONNECT). The number of students who participated in each survey is 102, 53 and 29, respectively. No demographic data were collected for this study.

3.2. Instruments

Three anonymous surveys were designed for this study. The first two surveys (pre- and post-EMBER) focused on the self-reported level of confidence and preparedness in different aspects. The third survey asked about how valuable the different aspects were of the CONNECT part.

3.2.1. Confidence. Both the pre- and post-EMBER surveys assessed students' confidence levels in eight areas: (i) academic transition to university, (ii) performing well academically in the first year, (iii) performing well in first-year math, (iv)

performing well in first-year physics, (v) performing well in first year chemistry, (vi) performing well in first year computing, (vii) the social transition to university, and (viii) making friends in the first year. Students were asked to rate their confidence on a 5-point scale, ranging from "Not confident at all" to "Very confident."

3.2.2. Preparedness. The pre- and post-EMBER surveys also asked students to what extent they felt academically prepared for the first year: math, chemistry, physics, and computing. The four questions could be answered with a 5-scale level of preparedness ranging from "Not prepared at all" to "Very prepared."

3.2.3. Attendance. The post-EMBER and post-CONNECT surveys asked students to choose the percentage of sessions they attended for EMBER and CONNECT.

3.2.4. Helpfulness and value of sessions. The post-EMBER and post-CONNECT surveys asked students to what extent the different sessions were helpful or valuable. For the post-EMBER survey, the sessions considered were (i) live tutorials, (ii) video modules, (iii) online quizzes, and (iv) Fireball Academy events. In this survey, students ranked each session from the most helpful to the least helpful and also answered a 5-scale level of helpfulness ranging from "Not helpful at all" to "Very helpful". For the post-CONNECT survey, students had to answer a 5-scale level of value for each of the sessions offered, ranging from "Not valuable at all" to "Very valuable" for the following sessions: (i) meet and greet, (ii) campus tour/scavenger hunt, (iii) soft skills, (iv) mock tests, (v) computer workshops (MATLAB, Microsoft, CAD, Python, Raspberry Pi) and (vi) a design-a-thon workshop.

3.2.5. Recommend the program to a friend. Both post-EMBER and post-CONNECT surveys also asked students whether they would recommend EMBER to a friend.

3.2.6. Open questions. The three surveys had open-ended questions so students could write freely about their expectations and sentiments (pre-EMBER), why they chose to register for the program (pre-EMBER), what aspects of EMBER they found helpful for academic preparation, social interaction and belonging (post-EMBER and post-CONNECT), and what aspects can be improved (post-EMBER and post-CONNECT).

3.3. Analysis

This paper focuses on the quantitative aspects of the data collected from the surveys. To simplify the analysis, we merged the two extremes of the 5-scale Likert answers (e.g., "not confident at all" and "not confident" were treated as one, as were "confident" and "very confident"). We assigned a numeric value to each answer, with 1 or 2 representing negative responses (e.g., "not confident at all" or "not prepared at all"), 3 representing neutral responses, and 4 or 5 representing positive responses (e.g., "confident" or "very confident," "prepared" or "very prepared"). We then calculated the median and mode for each question to describe the distribution of the answers.

For pre- and post-EMBER surveys, we calculated the proportion of students who responded negatively (values 1 or 2) and positively (4 or 5). Then, we compared the difference in the proportion of students answering negatively or positively before and after the program.

Finally, and for exploratory purposes, all numeric values for the confidence answers were summed up to obtain an overall confidence score. If a student answered to be "not confident at all" to all the confidence questions, then they will score 8 points, whereas a student that answered to be "very confident" to all the confidence questions will score 40 points. The same procedure was done with the preparation questions, but in this case, the overall score was between 4 and 20.

4. RESULTS AND DISCUSSION

Most students registered for all 4 EMBER modules (math, physics, chemistry, and computing). Table 1 indicates the number of students enrolled in each module for the pre- and post-EMBER surveys.

Table 1. The number of students enrolled in each EMBER module for the pre- and post-EMBER surveys.

Module	Pre-EMBER	Post-EMBER
Math	69	46
Physics	61	40
Chemistry	62	37
Computing	64	44

4.1. Confidence

Table 2 shows the median and mode for each confidence aspect for the pre- and post-EMBER surveys with the corresponding percentage of answers. Table 2 also shows that, at the start of the program, the aspects where most students reported that they felt "not confident at all" or "not confident" were about performing well (i) academically in the first year, (ii) in first-year physics and (iii) in first-year chemistry. Also, at the start of the program, most students self-reported being "neutral" in their confidence about the academic transition to university. Finally, most students feel "confident" or "very confident" about performing well in the first year (i) math and (ii) computing, (iii) the social transition to university, and (iv) making friends in the first year.

Table 2. Student's Confidence levels for pre- and post-EMBER surveys. The numeric values correspond as follows: 1- not confident at all, 2- not confident, 3- neutral, 4- confident and 5- very confident (N pre-EMBER = 102, N post-EMBER = 53).

Aspect	Pre-EMBER		Post-EMBER	
	Median %	Mode %	Median %	Mode %
Academic transition	3 42.16%	3 42.16%	3 35.85%	4 or 5 49.06%
Performing well academically in the 1st year	3 35.29%	1 or 2 37.25%	3 43.40%	3 43.40%
Performing well in 1st year math	3 31.37%	4 or 5 48.04%	4 or 5 62.26%	4 or 5 62.26%
Performing well in 1st year physics	3 27.45%	1 or 2 38.24%	3 26.41%	4 or 5 43.4%
Performing well in 1st year chem.	3 32.35%	1 or 2 36.27%	4 or 5 52.83%	4 or 5 52.83%
Performing well in 1st year comp.	3 25.49%	4 or 5 37.25%	4 or 5 52.83%	4 or 5 52.83%
Social transition to university	3 30.39%	4 or 5 43.14%	4 or 5 56.6%	4 or 5 56.6%
Making friends in the 1st year	3 31.37%	4 or 5 48.04%	4 or 5 60.38%	4 or 5 60.38%

After the program, most students reported they felt "confident" or "very confident" in all aspects except for performing well academically in the first year. Regarding this aspect, most students answered that they felt neutral.

Figure 1 shows the difference in the proportion of students answering negatively to the different confidence questions between the pre- and post-EMBER surveys. The proportion of students reporting feeling not confident or not confident at all (negative answer) decreased in all aspects. The greatest difference is found in the aspect of performing well academically in the first year (-22.16%), followed by the performing well in first year chemistry aspect (-17.4%).

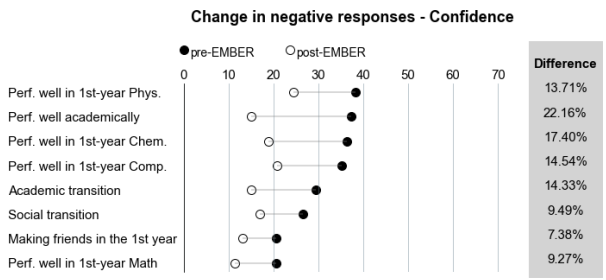

Figure 1. Changes in Confidence levels for students answering negatively in the pre- and post-EMBER surveys (N pre-EMBER = 102, N post-EMBER = 53).

Figure 2 shows the difference in the proportion of students answering positively to the different confidence questions between the pre- and post-EMBER surveys. The proportion of students reporting feeling confident or very confident (positive answer) increased in all aspects. The greatest difference is found in the aspect of performing well in first-year chemistry (+29.3%), followed by the academic transition aspect (+20.63%).

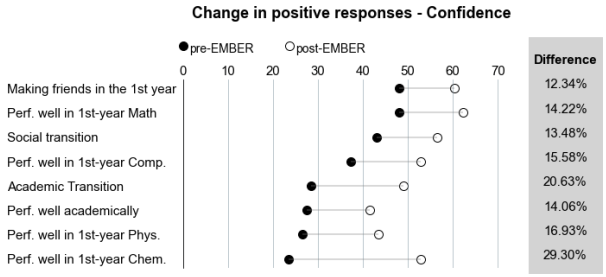

Figure 2. Changes in Confidence levels for students answering positively in the pre- and post-EMBER surveys. (N pre-EMBER = 102, N post-EMBER = 53)

Finally, the mean answer value for the overall confidence in the pre-EMBER survey was 24.86 (std = 5.52). For the post-EMBER survey, the mean was higher: 27.22 (std = 4.61). A t-test for independent samples showed there is a significant difference (statistic = 2.56, p-value = 0.011).

4.2. Preparation

Table 3 shows the median and mode for each preparation aspect for the pre- and post-EMBER surveys with the corresponding percentage of answers. Table 3 also shows that at the start of the program, the only aspect where most students reported that they felt "not prepared at all" or "not prepared" was the aspect of feeling academically prepared for first-year computing. Regarding academic preparedness for first-year chemistry and physics, most students reported being "neutral" at the beginning of the program. Finally, most students felt "prepared" or "very prepared" about feeling academically prepared for first-year math. After the EMBER program, most students reported they felt "prepared" or "very prepared" in all aspects.

Table 3. Student's Preparedness levels for pre- and post-EMBER surveys. The numeric values correspond as follows: 1- not prepared at all, 2- not prepared, 3- neutral, 4- prepared and 5- very prepared (N pre-EMBER = 102, N post-EMBER = 53).

Aspect	Pre-EMBER		Post-EMBER	
	Median (%)	Mode (%)	Median (%)	Mode (%)
Math	4 or 5 50.98%	4 or 5 50.98%	4 or 5 66.04%	4 or 5 66.04%

Chemistry	3 30.39%	3 30.39%	4 or 5 52.83%	4 or 5 52.83%
Physics	3 29.41%	3 29.41%	4 or 5 50.94%	4 or 5 50.94%
Computing	3 19.61%	1 or 2 41.18%	4 or 5 50.94%	4 or 50.94%

Figure 3 shows the difference in the proportion of students answering negatively to the different preparedness questions between the pre- and post-EMBER surveys. The proportion of students reporting feeling not prepared or not prepared at all (negative answer) decreased in all aspects. The greatest difference is in the level of academic preparedness for the first-year computing, followed by chemistry.

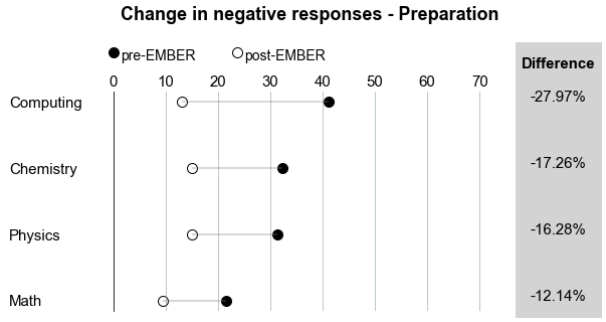

Figure 3. Changes in Preparedness levels for students answering negatively in the pre- and post-EMBER surveys. (N pre-EMBER = 102, N post-EMBER = 53)

Figure 4 shows the difference in the proportion of students answering positively to the different preparedness questions between the pre- and post-EMBER surveys. Considering the change between the pre- and post-EMBER surveys, the proportion of students reporting feeling prepared or very prepared (positive answer) increased in all aspects (see Fig. 4). The greatest difference is found in the aspect of academic preparedness in chemistry (27.34%).

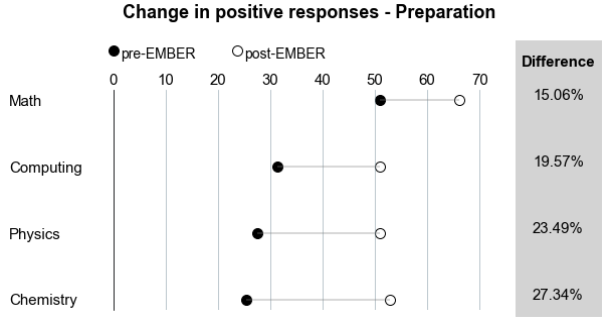

Figure 4. Changes in Preparedness levels for students answering positively in the pre- and post-EMBER surveys. (N pre-EMBER = 102, N post-EMBER = 53)

Finally, the mean answer value for the overall preparedness in the pre-EMBER survey was 12.16 (std = 3.14). For the post-EMBER survey, the mean was higher: 14.13 (std = 2.91). A t-test for independent samples showed there is a significant difference (statistic = 3.57, p-value < 0.001).

4.3. EMBER evaluation

Overall, the program received positive feedback. Out of the 53 answers in the post-EMBER survey, the vast majority of students would recommend EMBER to a friend (N = 48, 90.57%), and only one student (N = 1, 1.88%) reported that they would not recommend it, while the rest did not answer the question (N = 4, 7.55%).

The post-EMBER survey included two questions to assess how helpful the different aspects of EMBER were. The first question asked students to rank how helpful the four aspects of EMBER were (live tutorials, video modules, AvenueToLearn quizzes, and Fireball Academy events). The second question asked students to rate the helpfulness of each EMBER aspect individually. Table 4 shows the number of students that ranked each aspect from the most helpful (Rank 1) to the least helpful (Rank 4). Table 4 also shows that according to the first question, students ranked live tutorials and video modules as the most helpful EMBER aspects.

Table 4. Ranking of the helpfulness of each EMBER aspect (N = 53).

Aspect	Rank 1	Rank 2	Rank 3	Rank 4
Live tutorials	24	9	12	3
Video modules	19	16	10	4
AvenueToLearn Quizzes	4	15	14	16
Fireball Academy events	2	9	12	24

For the second question, most students found each EMBER aspect helpful or very helpful. Figure 5 shows the proportion of students that find the EMBER aspect helpful or not, considering that the "not helpful" category includes the answers "not helpful" and "not helpful at all", whereas the "helpful" category includes the answers "helpful" and "very helpful". Students highly appreciated the video modules: over 80% of students found them helpful.

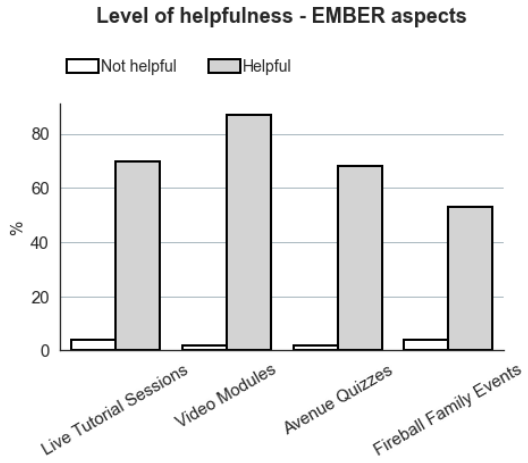

Figure 5. Levels of helpfulness for each EMBER aspect (N = 29).

4.4. CONNECT evaluation

When asking students if they would recommend CONNECT to a friend, most students answered they would (N = 27, 93.10%). Only one student indicated they would not recommend it (3.45%).

Figure 6 shows a summary of students' answers to the question of how valuable the different aspects of CONNECT were. The "Not valuable" category includes the "not valuable at all" and "not valuable" answers, whereas the "Valuable" category includes the "valuable" and "very valuable" answers. In all aspects of CONNECT, most students answered that they were valuable or very valuable. Students highly valued the Python (N = 27, 93.1%), CAD (N = 25, 86.21%) and MATLAB (N = 25, 86.21%) workshops. Moreover, no student reported that the Python, Microsoft, and design-a-thon workshops were not valuable to them.

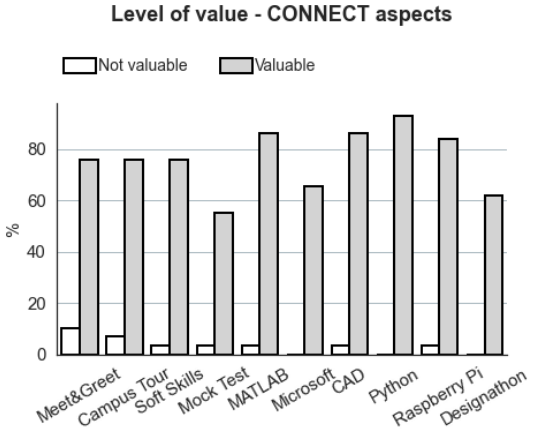

Figure 6. Value levels for each CONNECT aspect (N = 29).

5. CONCLUSIONS

This paper describes the EMBER program, the McMaster Engineering SBP and reports preliminary results on how the program can help reduce the proportion of students feeling not confident or prepared for the first year while also increasing the proportion of students feeling confident or prepared for the first year. The students highly valued the program, and most students found value in all parts of the program. Based on these results, it can be valuable to evaluate how this program can be expanded to other programs within the same university or to incorporate other academic topics beyond math, chemistry, physics, and computing.

While the overall mean values for confidence and preparedness were higher in the post-EMBER survey, these exploratory results must be interpreted with caution due to the anonymous nature of the data and the inability to assure the independence of the samples. Therefore, it is necessary to conduct another experiment set up to assess the effect of the program more thoroughly.

Another limitation of this study is how to assess whether these results are representative, given the high heterogeneity in the attendance and engagement of students in all the different activities of the program. For example, the post-CONNECT survey had 29 respondents, and the attendance for each day ranged from 24 to 63, so assuming a total of 63 students, 29 respondents would represent 46.03% of the sample.

Future research will consider de-identified data, allowing for an assessment of the effect of the EMBER program on students' academic achievement, considering covariables such as students' gender and attendance to all the different activities offered by EMBER. Also, from an EDI perspective, we plan to collect demographic data to collect typically under-represented populations in engineering and explore how the EMBER program helps them increase their levels of preparedness and confidence.

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References

[1] "Summer Bridge Programs. What Works Clearinghouse Intervention Report," *What Works Clgh.*, pp. 1–23, Jul. 2016.

[2] J. Barth, S. Dunlap, A. Bolland, D. McCallum, and V. Acoff, "Variability in STEM Summer Bridge Programs:

Associations with Belonging and STEM Self-Efficacy," *Front. Educ.*, vol. 6, 2021, doi: 10.3389/feduc.2021.667589.
[3] M. Ashley, K. M. Cooper, J. M. Cala, and S. E. Brownell, "Building Better Bridges into STEM: A Synthesis of 25 Years of Literature on STEM Summer Bridge Programs," *CBE - Life Sci. Educ.*, vol. 16, no. 4, Dec. 2017.
[4] S. E. Akina, "The Effects of a Math Summer Bridge Program on College Self-Efficacy and Other Student Success Measures in Community College Students," *ProQuest LLC*, pp. 1–292, 2016.
[5] B. C. Bradford, M. E. Beier, and F. L. Oswald, "A Meta-Analysis of University STEM Summer Bridge Program Effectiveness," *CBE - Life Sci. Educ.*, vol. 20, no. 2, Jun. 2021.
[6] D. Tempelaar *et al.*, "Effectiveness of a voluntary postsecondary remediation program in mathematics," *Pedagog. Stud.*, vol. 88, no. 4, pp. 231–248, 2011.
[7] Radford University, "Summer Bridge: Women in STEM." https://www.radford.edu/content/csat/home/women-in-stem.html (accessed Mar. 10, 2023).
[8] University of Toronto, "STEM Scholars Program." https://www.utm.utoronto.ca/experience/students/utm-stem-scholars-program (accessed Mar. 10, 2023).
[9] Queen's University, "QEng Prep." https://engineering.queensu.ca/Current-Students/First-Year-Studies/QEng-Prep.html (accessed Oct. 03, 2023).
[10] University of Regina, "Summer Bridge Program (SBP)." https://www.uregina.ca/student/ssc/summerbridge/index.html (accessed Mar. 10, 2023).
[11] University of Waterloo, "Bridge to Academic Success in English." https://uwaterloo.ca/bridge-to-academic-success-in-english/ibase (accessed Mar. 10, 2023).
[12] University of Alberta, "Welcome to Bridge2ENGG." https://www.ualberta.ca/engineering/bridge2engg/index.html (accessed Mar. 10, 2023).