Design and Impact of a Near Peer-Led Computer Science Summer Bridge Program

Jaelyn Dones*, Fred Martin†, Justin Lu‡ and Foozieh Mir§
University of Massachusetts Lowell
Lowell, Massachusetts 01854 USA
*Jaelyn_Dones@student.uml.edu †Fred_Martin@uml.edu, ‡Justin_Lu@student.uml.edu, §Foozieh_Mirderikvand@uml.edu

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***Abstract*—This full innovative practice paper presents a study on the effectiveness of a computer science bridge program at a mid-sized regional public university in the Northeast United States. The program was designed for incoming first-year full-time students pursuing a degree in computer science (CS) at the university. The structure of this program differs from others with its leadership consisting of undergraduate students of varying seniority. It also features an emphasis on building a strong sense of community and seeks to inspire creativity in CS through lesson plans that are complementary with what participants learn in the university's degree program.**

This study investigates the outcomes of the program after three iterations. To quantify its impact on participants, retention rates of program participants are compared with those of students who were invited to participate in the program but declined. Positive effects stemming from near-peer mentoring and the creation of a lasting digital support network for program participants are also analyzed.

The researchers expected the data collected to reflect a successful impact from students' participation in the program. Chi-square testing on the collected retention data from the first two cohorts revealed a statistically significant result for one cohort.

The third iteration of the program resulted in a highly active online community of freshmen that has been supported by students of higher seniority throughout participants' first academic school year.

Based on these findings, we urge all institutions seeking to support a diverse body of students in their STEM pathways to implement summer bridge programs. We recommend engaging existing undergraduate students in developing and leading such programs, and focusing on building a community and on-going support network.

***Index Terms*—Computer science, Student diversity, Retention rate**

I. Introduction and Background

SoarCS is a summer bridge program that has been conducted by the computer science department of a mid-sized regional public university in the Northeast United States. The program was created for incoming first-year, full-time, computer science students enrolled at the university.

The program welcomed all first-year computer science students. A key initiative was to enroll minoritized students, and a recruitment strategy which focused outreach on these students was developed. The recruitment strategy for this population of students was determined to be highly effective, with over half of the registrations occurring after the recruitment initiative.

The program was enrichment-focused, exposing participants to technologies that would not traditionally be explored in the university's computer science degree program.

The program also highlighted the importance of community and support systems by connecting participants with faculty, industry professionals, students of higher seniority, alumni of the university, and each other. This aspect was greater emphasized with the integration of a popular online messaging application, Discord, which was used prior, during, and subsequent to main program activities.

Rather than faculty or staff of the university leading the program, SoarCS was led by groups of undergraduate students that varied in their level of degree completion, ethnic background, gender, and skill-sets. The group changed from year to year with some members carrying over to subsequent iterations of the program. Some student leaders were alumni of the program from a previous year. The students ran the program with the assistance of a staff member who serves as the coordinator of undergraduate programs for the college and the associate dean of the college (who has a faculty appointment in computer science). Two of these students and these two staff members are the co-authors of this paper.

The researchers wanted to determine if SoarCS has had a positive impact on participants. Retention data of program participants were collected and compared against retention data of students who were invited to participate through the recruitment initiative but declined. At the time of the study, retention data for the first two cohorts were available. Chi-square tests were performed on the retention data which showed that the second iteration's participants were retained at a statistically significant higher rate.

To get a better understanding of the impact of the program's communal aspect, data from the Discord messaging platform were collected and analyzed from the third iteration of SoarCS. The data reflected continuous activity and communication of students even after the conclusion of the program.

II. Related Work

Bridge programs in this context will refer to an initiative hosted by a university for a population of undergraduate students that have yet to start their first semester, as defined by Douglas and Attewell [1]. These programs vary in length and execution, with some lasting a few days and others spanning across eight weeks [2].

A. Variety in Design of Bridge Programs Historically

STEM bridge programs have been designed and implemented in numerous ways across universities. Previous studies on their effectiveness have demonstrated overlap in both the goals they set out to achieve and how this success is measured. The first criterion that distinguishes a bridge program is the population of students for which it was designed. Often, programs will be designed for a certain group of undergraduate students, e.g. minority and low-income individuals [3]–[8]. As a computer science bridge program, women are an underrepresented minority population in accordance with other STEM programs' identifications of this group. Although less common, some bridge programs have been open to all undergraduate students (of a particular department or major) [2], [7], [9]. SoarCS took this approach and welcomed all first-year undergraduate computer science students, although minority students were especially encouraged to participate.

Bridge programs have also differed in what students receive in completing them. Some universities offer students course credits for participation, as their programs were designed to emulate what taking courses at the university is like [7], [10]. Others provide tuition assistance or stipends for students that participate for the full duration of the program [2], [8], [11].

The purpose of STEM bridge programs seems to follow one of three trends: they sought out to fill deficits of their participants [1], [2], [9], help enrich students to cultivate momentum for their first semester [8], [9], and/or increase the diversity of students in a specific major [13]. SoarCS was designed with the second in mind.

In a non-academic sense, STEM bridge programs have also set outcome goals for participants. Community building is a top outcome, whether intended or unintended with such programs [2], [8], [9]. This is followed by setting up participants with a support system within the institution [5], [8], [11]. In accordance with other bridge programs, the aspect of community is a top outcome of SoarCS as well.

III. Intervention

A. Recruitment

Although the program has welcomed all undergraduate full-time students in computer science, in the recruitment process there has been an emphasis on encouraging individuals from multicultural backgrounds, first-generation students, and women to take advantage of the program. To do this, the team requested and acquired from the university's admissions office a list of students that were a part of one or more of these groups. The list contained contact information and addresses of these students. The individuals on the list were then sent an informational postcard that promoted SoarCS and provided resources to learn more about the program.

A few weeks after the postcards were sent, student leaders were given university phone numbers and were assigned a group of individuals from the list to call that had not yet registered for the program. If an individual answered the phone, the student leader would follow a script and discuss the program with them. If the individual did not pick up the phone and their voicemail box was not full, student leaders followed a similar script encouraging the individual to check out the program. If the mailbox was full, the individual would be called again by one of the staff members and an email would be sent to them in addition.

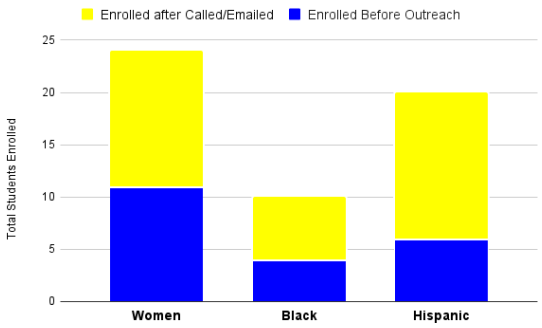

Fig. 1. Demographic Info for Enrolled Students Before and After Outreach (2020 and 2021)

The following is the script that student leaders loosely followed when calling students:

Hi, this is (your name) from UMass Lowell. This call is for (student name). I'm calling in regards to the summer bridge program, SoarCS, and wanted to see if you are interested in participating in the program. You should have gotten an email about it on May 18 and a postcard.

The following is the script that student leaders followed when leaving a voicemail:

Hi, this message is for (student name). This is (your name) from UMass Lowell. I'm calling in regards to the summer bridge program, SoarCS which is a free program for all incoming CS students and wanted to see if you are interested. You should have gotten an email about SoarCS on May 18. For details and registration instructions please visit uml.edu/soarcs.

For SoarCS 2020, 66 students enrolled in the program. 132 students were called after postcards were sent to them. 33 of these students ended up signing up for the program, making up half of the number of enrolled participants.

The following year, 53 individuals signed up for the SoarCS 2021. Student leaders called 152 students to encourage their enrollment, and 31 of these students signed up, making up over half of the total number of enrolled students.

Fig. 1 shows demographic information of called individuals in comparison to the entire group of enrolled students for SoarCS 2020 and 2021. This enrollment data for both years was grouped together as the difference in enrollment based on demographic information between the two iterations of the program was not meaningful. As shown in the figure, over half of the individuals in the three demographic groups signed

TABLE I
DEMOGRAPHIC INFO PROGRAM 2019-2021 VS
DEPARTMENT 3-YEAR AVERAGE

Year	Program Students	Pct. Women	Pct. Black	Pct. Hispanic
2019	26	27%	12%	38%
2020	39	33%	15%	38%
2021	43	26%	9.3%	12%
Full Dept 3-Year Avg		14%	4.2%	10%

up after the outreach: 54% of women who were a part of the program over the two years signed up after the outreach, as did 60% of black individuals and 70% of Hispanic individuals.

Looking at the demographic groups combined, it must be noted that over the two iterations of the program, over half of the minority participants signed up after the outreach, suggesting an overwhelmingly successful approach to recruiting this population of students.

Table I shows the overall demographic percentages of each iteration of SoarCS in comparison to the computer science department's percentages of the student body over the three years. The average percentage of women was double that of the department, at 28%. The average percentage of black students over the program's iterations was nearly triple that of the department average, at 12%. The percentage of Hispanic students who have participated in SoarCS was also nearly three times the department average, at 29%. With the outreach recruiting women, black, and Hispanic students to the program, SoarCS also brought together groups of students that may have had a harder time interacting with each other in classes due to these groups being a minority in the department.

B. Program Introduction

Although SoarCS was non-selective, interested students were asked to complete an application to be a part of the program. The application consisted of three questions:

1. Who or what has inspired you in your decision to study computer science?

2. UMass Lowell strives to become a university of choice for students and employees from diverse backgrounds and to be a model campus community where all students, faculty, and staff feel appreciated, respected, connected, valued, and engaged with the larger life of the campus and beyond. What are the key elements in an academic community and campus that will make you feel more supported as a member of our community?

3. What plans do you have after you finish your undergraduate degree?

Students who took the time to apply to the program and provided thoughtful answers to the questions were expected to be more serious about participation than students that decided not to fill out the application. During the first day of the program, participants were presented with word clouds that visualized common themes from their responses, as Fig. 2 demonstrates. These themes and common occurrences from the responses were then discussed.

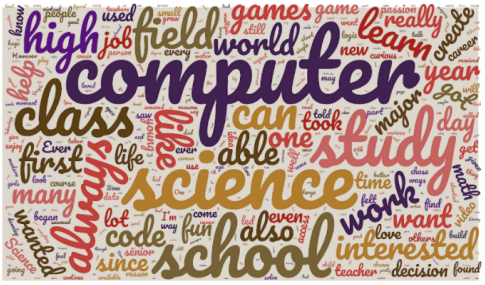

Fig. 2. Word cloud generated from SoarCS 2020 participant responses to first question

For the first question, which Fig. 2 visualizes, the most common response in 2020 was that taking a high school computer science course inspired individuals to pursue computer science in college (at 19 occurrences in responses). In contrast, this was the third most occurring answer in 2021 (at 9 occurrences in responses), while the most common answer for this year expressed that a parent, relative, or friend in the industry inspired individuals to pursue computer science.

In participating in SoarCS, students received materials that they would use in the program (supplements for the technology introductions) and a t-shirt. SoarCS was not for-credit, as the program was designed for enrichment rather than remediation or as an early start to one's degree. In the third iteration of the program, students who participated through its full duration had SoarCS added to their transcript as a zero-credit course. This was to make it official that they had been a part of the program and to make it easier to track this cohort of students for further studies relating to the program.

C. Program Design

SoarCS has aimed to provide fun and engaging activities to students to enrich their computational skills, encourage the formation of relationships among their future classmates, and build support structures between them and faculty, near-peers, and alumni to help increase their chances at a successful first year of college. An unintended but noteworthy outcome of the program was the creation of a digital support network for the 2020 and 2021 participants through an online messaging platform, Discord.

In each iteration of the program, students were exposed to three different "technologies" that were complementary to the university's computer science curriculum. These were designed to provide students with an introductory tool-set with skills that could be applied in their education.

In the first portion of the program, participants were introduced to the three technologies that sought to establish basic programming concepts. In the latter portion, they were then asked to create a final project based on one of the technologies to encapsulate the knowledge and skills they gained from the

program. Participants could work in teams or individually on a project and were asked to present their work on the final day of the program.

In addition to the technology lessons, the program also featured panels where faculty members, university alumni, and industry professionals shared their experiences to give students a variety of perspectives and useful information in regards to how to be successful in their education. Following the panel sessions, students had the opportunity to ask questions to the panel members and informally network with them.

A signature aspect of the SoarCS program is that the curriculum has been designed and led by undergraduate computer science students that have completed at least the first year of their degree. In comparison to reports and studies published about other STEM bridge programs, this appears to be an uncommon trait. With student leads, we sought to achieve a more relaxed, informal setting which in turn would help the comfort and engagement levels of the participants.

As previously stated, SoarCS was launched in the summer of 2019 and ran subsequently during the summers of 2020 and 2021. Each iteration of the program differed slightly: the technologies introduced to participants of the program were altered from year to year based on feedback survey data of participants and the format of the program was reconfigured to allow the program to run throughout the COVID-19 pandemic.

Despite this, we view each iteration as an adapted version of the same program, considering the general format, the desired outcomes, and core principles of the program remain unchanged. The following sections describe how each iteration of SoarCS was conducted.

D. SoarCS 2019

SoarCS was initially held as a four-day program that occurred during the second week of August. During the first two days of the program, participants were introduced to three technologies. For the remaining two days, they were allocated time to design, work on, and present their projects. In between, participants attended panels of faculty members, alumni, and industry professionals.

The program was held as an in-person, on-campus experience. Technologies were taught in university classrooms and participants stayed at a campus residence hall and were provided with three meals a day. Participants also were able to explore the university's campuses to become more familiar with the college environment before their fall semester. The program featured the following technologies: The BBC micro:bit, the Anki Cozmo Robot, and MYR.

The BBC micro:bit is a programmable pocket-sized computer board that features various sensors, buttons, and an LED display, as well as the ability to connect external electrical components and wires. All of the features can be controlled and programmed using a browser-based editor. Participants were provided with a BBC micro:bit, alligator clips, and external sensors such as a piezo buzzer and a micro servo.

The Cozmo Robot is a smart robot that uses a built-in camera to interact with a user and the objects around it. It also comes with the Cozmo SDK, which is a Python-based library that allows a user to control the Cozmo through programming. The SDK was modified to simplify the code for easier use. The participants were tasked to create a program for Cozmo to solve a maze-like course and perform various tasks such as picking up a cube and moving it to a specific location.

Fig. 3. SoarCS 2019 participants interacting with one another and the MYR technology

MYR is a browser-based platform, designed and developed by students at the university, where users can create a three-dimensional, animated scene in virtual reality using a JavaScript-based API [13]. MYR was used to teach basic programming concepts such as variables, randomly generated numbers, and loops. With these skills, participants were tasked to create a virtual scene featuring a forest of trees.

E. SoarCS 2020

For the second iteration of SoarCS, the format of the program was reconfigured to adapt to the circumstances of the time. Due to the COVID-19 pandemic, the university was not hosting any in-person events during the summer of 2020 and it was announced mid-summer that the fall semester was going to be conducted virtually as well. Thus, it was decided that SoarCS would commence as a virtual bridge program for this cohort of participants.

In order to emulate the same engagement as the in-person version of SoarCS, this iteration of the program introduced a popular online messaging platform, Discord, as a key communication element. Discord allows the creation of servers, which the company defines as spaces of communication for specific communities and or friend groups.

The SoarCS staff team created a server for the program and invited participants to join before the program officially began. The server allowed for participants to converse in text channels with one another and ask clarifying questions to the staff team. The staff team also used the server to communicate important information to students over the course of the program. Through Discord, participants got to bond with one another. For example, some participants exchanged pictures of their pets on the server, and there were various discussions regarding favorite foods, shared hobbies, and the best video games to play at the time.

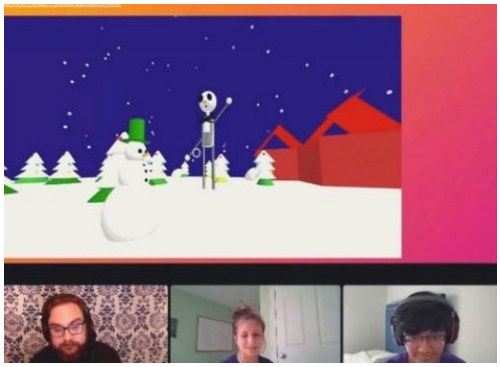

Fig. 4. SoarCS 2020 participants presenting their final projects virtually

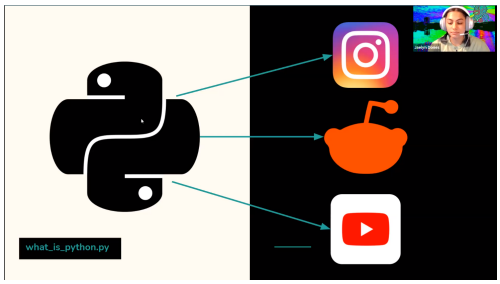

Fig. 5. Peer Leader teaching program participants Python virtually

To avoid burnout from sitting in front of a computer screen for long periods of time, the program was adapted to span across four weeks with three sessions occurring per week. Each session lasted around an hour and sessions were recorded so that students who could not attend one or more of them could watch them and stay up-to-date.

The format of the first three weeks was as follows: on Monday, a new technology was introduced to the participants by the student leaders of the program; on Wednesday, participants attended a virtual panel and were able to ask questions to the panelists; on Thursday, participants were invited to share what they had created with the technology taught earlier in the week, and a guest speaker presented for the remainder of the time.

During the last week of the program, participants worked on creative projects. On Monday, each participant was assigned a partner (if they requested one) and were placed in a group with other participants, which were referred to as pods. Pods were organized and led by SoarCS student leaders and participants were assigned to a pod based on whether they worked individually or with a partner.

Another alteration made to the program was the swapping of the Cozmo robot, which was taught in the first program, for a different technology: Google Colaboratory (Colab), a browser-based environment developed by Google that runs Python code using virtual system resources. This design change was the result of the robot curriculum being unsuited for the virtual environment of the program. Colab was used to introduce participants to the basics of coding with Python and the concept of using APIs to retrieve images via HTTPS requests.

Fig. 6. SoarCS 2021 as a hybrid program

F. SoarCS 2021

For the third iteration of SoarCS, restrictions of the pandemic had been loosened, which allowed for the program to be further adapted. The program kept the same four-week schedule and curriculum as the year prior, however, it was shifted to a hybrid model with a once-weekly, optional in-person component.

On Mondays and Wednesdays, participants attended the program virtually. On Thursdays, participants were given the option to either join remotely or come to the university's campus. In the classroom where the in-person meetings were hosted, the virtual meeting participants were displayed at the front of the room through a projector, and two camera angles were set up so that they could feel as immersed in the setting as possible (i.e., the concurrent attendance model). Students who opted to remain virtual were also supported, encouraged, and interacted with despite them not being in the room.

The technologies from the previous iteration remained the same, however, a newer version of the BBC micro:bit (which had a built-in speaker and an additional sensor) was provided.

IV. Methodology and Data Collected

To evaluate the impact of SoarCS on students' first year of college, retention rate data were used in accordance with other initiatives to measure bridge program success [4], [7]. We considered both retention in the computer science department and retention at the university. For both metrics, single-year retention is examined (i.e., whether the Fall 2019 cohort students were present in Fall 2020, and whether the Fall 2020 cohort students were present in Fall 2021).

The experimental/SoarCS group consists of students who completed the program. For a matching comparison group, we used a slightly different definition for the two program years. For the 2019 cohort, the comparison group is comprised of students who were invited to participate in the program but chose not to. For the 2020 cohort, since the program was virtual (and optional to log on to), there were also students who signed up for SoarCS but did not end up participating in the program. We defined the 2020 comparison group to comprise students who elected to not participate and as well as those who signed up but never logged on.

Department overall retention data in computer science and at the university for 2019 and 2020 were retrieved to provide a secondary comparison group to situate the experimental and

comparison group data in context. These data were provided from the university's Institutional Research database.

Tables II and III present the in-dept and at-university results for the 2019 cohort, respectively, and Tables IV and V provide the same for the 2020 cohort. Retention data for the 2021 cohort are not yet available at the time of writing.

The statistical significance of the retention rates of the experimental group in contrast with the comparison group was determined by performing a series of Chi-square tests. IBM SPSS was used to calculate Pearson Chi-square results from the data. A degree of freedom of one was used in generating the Chi-square value. These data are presented in Table VI.

One-tailed analysis of the tests was used given our hypothesis that the intervention could improve retention rates of participants that successfully completed the program.

TABLE II
SOARCS 2019 RETAINED IN COMPUTER SCIENCE

Group	Not Retained	Retained	Total (N=116)	Pct. Retained
SoarCS	12	14	26	53.8%
Comparison	43	47	90	52.2%
Dept Overall				67.5%

TABLE III
SOARCS 2019 RETAINED AT UNIVERSITY

Group	Not Retained	Retained	Total (N=116)	Pct. Retained
SoarCS	4	22	26	84.6%
Comparison	21	69	90	76.6%
Dept Overall				86.3%

TABLE IV
SOARCS 2020 RETAINED IN COMPUTER SCIENCE

Group	Not Retained	Retained	Total (N=116)	Pct. Retained
SoarCS	10	29	39	74.3%
Comparison	44	50	94	53.2%
Dept Overall				62.1%

TABLE V
SOARCS 2020 RETAINED AT UNIVERSITY

Group	Not Retained	Retained	Total (N=116)	Pct. Retained
SoarCS	2	37	39	94.8%
Comparison	22	72	94	76.6%
Dept Overall				80.8%

V. ANALYSIS & DISCUSSION

This section interprets the results from analysis of in-department and at-university retention results from the 2019 and 2020 program cohorts.

TABLE VI
PEARSON CHI-SQUARE TESTS OF RETENTION DIFFERENCE

	Difference in % Retained	Chi-Square Value	*p* value (1-sided)	SoarCS Participants (N)
2019 Dept. Retention	+1.6%	0.021	0.531	26
2019 Univ. Retention	+9.0%	0.754	0.282	26
2020 Dept. Retention	+21.1%	5.121	0.018 *	39
2020 Univ. Retention	+18.2%	6.225	0.008 **	39

A. SoarCS 2019

As shown in Table II, program participants had an *in-department* retention rate of 53.8% while the comparison group students (those invited who did not participate) had a retention rate of 52.2%. This is effectively the same rate; the difference is not statistically significant (Table VI, row 1).

Looking at student retention *within the university*, for the 2019 cohort of program participants, 84.6% were retained at the institution after their first year (Table IV). Members of the comparison group were retained at a rate of 76.7%. This difference was more promising, but given the small N of the program cohort size, it turned out to not be statistically significant (Table VI, row 2). Despite this, informally we do believe that the program had value for its participants. A number have reported to us that they have stayed in touch with one another throughout their undergraduate careers, and several have maintained contact with the faculty and staff leads of the program.

B. SoarCS 2020

For the 2020 program, Table IV shows that program students were retained in the department at a rate of 74.3%. This compares favorably to the in-department retention rates of the comparison group students (53.2%) and the department overall (62.1%). **The Chi-squared analysis comparing the program cohort to the comparison cohort indicates that this difference is statistically significant, with a *p* value of 0.018 (Table VI, row 3).**

Regarding at-university retention, Table V shows that 39 students that completed SoarCS in its second iteration. Only two students of the 39 were not retained at the university after the first year, yielding an enviable retention rate of 94.8%. This exceeds the retention rates of both the comparison cohort (76.6%) and department overall (80.8%), a statistically significant difference with respect to the comparison cohort (p value of 0.008 per Table VI, row 4). **The students who successfully completed the program during the summer of 2020 were well-poised for their first academic year of university.**

VI. QUANTITATIVE OBSERVATIONS: DISCORD

With SoarCS 2020 and 2021 occurring during a pandemic, the challenge of creating meaningful interactions and lasting

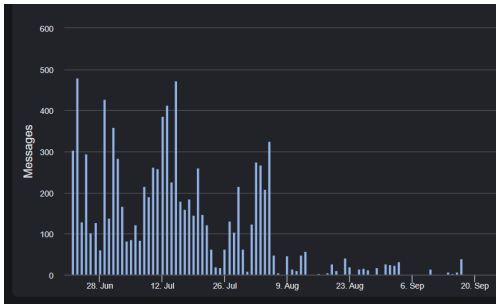

Fig. 7. Number of messages exchanged on SoarCS 2021 server June - September 2021 [15]

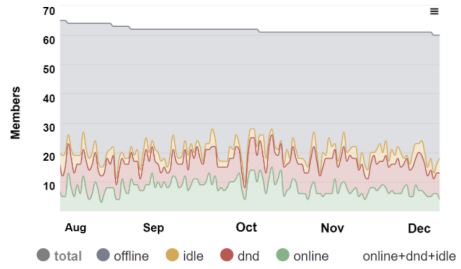

Fig. 8. Activity statuses of students that were a part of the SoarCS 2021 server, August to December 2021 [15]

bonds through hosting the program virtually posed a challenge. Discord was used to help mitigate this issue during the program and was later revealed to have a more lasting impact.

Upon initially launching the Discord server for SoarCS 2020 and 2021, there were students that were unfamiliar with the platform: some did not know how to join, some did not know how to navigate the interface, etc. There was a learning curve for some individuals, but the usage and exposure to Discord before the beginning of their first semester had a positive impact.

Those who signed up for SoarCS in 2020 and joined the server (even if they did not participate in the program to completion) reaped the benefits that came with the creation of a Discord account. With the fall semester being virtual, Discord helped students (SoarCS participants and those who did not complete the program) network with each other with ease. Literature prior to the pandemic has established a link between community and student success in online learning [17]. During a time in which making connections was difficult, SoarCS provided an online space to engage informally with future classmates, eliminating the social barrier that many others faced as they began college virtually. Participants found that Discord was a great tool for creating study groups and building relationships with one another, which was a shift that was shown within universities across the country [14], [16].

It is interesting to note that there were cases of students that did not attend the meetings of the program yet maintained an active presence by communicating with other individuals on the server.

For the 2021 SoarCS group, the hybrid model lessened the reliance on Discord for making friends during the program, however, the server was active for the duration of the program and for approximately a month after, as shown in Fig. 7.

Two student leaders of the program made a separate Discord server (that did not include the staff members that ran SoarCS) for the SoarCS group and any other first-year computer science students who wished to be invited to it. The idea behind this server was to provide a space for students of higher seniority in computer science to support, encourage, and assist first-year students as they transitioned back to in-person learning. As of December 2021, there were 109 members of this server. It has remained active since through the present as this paper is

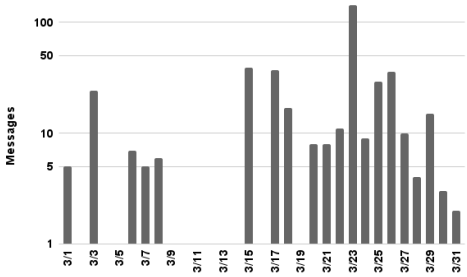

Fig. 9. Number of messages exchanged on student-only server March 2022

prepared (April 2022). As shown in Fig. 9, in March 2022, there were a total of 521 messages sent by users on the server over the course of the month. This level of activity is comparable to the September 2021 activity in the original program server. In addition, two students joined the server during March 2022, raising the total number of members on the server. The server has been used to spread computer science news, university announcements, career advice, and assistance with first-year computing concepts. The peak in messaging on March 23 reflected intensive conversation as students supported each other in engaging in a central second-semester computer science project.

As reflected above in Fig. 10, the 49 students that elected to chose to identify themselves as freshmen make up nearly half of the individuals that are a part of the server that was created by the two student leaders. Students had the option to declare a "role" that showed their year in college, mostly to distinguish

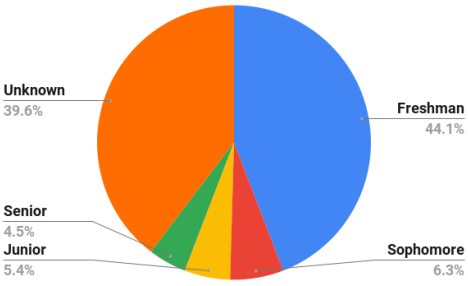

Fig. 10. Distribution of members on the student-only server

individuals of higher seniority. With this, the number of freshmen students on the server may be much higher since role declaration is elective and 44 students (39.6%) have not selected their year of college with the corresponding role.

Fig. 8 shows that activity among members who were a part of the SoarCS 2021 server has continued, suggesting that those who used Discord for SoarCS continue to use the platform for other means. It must be acknowledged that the graph definitely shows users that were online (green) inactive (yellow) or in do-not-disturb mode (red), however, users have a choice to display their online status. Users can choose to appear "invisible" which is recorded the same as offline and truly inactive users. This is not to be confused with the yellow inactive color, which denotes that a user is logged into Discord, but has not interacted with the client for a few minutes.

The researchers believe that the lasting community that came out of SoarCS is another way in which the program has positively impacted both participants of the program and registered students who not participate but were active on Discord. It has been suggested that minority students in STEM do not integrate into their scientific communities at the same rate as non-minority students, which is a social attribution as to why minority students drop out of STEM pathways at a higher rate [18]. SoarCS participants were already integrated with other computer science students via Discord as they started their academic career, which may have influenced their success in the computer science program.

VII. Limitations

Given that only one program cohort showed higher retention rates, these findings cannot speak for the effectiveness of the program as a whole. The 2019 group of students did not have a significant difference in retention rate in comparison to the comparison cohort for that year.

In addition, the higher retention rates of the second cohort could be attributed to other factors than program involvement. As a virtual, four-week program, there was a greater commitment involved to be considered part of this cohort. Perhaps students who completed the program virtually had a stronger drive for computer science or had greater time management skills in comparison to students who either did not complete the program or never signed up in the first place.

In this study, retention rates were the primary metric for student success post-program. Other data collection (e.g. proportion of computer science credits attempted vs earned of all cohorts, qualitative data from interviewing participants, etc.) may provide metrics that better define the success of SoarCS.

VIII. Further Directions & Conclusions

We plan to track the 2021 cohort for retention data as we have for the two cohorts analyzed in this paper. It is the largest cohort since the inception of the program and we are optimistic to also demonstrate successful retention of these students (43 participants per Table I). The 2022 program will be run in the same format as was done in 2021—a four-week program with three real-time meetings per week over Zoom and an option to attend the Thursday meeting in person. We have found that this format increases program accessibility. We are planning a qualitative study of program impact. This will include surveys and interviews with the upcoming cohort and retrospective surveys with the 2021 cohort. SoarCS alumni will be asked about their experiences with the program, how they perceive it helped them, their follow-on usage of Discord, who they keep in contact with from the program, etc. We anticipate that this will reveal other dimensions of SoarCS's impact which are not measured in this quantitative study. The use of Discord will also continue in subsequent iterations of SoarCS, with implemented tools within servers that measure student activity. This was done for the 2021 SoarCS server but not for the 2020 server or the one created after SoarCS 2021. The use of these tools can help better understand the communal aspect that arises from SoarCS. SoarCS alumni could continue to be tracked for further analysis. Second, third, and fourth year retention data in addition to the percentage of SoarCS alumni who completed their computer science degree could be evaluated. We are excited about the impact we have seen as a result of running SoarCS on our campus. We have been in touch with many students who have been part of the program to offer them subsequent opportunities for professional growth. We are launching programs for incoming students in other departments in our college of Sciences modeled after SoarCS. We have attracted additional corporate and alumni support for SoarCS and these new programs.

As other universities develop and improve their own bridge programs, we would like to highlight the recruitment strategy that was employed in SoarCS. Calling and sending postcards to minority students led to action that accounted for over 50% of their participation in the program, showcasing a method of recruitment that may be effective in other cases as well.

We would also like to highlight the near-peer, student-led design of SoarCS. This has been one of the most rewarding aspects of the program, not just for incoming students, but for the student leaders as well (two of whom are authors of this paper). Peer leaders reflect that their involvement with SoarCS helped build soft skills in in communication, planning, and management that were useful in the classroom and as they prepared to enter the workforce. In addition, the participants of the program were not the only ones who formulated a thriving community of shared experiences, jokes, collaboration, and friendship—the peer leaders formulated a similar community of camaraderie as they worked together before, during, and after SoarCS.

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