Fostering a Sense of Belonging for Women in Computing through Community Service

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Work-in-Progress: Fostering a Sense of Belonging for Women in Computing through Community Service (WIP)

1. Introduction and Motivation

Having a sense of belonging and involvement are critical indicators of student's success and retention in general but more specifically for female students in computing disciplines [1, 2, 3, 4]. Females are underrepresented in STEM majors, including computer science and software engineering. Female students' enrollment and retention in computing fields is low compared to males as depicted in [5]. Only 20% of computer science and 22% of engineering undergraduate degrees are earned by women in the US. In 2020, women made up only 19% of computer science graduates. Universities have been aware of this problem and significant effort has been steered to improve female students' enrollment and retention [6, 7, 8]. It has been evident that student's involvement in community service enhances their sense of belonging and ultimately their academic success [3, 2]. Students engage in community services through clubs, university-wide events and specific courses in the university curriculum or major courses. It is part of the extracurricular day-to-day activities they are involved in. Female students at Quinnipiac University's School of Computing and Engineering receive support through various avenues, one of which is the establishment and operation of Girls Who Code Club-QU (GWC-QU) since 2017.

This work addresses two specific research questions: 1- how is female students' sense of belonging affected by community service specifically, running GWC-QU and mentoring younger female students; 2-Does engagement in this extra-curricular activity affect their decision to stay in the major? This paper presents preliminary results obtained by passing a questionnaire at the beginning of Spring 2024 semester before running the club. These results will be used to test the support to the hypothesis for those students who were engaged in GWC-QU in the past three years, and act as a pre-questionnaire for those who will be running the club this year.

This paper is structured into the following sections: Section 1 presents background about sense of belonging of women in computing; Section 2 describes the GWC club activities and GWC-QU background; Section 3 discusses the research methods applied in this paper. Section 4 presents the results and analysis of findings; Section 5 discusses research limitations and finally, Section 6 concludes this work and presents future work.

2. Background - Sense of Belonging of Women in Computing

Students sense of belonging in college is an important indicator of student's success and graduation [9, 4, 10]. Multiple studies have concluded that students who self-identify as minority by gender, color or race have lower sense of belonging in general and specifically in computing disciplines [11, 12].

Engagement in extracurricular activities is one of the effective ways of enhancing students' sense of belonging in computing. Veilleux et al. [2] concludes that student's sense of belonging is

enhanced by engagement in extra-curricular activities and academic communities. Soria et al. [3] studied students' sense of belonging in relation to community service and found that community service is positively associated with students' sense of belonging on campus.

A limited number of studies focused on sense of belonging of women in computing disciplines. Sax et al. [12] performed a study in 2018 to examining sense of belonging among women in computing introductory courses. This study concluded that sense of belonging is in part a product of college environment and experiences gained during. Another study in 2020 [11] explored sense of belonging in computing students records lower levels of sense of belonging in women and minorities. It also notes that female students that participate in extra-curricular activities such as outreach and mentoring had higher sense of belonging. Finally, a study conducted in Brazil [13] compared female sense of belong to males in introductory computer science courses. Females recorded lower indicators of sense of belonging compared to male counterparts.

3. Background -Girls Who Code at QU

Girls Who Code (GWC) [14] is a nonprofit organization that is dedicated to closing the gender gap in technology and computer science. Their mission is to inspire more girls to become computer scientists and engineers by running clubs where girls grade 6 through 12 learn computer science skills from volunteer teachers. The GWC portal provides a 10-session curriculum that allows participants to program in different programming languages. It also provides meeting guides suited to the participants' age group, tutorials, and facilitator support. According to the GWC website [14], the club has reached 580,000 students in United States, Canada, India, and United Kingdom.

GWC-QU was established in 2017 and ran its first sessions in Spring 2018 [15]. It has been running every year since then except during COVID in 2019 and 2020 [16]. Running the club requires significant effort where the facilitators must visit schools around the area to recruit younger females as well as spread the word about the club. The club activities are scheduled for 10 weeks where the facilitators meet with the school-age students for an hour and a half to teach them computing principles using GWC curriculum. They also guide students through the completion of a personal project.
The club served an average of 37 students every year and had about six to seven female computer science/software engineering facilitator each offering. In Spring 2023, the club was run by nine female facilitators and served 36 female students. The student facilitators ranged from freshmen students to senior computing female students. This Spring, the club is facilitated by 11 female facilitators and attended by about 40 female students that started sessions in the first week of February. The number of club facilitators is around 20% of the population of female students in our programs.

In the past years, the facilitators were always able to build a small community of practice where they mentor each other as well as mentor younger female students that participated in the club.

Club facilitators engaged in the club have reported that they learned many skills due to their involvement in the club such as leadership skills and communication skills [16].

4. Methodology

Since this work targets students participating an extracurricular activity, the main method of data collection is a survey that was conducted and administered to all female students enrolled in Computer Science and Software Engineering in Spring 2024. The survey is an electronic form composed of 15 questions addressing demographics and other questions that measure intellectual sense of belonging. Questions were separated to target students who participated in GWC-QU in the past, are running the program this year and non-participants in the program. The six rating questions used to measure sense of belonging are:
On a scale of 1 to 5 (1 star to 5 stars), rate the following:

1. I feel understood and respected by the CSC/SER community.
2. I contribute to class discussions.
3. I feel like I belong here at the School of Computing and Engineering.
4. I am happy with my choice to be a CSC/SER major.
5. I can be myself in the CSC/SER community.
6. I believe my study efforts are rewarded within the CSC/SER community.

These questions are inspired by Stout and Blaney's [17] work in examining sense of belonging among first-generation college women in introductory computing classes.
A second set of questions is designed specifically for club facilitators this year or in previous years. These questions are as follows:

a) How many times have you participated in GWC-QU (not including this year)
b) If your question was not zero in question 1, then rate the following statement on a scale from 1 to 5: Participation in GWC-QU has made me more confident as a computer science/software engineering student.
c) Describe your experience with GWC-QU and how it affected you in the previous years.
d) What motivates you to participate in GWC-QU this year.

The questionnaire was distributed via email to a total of 30 female students enrolled in Computer Science and Software Engineering majors in the School of Computing and Engineering at the beginning of the Spring semester before the start of this year's club sessions. Nineteen responses were received with a response rate 63.3% and demographics as shown in Table 1.

Table 1 Participating students demographics

Criteria	**Number of responses**			
Major	**Computer Science**		**Software Engineering**	
	9		10	
Year	**First year**	**Sophomore**	**Junior**	**Senior**
	2	4	7	6
GWC past participation	**3 times**	**2 times**	**1 time**	**0 times**
	1	2	3	13

The next section demonstrates the analysis of responses by participation or non-participation in GWC in previous years.

5. Results and Discussion

This section presents and discusses the responses to the survey questions. The responses are presented for two groups: students who participated in GWC-QU before and students who have no prior participation in the club. The answers are displayed in two graphs showing three questions for clarity and concise presentation.

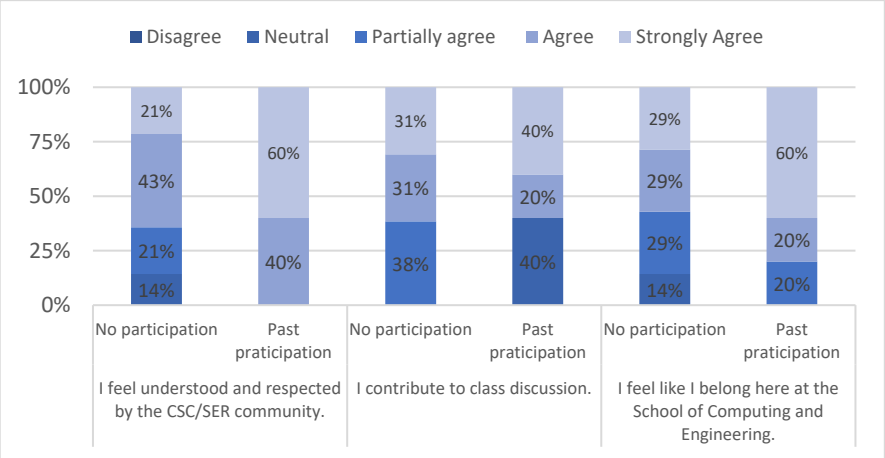

Figure 1 Responses for questions 1 to 3 by participation.

Figure 1 shows the responses to questions 1,2 and 3.
Question 1: I feel understood and respected by the CSC/SER community. All students who participated in the club either agreed or strongly agreed with this statement. Fourteen percent of the students who did not participate in the club gave a neutral answer to the question.

Question 2: I contribute to class discussion. Most responses by past participants either agree or strongly agree with the statement. Forty percent of the participants had a neutral feeling regarding this statement. For non-participants, 38% partially agreed with the statement while the rest of the participants either agreed or strongly agreed.

Question 3: I feel like I belong here at the School of Computing and Engineering Thirty three percent of non-participants felt either were neutral or partially agreed that they feel they belong at the School of Computing and Engineering. Yet only 20% partially agreed with the statement for the participating students while 60% strongly agreed.

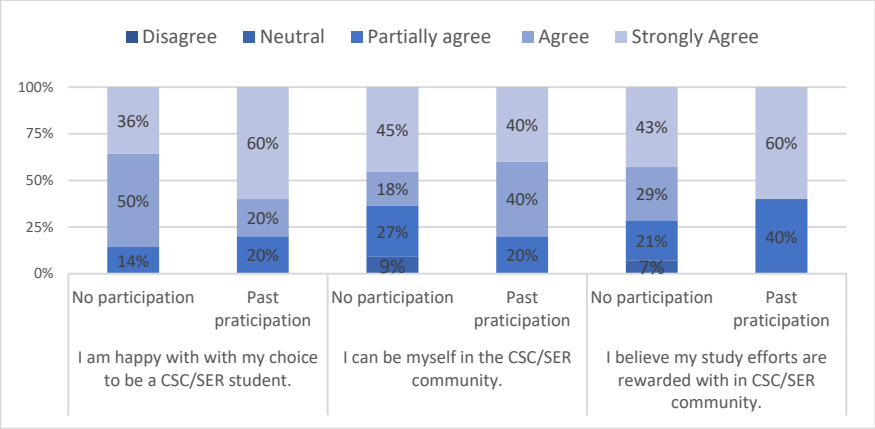

Figure 2 Responses for questions 4 to 6 by participation.

Figure 2 shows the responds received for question 4, 5 and 6.
Question 4: I am happy with my choice to be a CSC/SER student. Sixty percent of club participants strongly agreed with this statement while twenty percent partially agreed. For non-participants, 36% strongly agreed and 14% partially agreed.

Question 5: I can be myself in the CSC/SER community. Most club participants strongly agreed or agreed with this statement with 20% partially agreed. Nine percent of non-participants felt neutral about this statement.

Question 6: I can believe my study efforts and rewarded within the CSC/SER community. All club participants either partially agreed or strongly agreed with this statement while for non-participation 7% felt neutral.

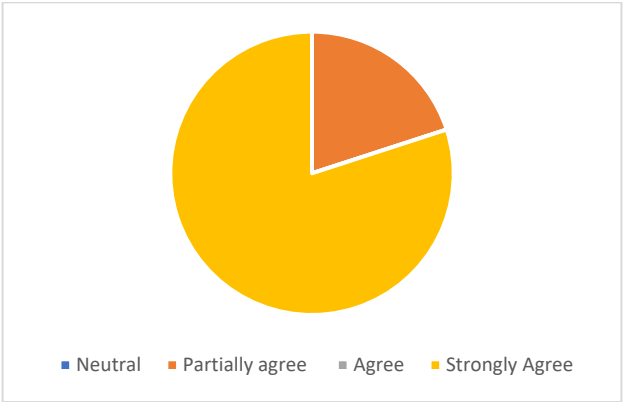

Figure 3 GWC-QU facilitators ratings of the statement: "Participation in GWC-QU has made me more confident as a computer science/software engineering student."

Question b. Participation in GWC-QU has made me more confident as a computer science/software engineering student. Most club facilitators strongly agreed that participation in

the club has given them more confidence as CSC/SER students while the rest agreed with the statement as depicted in Figure *3*.

Sample answers to question c- "Describe your experience with GWC-QU and how it affected you in the previous years" are as follows:

> "The girls in the club, having a sense of importance, and feeling like you are helping the community."
>
> "I want to continue making in impact for girls considering entering into the field, so they don't have the same fear as I did. Being able to see the positive impact this program has on young girls makes me want to come back every year."
>
> "Being a part of the club reminds me what it was like to be the students ages again and how eager I was to start coding. Being a girl in this degree can be challenging and working with younger students has reminded me of the role models I once had and the impact they had on my choice to enter SWE. So continuing what my role models once did for me and creating a support system for the future girl coders is what drives my participation"

Sample answers to question d- "What motivates you to participate in GWC-QU this year" are as follows:

> "It was a great way to meet other women in comp sci and to form a community both with each other and with the students there to learn."
>
> "It has always been a super welcoming environment and introduced me to people I've had classes with but never really talked to before."
>
> "My experience in GWC@QU has allowed me to connect with other incredible students who share the same passion for coding as me. It also is a great community of women teaching young girls to fall in love with coding as well. "
>
> "It gave me a sense of confidence in my knowledge in the software field. But it also created a smaller community within our school."
>
> "It helped me find a group of women that were interested or went through the same classes that I did. Was helpful to get advice and see someone else go through the program too."

An overall conclusion from the collected data shows that indicators of sense of belonging are higher for GWC-QU club facilitators than non-facilitators. Except for question 3, female student who participated in the club scored higher and showed stronger agreement with the statements. Sample answers for questions c and d are evidence of how the club has helped female students build a small community of practice where they down mentored younger females and where peer mentored by other female student which is important factor for their sense of belonging as computing students.

6. Limitations

It is important to acknowledge that the size of the recipient pool is small even with sending the survey to all females enrolled in all computing majors. The responses received represent 65% of this small size which is even a smaller number. Collecting more data in the next few years will provide better evidence to support the suggested hypothesis.

7. Conclusion and Future work

This paper explores the potential association between computing female students' sense of belonging and their involvement in community service through engagement in GWC-QU. A questionnaire was applied to all female students in computing majors in the Quinnipiac University's School of Computing and Engineering. The questionnaire initial results show that female students who facilitate the club have a higher sense of belonging than those who didn't participate in the club. Club facilitators answered qualitative questions and provided valuable insights into how much they feel connected to other students because of their involvement in the club.

The next steps in this research include collecting further data after the conclusion of the club this year to measure the sense of belonging for new club facilitators. It also includes expanding the survey questions and collecting data for incoming female students specific to the role of mentoring down and peer mentoring in their sense of belonging and wellbeing as computing students as well getting retention data to validate the second hypothesis.

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