2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
Paper ID #51459

Analysis of a Five-Year Journey Nurturing Women in Computing Programs at a Public Undergraduate Institution

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Dr. Aydin's research is in the general area of wireless and mobile networks with a focus on transport layer issues including multihoming, SCTP, congestion control, and network coding. Dr. Aydin has mentored undergraduates and high school students on research projects that involve the use of Arduino boxes and Raspberry Pi's in the context of Internet of Things as well as use of the public networking testbeds such as GENI, CloudLab, and FABRIC.

Dr. Aydin has been a vivid supporter of women in computing and increasing diversity in computing. She has been the co-faculty advisor for Women in Computing club at Farmingdale, contributed in Grace Hopper Celebration as a technical committee member and reviewer. Dr. Aydin has published and presented in peer reviewed venues about women in computing and broadening the participation over a decade.

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Abstract

This paper presents a comprehensive five-year analysis of programs (initiatives) aimed at improving the experiences and outcomes for women in undergraduate computing programs, specifically the Computer Programming and Information Systems (CPIS) and Computer Science (CS) majors, at a public state institution. Motivated by the broader vision of reducing the gender gap in computing fields, authors implemented and sustained a series of targeted interventions, including 1) a Women in Computing student club, 2) hosting summer orientation programs specifically for incoming women students in computing majors, and 3) fieldtrips to women-centered computing events and conferences.

The primary research goals were to improve women students' overall experience while improving sense of belonging (SoB) and Academic Self Concept (ASC) throughout their studies. Using a mixed-methods approach, the study analyzes longitudinal End-of-Semester survey data (Likert-like-scale items and open-ended responses) in conjunction with institutional enrollment metrics to assess perceived impacts over time. The study is approved by the college Institutional Review Board (IRB), and survey data are collected over four academic years.

Findings indicate that participation across all three implemented initiatives is consistently associated with positive outcomes, including women students' experience on campus as they complete their degrees, their SoB, their ASC, and increased peer bonding and support and motivation to persist in the computing programs. While overall women enrollment in the combined CPIS and CS programs did not increase significantly during the study period, institutional data reveal a modest improvement in gender composition of the programs, reflected in a gradual shift in the male-to-female enrollment ratio.

1. Introduction and Background

Farmingdale State College (FSC) campus is in the northeast of the United States and part of a large state university system. FSC is primarily a commuter college serving the local population where approximately 6% of the 10,000 students reside on campus. FSC has a diverse and 'majority minority' student population where 64% of the students are from underrepresented backgrounds, 84% of the students are eligible for financial aid in first year, 73% of degree-seeking undergraduate students are offered financial aid, and 82% of students are employed on- or off-campus while balancing their course workload. Women student enrollment is 42% across all programs. These demographics are relevant because the student population is *a*typical of traditional residential colleges and influences success and participation in initiatives embarked by the authors targeting the women undergraduate students in the computing degree programs at FSC.

The authors set out in 2020 to re-address the glaring gender disparity issue in computing degrees that are well-known and historically documented beyond FSC campus [1]. However, the issue appeared to be worsening on their campus as shown in Figure 1 where women enrollment in Computer Programming and Information Systems (CPIS) degree program was at an all-time low from 2010-2012. The Computer Systems department has offered the CPIS degree program for over 20 years while Computer Science (CS) degree program was launched in fall 2021. The CS degree program also has had a similar gender disparity issue since its establishment.

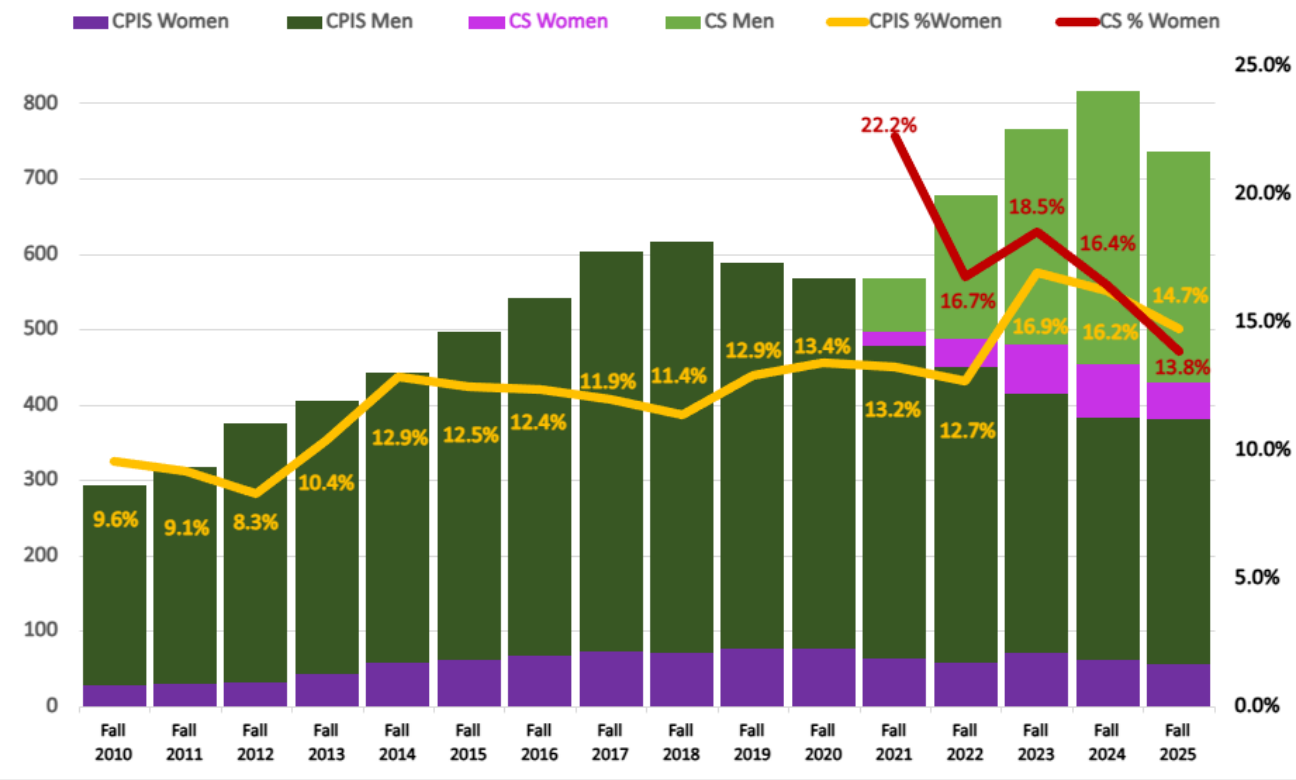

Figure 1: Undergrad Enrollment trends in CPIS and CS degree programs of FSC since fall 2020, highlighting women percentages

The authors began the study by analyzing the issue and earlier efforts started to address the issue on their campus before 2020 but discontinued due to various on and off campus factors such as campus and national budget freezes and cuts, funding limitations, staff and faculty shortages, and administrative support [17,18]. With eagerness to get started, the researchers decided to pursue three Women in Computing (WiC) interventions that were feasible despite sporadic and limited local funding and aimed at improving women students' experience, sense of belonging, and academic self-concept in the short term, and women enrollment on their campus in the long run. The three WiC initiatives pursued in this study are: 1) maintaining a women in computing student club, 2) hosting summer orientation programs for women computing students, and 3) attending women in computing conferences (field trips). The study was approved by the Institutional Research Board (IRB) of FSC and results from planning, execution, and analysis of the initiatives were shared with the community via various publications and presentations. The timeline and data reporting (publications) from the initiatives are summarized in Table 1, while details and highlights of the initiatives are as follows.

*Table 1: Timeline of WiC Initiatives, Data Collection and Dissemination (*No EoS survey given in Fall'24)*

Initiatives	Spring 2020 - Spring 2021	Summer 2021	Fall 2021	Spring 2022	Summer 2022	Fall 2022	Spring 2023	Summer 2023	Fall 2023	Spring 2024	Summer 2024	Fall 2024	Spring 2025
#1 SWiC Student Club	Fall '20 Reinstated Club with FSC Student Gov't	Active	Active	ACM-W Student Chapter Status	Active ACM-W	Active ACM-W	Active ACM-W	Active ACM-W	Active ACM-W	Active ACM-W	Active ACM-W	Active ACM-W	Active ACM-W
#2 Summer Orientation		1st Inaugural 22 attended *Pre: 26 Post: 22*			2nd annual 32 attended *Pre: 31 Post: 29*			3rd annual 43 attended *Pre: 37 Post: 34*			4th annual 41 attended Pre: 28 Post: 29		
#3 Field trips	Spring '20 NYCWiC regional 30 women, 2 faculty CANCELLED - COVID Spring '21 NYCWiC virtual 8 students attended			NYCWiC regional 25 women, 10 men, 2 faculty attended *Pre: 36 Post: 31*			NYCWiC regional 34 women, 2 faculty attended *Pre: 26 Post: 30*			Harvard WeCode 10 women, 1 faculty attended Pre: 9 Post: 9		Grace Hopper 18 women, 2 faculty attended N=7	Harvard WeCode 12 women, 1 faculty attended
***EoS* Surveys**			N=19	N=23		N=38	N=36		N=45	N=19		N=0	N=28
Data Reported		[21]	[19]	[24]	[22]	[25]							
				[23]			[26]						

1. *Maintaining the Supporting Women in Computing (SWiC) student club:* SWiC was first launched in 2014. From 2014-2020, the club was inconsistently active. It was officially re-instantiated during the fall 2020 semester during the COVID19 global pandemic. Finding student leaders with the time and commitment to participate in leadership training, completing administrative club paperwork each semester, planning, organizing, and hosting club activities has been challenging [20]. FSC serves primarily commuter students with considerable outside of school commitments (e.g. part- or full-time employment and familial responsibilities). However, the SWiC faculty advisors (authors) have recruited students and maintained consistent online and in-person communication and periodic meetings yearlong, which has yielded some student leaders to own the club "business" across semesters. The club obtained and maintained ACM-W student chapter status since fall 2022. The time faculty advisors spent to nurture the student leadership of the SWiC has paid off whereby a system of assigning under class women as co-officers for executive board positions has served as good training and helped to maintain continuity of the club. This resulted in a vibrant club that organizes hybrid events (with both in person and online presence) on campus, including hosting ACM-W renowned speakers [27, 28].
2. *Summer (Re)Orientation for Women Computing Students:* Student orientations provide students with opportunities to familiarize themselves with their peers and computing faculty and develop a community among participants. Summer (re)orientation programs were organized at FSC and hosted for all incoming (freshmen and returning) women computing students in the August of 2021 (inaugural), 2022, 2023, and 2024 as one-day events to engage women in a small community prior to the start of the academic year. These events offered opportunities for women computing students to engage in game-based team building exercises, explore technical skills needed for their future courses, and attend panel discussions of role model women in the computing field including computing degree programs alumni [21, 22].

3. *Field trips to women-centric conferences:* Each spring the ACM-W Regional Celebration of Women conference is hosted in the state. Due to its proximity and affordable registration cost that included overnight accommodations, FSC was able to provide the participation opportunity to women computing students in three consecutive spring semesters (2021-virtual, 2022 and 2023) [24, 26]. In total 67 women students (8 virtually) and 10 male students attended the regional celebration conference since Spring'21. In addition, authors organized and chaperoned women students WeCode event in Harvard University in (10 women in Spring'24 and 12 women in Spring'25) and Grace Hopper Celebration in Philadelphia (18 women students in Fall'24). Harvard WeCode and Grace Hopper Celebration were significantly more expensive than regional trips to attend; thus, a smaller population of students are included. This presents a dilemma of the tradeoff whether to include more students attending local regional conferences versus the small number of students for a broader, richer experience.

The authors were inspired by schools and programs that accomplished increase in women in computing enrollment achieved with a variety of interventions (e.g., the BRAIDs program [2], Harvey Mudd College [3]). However, the FSC student demographic presents more challenges due to the high number of commuters with many commitments (work and family responsibilities) beyond their studies. While the short-term goals of this research and the three WiC initiatives in place is to improve the CPIS and CS women student experience, the long term the goal is to increase the women student enrollment.

Funding for the WiC initiatives implemented in this research was secured through multiple sources, as a result of authors' grant and proposal writing efforts. These sources primarily included local institutional resources (such as department chairs, deans, and provost budgets, as well as on campus seed and small grants) totaling $32,500 over the study period. External funding from a regional foundation in the amount of $4,000 was also obtained for a year.

Following the transition of computing programs to the School of Engineering Technology (in Spring'22), the authors were provided with the opportunity to submit budget requests directly to the Dean as part of the annual budgeting process. Through this mechanism, funding was secured to support student participation in the Grace Hopper Celebration as well as the continued hosting of summer (re)orientation program for women students. Department funding has been a source of support while Student Government funding has contributed to field trip expenses in Spring'24 and Spring'25 semesters. Therefore, while early program support relied heavily on competitive local funding applications to underwrite the WiC initiatives-related expenses, institutional support has increased in recent years. While the state institutions have a precarious budgeting process, the authors appreciate the consistent internal support received more recently. This funding reflects an increasing institutional recognition of the value and impact that Women in Computing (WiC) initiatives have contributed to the campus since 2020.

In this study, pre- and post-event (-orientation and -field trip) surveys are conducted to measure the immediate impact of a specific initiative while End of Semester (EoS) surveys are conducted to measure the longer-term impact of the three initiatives. The EoS surveys were piloted in Fall'21 and results were published in a preliminary paper [19], then Year 1 (Fall'21, Spring'22) and Year 2 (Fall'22, Spring'23) EoS survey results were published in earlier work [23, 26]. This paper includes

EoS survey results from later semester (Fall'23, Spring'24, and Spring'25 – no survey was administered in Fall'24) to perform longitudinal analysis over the lifetime of the project.

This paper analyzes the longitudinal data collected by the researchers throughout the study to determine the impact of women in computing initiatives. The three areas measured are (i) women students' experience as they pursue their studies at FSC (ii) women students' sense of belonging (SoB) and (iii) women students' academic self-concept (ASC). The personal observations and reflections of the authors during the planning and implementation of the initiatives are also shared in this paper.

The remainder of the paper is organized as follows. Section 2 presents related work about SoB and ASC. Section 3 presents the research methodology including research questions and data collection. Section 4 reviews the results and data analysis from the surveys. Section 5 presents authors' reflections about the implementation of the initiatives and limitations of the study. Finally, Section 5 concludes the paper with future goals.

2. Related Work

There is a persistent gender gap in STEM enrollment and degree attainment at universities across the nation. For example, earned undergraduate degrees for women in Math, Computer Science, and Engineering lags other STEM majors such as Biology [4]. Addressing this imbalance requires attention not only to recruitment, but also to retention and persistence within computing majors. It is established by researchers that sense of belonging (SoB) and academic self-concept (ASC) are critical factors that improve retention and academic performance of students.

Engagement in extra and co-curricular activities has been shown to foster a strong sense of belonging (SoB) in higher education contexts. Students who reported a strong sense of community with their college demonstrate higher retention and graduation rates [5]. Engaging in academic and social experiences creates opportunities for students to strengthen their perception of belonging, which in turn positively influences their academic success and persistence [6]. By being involved in academic and social experiences, students develop social networks that include both faculty and peers. These social networks are vital to persistence in college and within a major [7, 8].

One research [16] demonstrated that a strong sense of belonging in college is positively associated with improved academic outcomes, higher levels of engagement and greater persistence - particularly for underrepresented groups such as women in STEM. Orientation programs that intentionally foster early community building, peer connection, and institutional support can enhance students' sense of belonging. Because belonging is strongly linked to academic engagement and performance, such programs may indirectly contribute to improved academic success and persistence for women in computing disciplines.

Conference participation has also been studied as an intervention strategy. A study [13] found that attending the Grace Hopper Celebration (GHC) helped address barriers that discourage women from pursuing computer science. Participants reported improved understanding of CS, more positive perceptions of computing culture, and increased intentions to take additional CS courses and major in CS. However, while attendees reported stronger networks within their home institutions, many did

not intend to maintain connections formed at the conference itself, suggesting mixed outcomes in broader professional network development.

One study [14] reported that female student facilitators in a Girls Who Code club built a community of practice through mentoring and outreach, enhancing their sense of belonging and influencing their decision to remain in the major. Similarly, [15] found that formalizing a Women in Computing club with meaningful membership practices strengthened community formation and a sense of belonging for women CS students —an essential contributor to academic motivation and persistence. Another study [9] shows how a combination of student-advisor (faculty) interaction and participation in extracurricular activities results in a higher first-to-second year retention rate (fall to fall) among students. Within computing specifically, women-focused initiatives have demonstrated promising outcomes. This study focuses on the women students in computing majors and improving their SoB.

Educational researchers have also demonstrated the efficacy of a positive academic self-concept (ASC). Academic Self-Concept is defined as students perceived academic abilities through self-reflection and comparison to others and have been positively associated with academic performance [10]. Academic self-concept may provide insight into students' perception of their academic abilities and how they persist through academic challenges. ASC also provides insight into the non-cognitive elements of achievement, especially for students from groups traditionally underrepresented in STEM [11]. Despite progress in STEM participation overall, women earned only 25% of the bachelor's degrees in engineering, mathematics, and computer science in 2020 [4]. Overall, women also self-report lower levels of academic self-concept in these disciplines [12]. These disparities suggest that interventions aimed at strengthening ASC may be particularly important for women in computing. Accordingly, this study aims not only to enhance sense of belonging, but also to improve academic self-concept among women computing majors.

3. Research Methodology

This research received approval from the FSC's Institutional Review Board (IRB) board and targets the undergraduate computing students in CPIS and CS majors at FSC who identify as women (including cisgender or transgender) as reflected in FSC records.

3.1. Research Questions

Researchers posit that (1) providing students with a vibrant engaging Supporting Women in Computing (SWiC) student club featuring activities, speakers, and meetings (2) welcoming them with a Summer (re)orientation for women students that includes team-building exercises, technical sessions and guest speakers, and (3) offering them to participate in off-campus, women-centric conferences, will positively influence women students sense of belonging (SoB) and academic-self-concept (ASC) as well enhance their overall campus experience while pursuing studies at FSC. Accordingly, this study investigates the following research questions:

- **RQ1:** Does participation in the WiC initiatives positively influence *woman students' experience* while pursuing their studies?
- **RQ2:** Does participation in *Women in Computing student club* on campus improve woman students' SoB and ASC?

- **RQ3:** Does participation in a women-focused s*ummer (re)orientation* program improve woman students' SoB and ASC?
- **RQ4:** Does attendance to women-centric off-campus *field trips* improve woman students' SoB and ASC?

3.2. Data Collection

Table 1 above summarizes the timeline of the three WiC initiatives implemented since 2020, along with the corresponding data collection (surveys) and dissemination (prior publications).

Participation in the WiC initiatives was voluntary and optional. Participation in the associated surveys was voluntary and anonymous. Students were invited to take the surveys prepared with Qualtrics via email. Although researchers sent periodic emails to encourage participation in the surveys, no other additional incentives were offered for participation. Pre- and post-event surveys conducted per (re)orientation program and field trip in addition to the End of Semester (EoS) surveys. Both Likert style questions and open-ended questions are included in the pre- and post-event surveys and the EoS surveys. As students can participate in multiple WiC initiatives, they can appear across multiple initiatives in the survey results.

Pre- and post-event surveys were designed to collect students' perspectives on their encounters with the corresponding summer (re)orientation program and field trip. Data from previous summer (re)orientation programs and field trips have been reported separately in prior work (see Table 1 for self-references). The end-of-semester (EoS) surveys conducted to reflect holistically on the impact of student participation in student club activities, field trips, and summer (re)orientation programs particularly with respect to their campus experience, SoB and ASC. Additionally, this paper also includes the qualitative feedback from some EoS surveys and (testimonials) from the latest field trip to Grace Hopper Celebration in Fall'24 that was not disseminated earlier, for completeness and deeper insights.

Table 2 summarizes participation and the response rates for the EoS surveys administered since Fall'21. The researchers acknowledge that the number of women enrolled in CPIS and CS degree programs at FSC is relatively low; consequently, survey response rates are modest. Also, response rates have declined over the past two years, which may be attributed in part to the timing of survey distribution. Surveys were sent during finals week and shortly thereafter, a period when students are typically heavily engaged in exam preparation and final project work, potentially limiting response rate.

Table 2: EoS Survey response rates (No EoS survey was administered in Fall'24)

EoS Survey	***Invited (Emailed)***	***Participated***	***Response Rate***
Fall'21	*69*	*19*	*28%*
Spring'22	*79*	*23*	*29%*
Fall'22	*100*	*38*	*38%*
Spring'23	*93*	*36*	*39%*
Fall'23	*133*	*41*	*34%*
Spring'24	*127*	*19*	*15%*
Spring'25	*127*	*28*	*22%*

4. Results and Data Analysis

Table 3 summarizes the demographic characteristics of participants who completed the EoS surveys since the inception of the project. The Fall'21 pilot survey did not include several demographic variables and other metrics that were incorporated into later surveys.

Across all survey administrations, most respondents identified as women. A high proportion of participants from CPIS and CS majors identified as members of ethnic and racial minority groups, which align with the overall demographic profile of FSC campus. In addition, a substantial percentage of respondents were transfer students. Enrollment among participants was slightly higher for the CPIS major compared to the CS major as expected (as there are more women in CPIS program than the newly started CS program).

The number of EoS survey respondents who were involved in the SWiC club and participated in the summer (re)orientation programs fluctuated across semesters. EoS surveys were only administered to the CPIS and CS majors. The SWiC club has been vibrant and active also due to the participation of students from other majors (mostly computer security) who were not included in the survey population. In spring 2022, the Computer Systems Department overseeing the CPIS and CS degree programs at FSC was restructured within the college and moved from the School of Business to the School of Engineering Technology, forming a 'Division of Computing' aligned with the Security Department that continued in place in Engineering Technology School. As an act of collegiality, the researchers welcomed the security students to participate in the initiatives. However, to keep this study consistent as approved by the IRB, researchers continued to only survey women CPIS and CS majors.

As a mostly commuter college, students often balance off-campus work and family responsibilities, which further contributes to the uneven and inconsistent participation in the club activities, orientation programs, and hence the EoS survey response rates. In addition, the number of EoS survey respondents who attended field trips is low. In particular, the number of students chaperoned to an off-campus field trip was reduced in the past two years due to a strategic shift, which directed students to attend larger and national conferences requiring more travel time and financial resources, rather than more affordable and closer regional conferences; this consequently limited the number of students able to attend a field trip.

Table 3: Demographics of the EoS survey participants

	Fall '21*	***Spring '22***	***Fall '22***	***Spring '23***	***Fall '23***	***Spring '24***	***Spring '25***
Self-identified Woman	*89%*	*100%*	*89%*	*91%*	*100%*	*100%*	*100%*
Ethnic/Racial minority	*-*	*91%*	*92%*	*80%*	*85%*	*69%*	*85%*
Transfer student	*20%*	*57%*	*40%*	*53%*	*49%*	*53%*	*75%*
CS major	*-*	*39%*	*58%*	*14%*	*41%*	*42%*	*29%*
CPIS Major	*-*	*61%*	*42%*	*86%*	*59%*	*58%*	*68%*
SWiC member	*-*	*32%*	*63%*	*85%*	*48%*	*47%*	*57%*
Attended Orientation	*42%*	*35%*	*78%*	*50%*	*55%*	*27%*	*59%*
Attended Field Trips	*23%*	*21%*	*33%*	*36%*	*21%*	*15%*	*24%*

**Fall'21 EoS pilot survey lacked some of the demographic data collected in future EoS surveys.*

The following subsections present survey results and analyze the impact of the three WiC initiatives on women student experience, sense of belonging (SoB), and academic self-concept (ASC) as well as enrollment of gender disparity.

4.1. Impact of the WiC Initiatives on Women Student Experience

Table 4 summarizes participants' self-ratings of their academic, social, and extracurricular experience as reported in the End-of-Semester (EoS) surveys across multiple semesters. Percentages reflect the proportion of respondents who rated their experiences as *Excellent* or *Good*. The data are disaggregated by respondents who participated in one or more Women in Computing (WiC) initiatives (student club, field trips, and summer orientation programs) and those who reported no participation in WiC initiatives.

The Fall'21 EoS pilot survey differed slightly from the EoS surveys administered in subsequent semesters and is therefore reported differently in earlier work [25]. In particular, the Fall'21 EoS survey did not include a measure of SWiC involvement. In contrast, later EoS surveys incorporated a categorical measure of SWiC participation, distinguishing between respondents who attended 1-3 events or those who attended 4+ events. At the time of Fall'21 EoS survey, respondents had limited opportunities to participate in Women in Computing initiatives. Specifically, the only initiatives available in Fall'21 survey were attendance at the first virtual regional women in computing conference held in Spring'21 and the inaugural summer (re)orientation in August 2021.

Overall, while the *academic experience* ratings were higher among respondents involved in WiC initiatives in four of the seven survey periods, in Spring'22, Spring'23, and Spring'24 EoS surveys, respondents without WiC involvement reported slightly higher academic experience ratings, and collectively indicating no dependable positive association between WiC involvement and academic experience.

In contrast, *social experience* ratings were consistently stronger among respondents involved in WiC initiatives. Participants engaged in WiC activities reported *equal or higher* ratings of good or excellent social experience in all but one survey period (Spring'22), indicating a positive association between WiC involvement and students' social integration.

Finally, *extracurricular experience* was rated higher in *every* survey period by respondents who participated in WiC initiatives. This consistent pattern suggests that WiC initiatives play a significant role in enhancing students' engagement and satisfaction with extracurricular opportunities.

Table 4: Self-Ratings of Women Computing Student Experience

EoS	Involved with one or more WiC initiatives				Not involved with any WiC initiative			
	N	Responded Excellent or Good Academic experience	Responded Excellent or Good Social experience	Responded Excellent or Good Extracurricular experience	N	Responded Excellent or Good Academic experience	Responded Excellent or Good Social experience	Responded Excellent or Good Extracurricular experience
Fa21	10	90%	70%	-	8	100%	62.5%	-
Sp22	13	77%	46%	36%	7	86%	57%	0%
F22	19	84%	74%	79%	12	83%	42%	33%
Sp23	17	88%	76%	71%	8	100%	50%	50%
Fa23	20	80%	60%	65%	18	88.89%	33.33%	22%
Sp24	6	100%	50%	83%	6	83%	50%	33.33%
Sp25	15	93%	60%	85%	4	75%	50%	50%

4.1.1. Support for RQ1

The results presented in Section 4.1 above collectively support RQ1 such that WiC initiatives implemented since 2020 have positive impacts on social and extracurricular experience of the women computing students as they complete their study on campus.

4.2. Impact of the Student Club

The subsections below detail the impact of involvement with the student club on the participating woman students' sense of belonging and academic self-concept.

4.2.1. Student Club: Impact on Sense of Belonging

Table 5 presents EoS survey responses related to women students' sense of belonging, disaggregated respondents as highly active (4+ meetings) vs. somewhat active (1-3 meeting) attendance. The percentages shown represent respondents who selected Strongly Agree or Agree to the sense of belonging questions in the EoS surveys.

Overall, respondents reported a strong sense of connection with classmates and peers, particularly in response to the statement "*I feel I bonded with classmates and peers*". Agreement with this statement remained above 50% across the EoS surveys with two exceptions observed in Fall'23 and Spring'25. Similarly, responses generally reported developing a stronger peer support group, with agreement consistently exceeding 50% across semesters, except for a decline in Fall'23. The researchers attribute the Fall'23 dip to lower involvement in SWiC involvement as presented in Table 3 demographics where less than 50% of respondents reported participation in SWiC involvement during that period. As an explanation for the decline in peer bonding and support measures during Spring'25, although SWiC involvement increased to 57% in Spring'25 (as per Table 3), authors observed that the compressed planning timeline and the high organizational demands of a large-scale, 2-day, inaugural, on-campus hackathon SWiC officers undertook in collaboration with other active computing clubs on campus, placed a strain on the student leaders. The researchers observed that the hackathon organization contributed to the tension among officers, stemming from competing priorities and differing agendas. Additionally, divisions in objectives and approaches between CS & CPIS and Security students may have further impacted this response of decline in perceived bonding and peer support during Spring'25.

Lower ratings were consistently observed for items related to expanding networks beyond FSC. This trend aligns with the structure of SWiC club meetings, which typically emphasize internal, campus community building and have limited opportunities for external networking beyond invited external guest speakers. Notably, responses were higher when participants were asked about connecting with people working in the computing field.

Despite comparatively lower ratings related to networking beyond the institution, the overall data indicate that participation in SWiC contributes to a strong sense of belonging among respondents.

Table 5: Impact of Supporting Women in Computing (SWiC) student club on Sense of Belonging of women

Impact of SWiC on Sense of Belonging of women	***EoS surveys in chronologically increasing order****					
Strongly Agree or Agree	***sp22 (n=9, where 3 attended 4+ meetings, 6 attended 1-3 meetings)***	***f22 (n=12, where 5 attended 4+ meetings, 7 attended 1-3 meetings)***	***sp23 (n=15, where 5 attended 4+ meetings, 10 attended 1-3 meetings)***	***fa23(n=10, where 3 attended 4+ meetings, 7 attended 1-3 meetings)***	***sp24 (n=4, where 1 attended 4+ meetings, 3 attended 1-3 meetings***	***sp25 (n=13, where 7 attended 4+ meetings, 6 attended 1-3 meetings***
I feel I bonded with classmates and peers at FSC	*55.56%*	*75.00%*	*66.67%*	*40%*	*75%*	*46%*
I feel I have a better peer support in my classes at FSC	*55.56%*	*75.00%*	*73.33%*	*30%*	*50%*	*62%*
I feel I expanded my network with people beyond FSC	*33.33%*	*58.33%*	*60.00%*	*30%*	*25%*	*31%*
I feel more connected with people in my field	*55.56%*	*75.00%*	*73.33%*	*40%*	*50%*	*69%*

**Fall'21 pilot EoS survey lacked SWiC related questions; hence excluded in this table.*

4.2.2. Student Club: Impact on Academic Self-Concept

The results presented in Table 6 summarize survey participants' perceptions of the impact of the SWiC involvement on their academic confidence and motivation to complete their degree.

Overall, reported levels of academic confidence remained consistently high (100% in Spring'24 despite the small sample size). While the lowest reported value occurred in Fall'23, 50% of respondents still indicated a positive impact on academic confidence. Taken together, these findings suggest that involvement in SWiC is associated with increased academic confidence and motivation to complete their degrees, supporting the interpretation that SWiC participation positively influences academic self-concept of women students.

Table 6: Impact of SWiC Involvement on Academic Self-Concept of women

Impact of SWiC Involvement on Academic Self-Concept of women	***EoS surveys in chronologically increasing order****					
Strongly Agree or Agree	***sp22 (n=9, where 3 attended 4+ meetings, 6 attended 1-3 meetings)***	***f22 (n=12, where 5 attended 4+ meetings, 7 attended 1-3 meetings)***	***sp23 (n=15, where 5 attended 4+ meetings, 10 attended 1-3 meetings)***	***fa23 (n=10, where 3 attended 4+ meetings, 7 attended 1-3 meetings***	***sp24 (n-=4, where 1 attended 4+ meetings, 3 attended 1-3 meetings***	***sp25 (n=13, where 7 attended 4+ meetings, 6 attended 1-3 meetings***
I feel more confident to academically succeed in my computing classes	*88.89%*	*75.00%*	*60.00%*	*50.00%*	*100%*	*62%*
I feel more motivated to complete my computing degree	*77.78%*	*83.33%*	*66.67%*	*50.00%*	*100%*	*62%*

**Fall'21 pilot EoS survey lacked SWiC related questions; hence excluded in this table.*

4.2.3. Free Form Responses showing Student Club Impact

Open-ended survey responses presented in Table 7 provide important context and insights, highlighting not only positive but also negative experiences of the women students. One respondent described a '*cliquish'* atmosphere within the group, a perception that contrasts with the core mission of SWiC, which is to foster inclusion and connection among women who are often underrepresented in their computing courses.

In contrast, several respondents emphasized positive outcomes associated with participation. One participant noted that seeing other women in computing was motivating in courses that are predominantly male. Another respondent reported that involvement in the club led to the development of meaningful friendships with other members. In Spring 2025, respondents explicitly cited friendships, increased academic motivation, and inspiration as outcomes of their participation in SWiC.

Taken together, these qualitative responses reinforce the overall findings that SWiC contributes positively to students' sense of belonging and academic motivation, while also identifying areas for continued attention to ensure inclusivity within the group.

Table 7: Free Form Responses about SWiC Involvement on campus

Survey	Free Form Responses
Fall 2023	▪ "*I have attended meetings with a friend that I met outside of SWiC. The dynamic I feel is cliquey and would not consider going again unless I am going with a previous friend."* ▪ "*It does feel more motivating to see other women in the same major because it does help relating to other women and it can be hard to find the community when in many classes most of the time it is male dominated."*
Spring 2024	▪ "*I like spending time with other women in the program; they have become my friends*."
Spring 2025	▪ *"The events have allowed me relate with my peers comfortably and I've made friends too, it has also helped me academically with the seminars which have been motivational and they inspire me to do better."*

4.2.4. Support for RQ2

The results presented in Section 4.2 above collectively support RQ2 and indicate that involvement with the Women in Computing student club on campus improves both sense of belonging and academic self-concept of the participating women students.

4.3. Impact of the Summer (Re)Orientation

The subsections below detail the impact of attending the summer (re)orientation for women computing students prior to the fall semester, woman students' sense of belonging and academic self-concept.

4.3.1. Summer Orientation: Impact on Sense of Belonging

Table 8 presents respondents' perceptions of the impact of Summer (re)orientation participation. This data was collected through EoS surveys after students spend one or more semesters attending the summer (re)orientation. The results include respondents who attended one or more summer (re)orientation programs, as reflected in the participation breakdown. It should be noted that the (re)orientation program welcomes both new and returning women students, to explain why women students would attend more than one summer orientation.

In earlier survey periods (prior to Spring'23) attendance at the Summer (re)orientation had a strong positive influence on women students' decision to participate in the SWiC student club, with agreement rates ranging from 55%-71%. In contrast, this influence declined in later semesters from Fall'23 onward, with agreement rates decreasing between 33%-44%. This shift in the last two years may be attributed to the SWiC club becoming more established in recent years, with a great proportion of returning officers and fewer new leadership opportunities for incoming students. Authors (also the faculty advisors for SWiC student club) do work hard to have leadership roles backfilled with underclass women for training and club continuity; however, this message may not have been clearly communicated with the students.

Across nearly all survey periods, a high percentage of respondents (64% or higher) agreed that participation in the Summer (re)orientation made them feel '*less intimidated when attending classes*.' Except for Fall'21, the inaugural post-COVID19 pandemic session, all survey periods reported agreement levels exceeding 50%, with several semesters reporting notably high values, including 100%, 85.72%, and 86.6%. Collectively, these findings suggest that participation in the summer (re)orientation program contributes positively to students' sense of belonging and confidence, among the participating women students.

Table 8: Impact of Summer Orientation Participation on Sense of Belonging and Experience of Women Students

Impact of summer orientation participation on SoB experience of women	***EoS surveys in chronologically increasing order***						
Strongly Agree or Agree	***f21 (n=9)****	***sp22 (n=7)***	***f22 (n=14, where 4 of 14 attended both summer'21 and '22 orientations)***	***sp23 (n=14, where 4 of 14 attended both summer'1 and '22 orientations)***	***fa23 (n=18, where 3 attended in summer'21, 3 summer'22 and 12 summer'23)***	***sp24 (n=6, where 2 attended summer'21, 2 summer'22 and 2 summer'23)***	***sp25 (n=16, where 8 attended summer'24, 7 summer'23 and 1 summer'22)***
As a result of attending a summer orientation "I got involved with SWiC"	*55.56%*	*57.14%*	*71.43%*	*64.29%*	*33.34%*	*33.34%*	*44%*
As a result of attending a summer orientation, "I felt less intimidated attending classes"	*44.44%*	*100%*	*64.29%*	*85.72%*	*86.67%*	*67%*	*56%*

**Fall'21 EoS pilot Survey used a binary ('Yes or No') response format, rather than the Likert scale (Strongly Agree to Strongly Disagree, plus N/A)*

4.3.2. Summer Orientation: Impact on Academic Self Concept

Table 9 reports women respondents' perceptions of how participation in one or more summer (re)orientation for women computing students influenced their academic confidence. This data was collected by EoS surveys after students spend one or more semesters attending the summer (re)orientation. The results reported reflect the percentage of respondents who selected *Strongly Agree* or *Agree*.

Except for Fall'21, the EoS survey data consistently indicates a positive influence of the summer (re)orientation programs on academic confidence of women. Across the six EoS survey administrations, two reported agreement levels above 80%, one above 70%, two above 60%, and one above 50%. The Fall'21 EoS survey reported a lower agreement level of 44.44%, which can be attributed to several contextual factors. Summer'21 inaugural (re)orientation coincided with the return to in-person instruction after approximately two and a half semesters of remote learning due

to the COVID19 pandemic. Attendees were required to wear masks and were 'newbies' – meaning none had attended a (re)orientation program before, and many were new to FSC as they had not been to campus in-person though they were enrolled at FSC for a year! In contrast, subsequent (re)orientations benefited from the involvement of SWiC student leaders, who helped incorporate interactive team-building activities and socializing opportunities.

In addition, during the Summer'21 (re)orientation, the authors (who organized and hosted the orientation) conducted a guided tour of the building where most CS and CPIS classes are held. In the succeeding years, SWiC student leaders designed and implemented a scavenger hunt that introduced the attendees to key locations on campus including the academic buildings, the campus center and the site of the new CS building where ground was recently broken. These enhancements with the (re)orientation agenda have likely contributed to the disparity between the Fall'21 EoS results vs. the subsequent EoS results.

Overall, these findings support the conclusion that participation in summer (re)orientation positively impacts women students' confidence in attending classes and their ASC.

Table 9: Impact of Summer Orientation Participation on Academic Self-Concept of women

Impact of summer orientation on Academic self-concept of women	***EoS surveys in chronologically increasing order***						
Strongly Agree or Agree	***f21 (n=9)****	***sp22 (n=7)***	***f22 (n=14, where 4 of 14 attended both summer'21 and '22 orientations)***	***sp23 (n=14, where 4 of 14 attended both summer'21 and '22 orientations)***	***fa23 (n=18, where 3 of attended summer '21, 3 summer'22 and 12 summer'23)***	***sp24 (n=6, where 2 attended summer '21, 2 summer '22 and 2summer '23)***	***sp25 (n=16, where 8 attended summer '24, 7 summer '23 and 1 summer '22)***
As a result of attending a summer orientation "I felt academically more confident attending classes"	*44.44%*	*57.14%*	*64.29%*	*85.7%*	*807%*	*50%*	*56%*

**Fall'21 EoS pilot survey used a binary ('Yes or No') response format, rather than the Likert scale (Strongly Agree to Strongly Disagree, plus N/A)*

4.3.3. Free Form Responses showing Summer (Re)Orientation Impact

Table 10 presents open-ended responses from participants regarding their experiences attending Summer (re)orientation. These comments were collected through the EoS surveys, after one or more semesters past the orientation, rather than immediately following the corresponding (re)orientation session.

Table 10: Free Form Responses about attending Summer (Re)orientation

Survey	Free Form Responses
Fall 2023	▪ "*Great speakers showed and shared their experiences in the field. Professor's introducing the computer programming with a great performance and dedication."* ▪ "*I've made friends and familiar faces in my classes."* ▪ *"I think aside from the conference social meetings, there should be one just for the FSC girls. I think the girls who went alone felt it harder to network*".
Spring 2024	▪ "*Was great to meet my peers"* ▪ *"It's nice getting to know people both new and old to the program. Especially as someone that transferred in – its nice to get to know some faculty so that I don't feel like I am starting from knowing absolutely no one or nothing*."
Spring 2025	▪ *"Someone at my table has been with me in both my computer programming courses. We sat next to each other. It was nice to make a friend before classes even started*." ▪ "*I enjoyed the orientation. It was nice meeting other students who are studying computer science before starting my classes. It helped me to make friends in my classes."*

The responses reflect overwhelmingly positive perceptions of Summer (re)orientation, particularly with respect to opportunities to meet peers and establish connections that later developed into friendships within classes. One respondent specifically noted being a transfer student and expressed appreciation for the opportunity to meet faculty and peers prior to the start of classes.

Collectively, these qualitative responses further support the conclusion that participation in summer (re)orientation contributed positively to sense of belonging of women in the CPIS and CS programs.

4.3.4. Support for RQ3

The results presented in Section 4.3 above collectively support RQ3 and suggests a positive relationship between participation in the summer (re)orientation program prior to the start of the fall semester on sense of belonging and academic self-concept and of women computing students.

4.4. Impact of the Field Trips

The subsections below detail the impact of attending the women-centric off-campus field trip in the sense of belonging and academic self-concept of the women computing students.

4.4.1. Field Trips: Impact on Sense of Belonging

Table 11 summarizes respondents' SoB following participation in women-centric field trip(s) including the number respondents who participated in more than one trip, as reflected in the participation breakdown.

The data indicate consistently positive SoB-related outcomes across all survey periods. Bonding with classmates was highest from Spring'22 through Fall'23 and, although lower in subsequent terms, remained at 50% in both Spring'24 and Spring'25.

The researchers attribute the decline observed in Spring'24 and Spring'25 to several factors. These later trips included substantially smaller numbers of attendees and, in some cases, participants from security degree programs, which may have altered group dynamics. In addition, lower response rates among field trip participants further limit the interpretation of these findings. The researchers also

speculate that the novelty of traveling off campus and bonding with peers may diminish over time as students gain increased exposure to such experiences.

In contrast, the initial overnight trips to regional conferences involved larger cohorts, providing more extensive opportunities for peer interaction and relationship building. Participants on these early trips returned notably more enthusiastic about the experience and expressed stronger appreciation for the opportunity to travel and attend conferences and spend extended time with their peers. These findings may raise questions about the strategic shift to taking smaller groups to larger national and international conferences rather than a bigger group to close by regional conferences. However, based on the authors' experience, *a* best practice may be to alternate the conference destinations and avoid attending the same conference in consecutive years. For example, after attending the same regional conference for a second time, some participants reported that the content and overall experience felt redundant. A similar pattern was observed following consecutive Spring'24 and Spring'25 trips to Harvard WeCode. As a result, the plan for 2026 field trips is to return to the regional conference with a larger cohort to alternate the trip.

It is important to note that a fully funded conference trip represents a rare and meaningful opportunity for students at this public, majority-commuter institution. For many participants, these trips mark the first time they have traveled overnight without their parents, further demonstrating the social and development growth opportunity afforded beyond the ASC and SoB value.

Across all survey periods, respondents reported improved peer support in their classes because of attending conferences, with the lowest level observed in Spring'24 at 50%. The researchers theorize that the decline in these responses aligned with the same observations mentioned above that larger groups of attendees to regional conferences returned more enthusiastic.

Beyond FSC, the findings also suggest that women students felt more connected to professionals in the computing field, with 50% or more respondents indicating agreement in every survey period. There was also strong interest in future conference participation, with 100% of respondents expressing interest in attending another conference in three survey periods. Although interest declined in Spring 2025, it remained substantial at 62.5%.

Overall, these results suggest that conference field trips contribute positively to students' sense of belonging including peer support, and professional connectedness.

Table 11: Impact of Field Trips on Sense of Belonging on trip-attending women

Impact of Field Tripson SoB of trip-attending women	***EoS surveys in chronologically increasing order***						
Strongly Agree or Agree	***f21 (n=4)****	***sp22 (n=4)***	***f22 (n=6)***	***sp23 (n=13 where 3 of 13 attended both sp22 and sp23 trip)***	***f23 (n=6 where 4 attended sp23 and 2 sp22 trip)***	***sp24 (n=4, where 1 attended sp22, 1 attended sp23, 2 attended sp24 trip)***	***sp25 (n=8, where 4 attended sp23, 2 attended sp25, 3 attended Grace Hopper fa24 trip)***
I feel I bonded with classmates and peers at FSC	*N/A*	*75.00%*	*100.00%*	*76.92%*	*80%*	*50%*	*50%*
I feel I have a better peer support in my classes at FSC	*N/A*	*75.00%*	*83.33%*	*92.31%*	*60%*	*50%*	*75%*
I feel I expanded my network with people beyond FSC	*N/A*	*50.00%*	*66.67%*	*84.62%*	*60%*	*50%*	*62.5%*
I feel more connected with people in my field	*N/A*	*75.00%*	*50.00%*	*61.54%*	*80%*	*50%*	*50%*
"Yes" to attending the same or another conference again	***75.00%***	*100.00%*	*100.00%*	*84.62%*	*80%*	*100%*	*62.5%*

**N/A: Fall'21 EoS pilot survey lacked these questions.*

4.4.2. Field Trips: Impact on Academic Self-Concept

Table 12 reports responses from EoS survey items assessing respondents perceived impact on academic confidence after attending a women-centric field trip such as a regional women in computing conference. As noted previously, following the transition from regional, lower-cost conferences to events requiring longer-distance travel, fewer students were able to participate; consequently, the number of responses for field trip attendees is relatively small.

Across all survey periods, 50% or more of respondents selected *Strongly Agree* or *Agree* when asked whether attending a field trip increased *'their confidence in academically succeeding in computing courses'*. Responses were overwhelmingly positive regarding increased motivation to complete their degree following conference attendance. While agreement levels in Spring'24 and Spring'25 remained at or above 50% across all items, they were lower than those observed in earlier survey periods.

The researchers believe this subtle decline, while still reflecting majority agreement (still at 50% and higher), aligns with the previously noted contextual factors (in Section 4.4.1), including smaller group sizes, shift in participant composition, and a potential reduction in the novelty of conference attendance. These factors are likely to contribute to the lower reported percentages in the most recent survey administered and should be taken into consideration when interpreting these results.

Table 12: Impact of Field Trips on Academic Self-Concept of trip-attending women

Impact of Field Trips on Academic Self-Concept of trip-attending women	***EoS surveys in chronologically increasing order (No EoS survey was given in Fall'24)***						
Strongly Agree or Agree	***f21 (n=4)****	***sp22 (n=4)***	***f22 (n=6)***	***sp23 (n=13 where 3 of 13 attended both sp22 and sp23 trip)***	***fa23 (n=6 where 4 attended sp23 and 2 sp22 trip)***	***sp24 (n=4, where 1 attended sp22, 1 attended sp23, 2 attended sp24 trip)***	***sp25 (n=8, where 4 attended sp23, 2 attended sp25, 3 attended Grace Hopper fa24 trip)***
I feel more confident to academically succeed in my computing classes	*N/A*	*50.00%*	*100.00%*	*69.23%*	*60%*	*50%*	*62.5%*
I feel more motivated to complete my computing degree more than prior to attending the conference	*N/A*	*75.00%*	*83.33%*	*92.31%*	*80%*	*25%*	*62.5%*
I feel empowered from the knowledge gained from the industry leaders, women, researchers	*N/A*	*N/A*	*50.00%*	*84.62%*	*100%*	*50%*	*62.5%*

**N/A: Fall'21 EoS pilot survey lacked these questions. But note that 100% (n=4) of the Fall'21 EoS survey participants responded "Yes" to "attending Spring 2021 Virtual NYCWiC impacted my fall 2021 semester positively" question.*

Respondents also consistently reported *'feeling empowered by the knowledge gained'* from industry leaders, women professionals, and researchers at the conferences attended. In all survey periods, 50% or more of respondents reported feeling empowered, with Fall'23 reporting 100% agreement and Spring'23 nearly 85%. The consistency of this response is encouraging and suggests that exposure beyond the campus and to industry professionals and women role models contributes meaningfully to participants' sense of empowerment and motivation. These experiences appear to reinforce students' commitment to persist in their computing programs and increase their enthusiasm for engaging with the broader community of women in computing.

Overall, these findings suggest that participation in women-centered computing conferences and field trips has a positive impact on academic self-concept of trip-participating women.

4.4.3. Free Form Responses showing Field Trip Impact

Table 13 presents free-form responses collected from EoS surveys administered in Fall'23 and Spring'24, along with seven responses (testimonials) from students who attended the Grace Hopper Celebration trip in Fall'24 to provide a strong evidence of the positive impact conference participation had on women students, highlighting the value of experiences that extend beyond FSC to broaden women students' knowledge, professional networks, and perspectives within the computing field.

The Grace Hopper Celebration'24 was hosted close by Philadelphia and represented a unique opportunity, as the expensive and logistically harder to organize air travel was not required. Authors (organizers and chaperones for the trip) were able to secure funding to support participation for a large cohort of students (N=18). This accessibility enabled broader participation for greater overall impact of the experience.

Several of these free form responses support improved sense of belonging of women. One participant reflected on Grace Hopper experience by noting that there were *'a healthy number of people to coordinate, connect, and bond with, over group dinners and events,'* observing the benefit of peer connection and community building. Other responses align with academic self-concept (ASC), as students described increased awareness of expectations and motivation within the field. One student stated, *'I've realized how competitive the tech field is, which motivates me to work even harder to achieve my goals'* while another commented *'I realized about the many opportunities that are available but also what I need to work on and improve to be able to be qualified'*. These reflections demonstrate academic motivation resulting from the conference's participation.

Table 13: Free Responses from EoS surveys about Field Trips and Testimonials from Gace Hopper Trip in Fall'24

Survey	Free Form Responses
Fall 2023	▪ "*It has inspired me to strive for more learning opportunities*."
Spring 2024	▪ *"It's a fun experience new and different things like WeCode to learn things that some would never even know existed or how to do something correctly. Getting to step away from classes and still be able to learn and connect with others is a lot more fun."*
Grace Hopper Testimonials	▪ *"The GHC encouraged learning new material and becoming adjusted in a professional networking environment. It personally had opened a lot of different opportunities in connecting with others from different backgrounds. Regardless of the GHC, the trip and the bonds created within our own SWIC has been comforting to know other women within our regular spaces in computing. I would highly recommend GHC trip to anyone wanting to gain wisdom and experience with all things networking and computing."* ▪ "*I loved a lot about the trip. I liked the expo I got to learn so much about how to talk to recruiters and what they are looking for. The conferences were very informative and now I feel a lot better about going into technical interviews. Being able to connect and talk to so many people was amazing. I would definitely recommend this trip to others."* ▪ *"The Grace Hopper Conference was very impactful for me, being in the presence of many talented and gifted women made me feel empowered and motivated , I loved the opportunity to connect at the Career Exposition and I love that the trip helped me to bond more with my mates from the college, I appreciate the Department and Farmingdale State College for giving me the opportunity to experience something as beautiful as this, lastly I loved that I was able to travel and go to a new city, Philly was such a great vibe. This is something I would recommend to others definitely!!"* ▪ *"The Grace Hopper Celebration is an amazing opportunity for early-career professionals seeking internships or new graduate roles. I had the chance to meet incredible people from all over the world, including recruiters from Google, software engineers, product managers, and data analysts from companies like Uber, Chewy, and Amazon. It was particularly valuable for me to learn about various companies' cultures and hear firsthand about their employees' experiences. I've realized how competitive the tech field is, which motivates me to work even harder to achieve my goals. Most importantly, I now have a clear roadmap to success in my career. I highly recommend this conference to every woman in tech—it's a truly unique experience that goes beyond what you can learn in the classroom."* ▪ *"This trip is by far the best executed conference trip SWiC has done so far. 20 attendees, in my opinion, were a healthy number of people to coordinate, connect, and bond with, over group dinners and events. The trip itself provided a lot of avenues for itself, without it overstaying its welcome, with conference events being spread out for 4 days. The sessions and career fair far outweighed the ones on the previous trips, as big companies and a bunch of industry experts were there to represent. The Amtrak ride itself was also great,*

since it was not stressful like an airport nor as expensive as renting a bus for hours, and we got to sit back and enjoy the ride. I highly recommend any female students in computing to attend this conference, and for the computing departments to get more funding to bring these female students' grand opportunities for success."

- " *The highlights for me were the career/job fair. The impact it had on me was that I was able to meet and talk to recruiters one on one. Yes, I would recommend this to others, it was a great opportunity."*
- "*Attending the GHC was an eye opening and beneficial trip. I was able to learn and connect with various companies and organizations. I realized about the many opportunities that are available but also what I need to work on and improve to be able to be qualified. I would definitely recommend it to others, whether you want to educate and empower yourself or to simply grow your connections and network*."

4.4.4. Support for RQ4

The results presented in Section 4.4 above collectively support RQ4 and suggest a positive relationship between attending women centric conference field trips and sense of belonging and academic self-concept of the participating women students.

4.5. Impact of the Three WiC Initiatives on Enrollment of Gender Disparity

The long-term goal of this work is to achieve a gender balance in computing programs at FSC. Figure 1 above presents institutional enrollment data beginning in Fall'10, broken down by program and gender. These data include years prior to this study period (2020–2026) to provide historical context and to illustrate the persistence of gender disparities in computing programs at FSC.

The highest percentages of women enrolled during the study period occurred in Fall'23 and Fall'24, with women comprising 16.9% of enrollment in the CPIS program and 18.5% in the CS program. An earlier peak of 22.2% women in the CS program is interpreted as an anomaly associated with the CS program's inaugural semester; enrollment patterns subsequently stabilized in later years.

In the most recent Fall'25 semester, women represented 14.7% of CPIS enrollment and 13.8% of CS enrollment. While these figures reflect a modest improvement compared to Fall'19 (prior to implementing interventions analyzed in this paper)—when women comprised 12.9% of CPIS enrollment, the only computing program offered by the department at that time—they underscore the continued underrepresentation of women in computing at FSC.

The researchers recognize that meaningful shifts in enrollment patterns are gradual, and that sustained long-term efforts are required before more substantial impacts in enrollment gender balance can be realized.

5. Discussion

This section outlines the authors' observations and provides recommendations for others interested in launching similar Women in Computing (WiC) initiatives on their campus while also acknowledging the limitations of their research.

5.1. Observation and Reflections

About the Women in Computing Student Club: The initial development and guidance provided to SWiC student club leadership required a substantial investment of time and effort by the authors that

have been faculty advisors for SWiC since 2020. Over time, this investment has yielded positive returns, as student leaders now actively mentor and train subsequent cohorts of student leaders. Although continued faculty oversight remains necessary, particularly in advising, sourcing speakers, and supporting the executive board, the time commitment from faculty has decreased relative to the program's early stages.

About the Summer (re)orientation program: In contrast, planning and executing a summer orientation program remains highly labor-intensive. Despite the benefit of rolling over a core agenda from year to year, the process of organizing activities, securing speakers, and coordinating logistics continues to demand significant planning and oversight. Attendance variability also presents challenges; students often RSVP but do not attend due to competing academic and personal obligations and conflicts. As a result, the cost–benefit balance of this initiative warrants continued evaluation.

About the field trips: Field trip planning is particularly onerous within a public institution context, given financial constraints and administrative requirements. However, when funding is secured, these experiences appear to have a disproportionately positive impact on students' academic confidence, motivation, and empowerment. From an outcome's perspective, this intervention demonstrates strong potential value despite its logistical challenges.

5.2. Limitations

Several limitations to validity of this study should be considered when interpreting these findings.

First, the relatively small number of women enrolled in CPIS and CS degree programs at FSC limits sample sizes and contributes to low survey response rates. This constraint reduces statistical power and limits the generalizability of the findings beyond similar institutional contexts.

Second, participation in the WiC initiatives and associated surveys was voluntary, introducing potential self-selection bias. Students who choose to participate may already possess higher levels of motivation or engagement than non-participants.

Third, survey timing represents an additional limitation. End-of-semester surveys were administered during or shortly after finals week, a period of heightened academic stress. This timing has likely contributed to declining response rates in recent years and may have excluded perspectives from students experiencing the greatest academic pressure.

Fourth, the shift from regional, lower-cost conferences to national events reduced field trip participation due to increased financial and travel demands. This change further constrained response numbers and may have skewed feedback toward students with greater access or availability.

Finally, the reliance on self-reported measures of SoB and ASC introduces the possibility of response bias. While open-ended qualitative responses—such as reflections from conference attendees—add valuable depth and context, future research would benefit from the inclusion of longitudinal measures, comparison groups, or additional mixed-method approaches.

Despite these limitations, the findings provide meaningful evidence that layered, community-centered interventions can positively influence women students' experiences in computing. The

results highlight the importance of sustained institutional support and offer direction for strengthening future program design and assessment strategies.

6. Conclusions and Future Plans

The data across all sections indicate that each of the three interventions—maintaining an active Supporting Women in Computing (SWiC), organizing summer (re)orientation programs for women students, and attending women-centered field trips—have positive impacts on both on sense of belonging (SoB) and academic self-concept (ASC) of participating women students. These layered initiatives collectively address academic confidence, peer connection, and professional identity development for women in computing. Institutional enrollment data suggests that these interventions may be contributing to subtle improvements in gender composition.

The institutional composition at FSC presents challenges to inclusiveness and extracurricular engagement, particularly due to time constraints often not imposed on undergraduates. These constraints underscore the importance of intentional, community-centered interventions. Within this environment, the WiC initiatives have been enjoyed by the students that engage and serve as a critical mechanism for fostering connection and persistence at a public, majority-commuter institution.

While the impact demonstrated on these initiatives is encouraging, questions remain regarding long-term sustainability. The programs have relied heavily on faculty leadership and coordination, raising concerns about maintaining momentum without sustained financial support. Researchers are cautiously optimistic given the current support and funding provided by FSC as discussed above but the fear of state budget cuts at any given time always looms as institution budgets are often beyond their control and dictated by the state.

Future work will focus on securing long-term funding to sustain and expand the WiC initiatives and establish a Women in Computing Center to oversee the initiatives. Additionally, longitudinal follow-up studies—such as surveying or interviewing students/alumni several years after participation—would provide valuable insight into the persistence of impacts on academic self-concept, sense of belonging, and career trajectories.

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