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The Harbor of Engineering
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Board 391: Supporting and Understanding Undergraduates' Computing Pathways Through the Flit-GAP S-STEM Program

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Nivedita is pursuing her Ph.D. in Engineering & Computing Education at Florida International University. She has a computer science and engineering background as well as K-12 teaching. She thinks about creating an inclusive learning environment using critical and feminist frameworks in undergraduate engineering and computing classrooms.

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Mark Allen Weiss is an Eminent Scholar Chaired Professor, Associate Dean for Undergraduate Education in the College of Engineering and Computing, and Associate Director in the School of Computing and Information Sciences at Florida International University (FIU) in Miami Florida.

He joined FIU after receiving his Ph.D. in Computer Science from Princeton University in 1987. His interests include data structures, algorithms, and education, and he is most well-known for his Data Structures textbooks, which have been used at hundreds of universities worldwide. From 1997-2004 he served as a member of the Advanced Placement Computer Science Development Committee, chairing the committee from 2000-2004. Dr. Weiss is an ACM Distinguished Educator, AAAS Fellow, and the recipient of the 2015 SIGCSE Award for Outstanding Contribution to Computer Science Education and 2017 IEEE Taylor Booth Education Award.

Dr. Michael Georgiopoulos, University of Central Florida

Michael Georgiopoulos received the Diploma in EE from the National Technical University in Athens, his MS degree and Ph.D. degree in EE from the University of Connecticut, Storrs, CT, in 1981, 1983 and 1986, respectively. He is currently a Professor in the Department of EECS at the University of Central Florida in Orlando, FL. From September 2011 to June 2012 he served as the Interim Assistant Vice President of Research at the Office of Research and Commercialization. Since July 2012 he is serving as the Interim Dean of the College of Engineering and Computer Science.

His research interests lie in the areas of Machine Learning and applications with special emphasis on neural network and neuro-evolutionary algorithms, and their applications. He has published more than 60 journal papers and more than 170 conference papers in a variety of conference and journal venues. He has been an Associate Editor of the IEEE Transactions on Neural Networks from 2002 to 2006, and an Associate Editor of the Neural Networks journal from 2006 to 2012. He has served as the Technical Co-Chair of the IJCNN 2011.

Mrs. Jacqueline Faith Sullivan, University of Central Florida

Since 2012, Jackie Sullivan (MSEnvE), has been an Adjunct Instructor at UCF (Orlando) in the College of Engineering and Computer Science (CECS) and has instructed the first year engineering students since 2015. Ms. Sullivan worked in consulting engineerin

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Maimuna Begum Kali is a Ph.D. candidate in the Engineering and Computing Education program at the School of Universal Computing, Construction, and Engineering Education (SUCCEED) at Florida International University (FIU). She earned her B.Sc. in Computer Science and Engineering from Bangladesh University of Engineering and Technology (BUET). Kali's research interests center on exploring the experiences of marginalized engineering students, with a particular focus on their hidden identity, mental health, and wellbeing. Her work aims to enhance inclusivity and diversity in engineering education, contributing to the larger body of research in the field.

Bailey Bond-Trittipo, Florida International University

Bailey Bond-Trittipo is an engineering and computing education Ph.D. student in the School of Universal Computing, Construction, and Engineering Education (SUCCEED) at Florida International University. Her work centers on understanding how systems of oppression shape the culture of undergraduate engineering education and developing strategies to support engineering students in resisting oppression within institutions of higher education and society more broadly.

Florida IT Graduation Attainment Pathways (Flit-GAP)

The Florida IT Graduation Attainment Pathways (Flit-GAP), an NSF S-STEM, Track 3 grant effort, involves three public metropolitan institutions from Florida's three most populous areas: Florida International University (FIU) in Miami, University of Central Florida (UCF) in Orlando, and University of South Florida (USF) in Tampa. Flit-GAP supports up to 50 students per year for each of the first 3 years of the project'; recruits are juniors from Computer Science, Information Technology, Computer Engineering, and Cybersecurity, and other computing majors. The relationship among the three institutions is formalized as the Consortium of Florida Metropolitan Research Universities. The consortium is a strategic priority of each institution. In Year 1, 42 students participated in the scholarship program at the three institutions (16 FIU; 14 UCF; 11 USF).

Rationale:

The NSF considers areas such as Data Science, Machine Learning, Artificial Intelligence, Cybersecurity, and Quantum Computing as among the highest impact and growth fields going forward. Student demand for computing programs is at an all-time high, including large numbers of students who change majors after their freshman year (and would thus not be considered for scholarships that target first-year CS majors). Meanwhile, there is a significant shortage of both computing professionals and qualified faculty to teach at universities and a lag in computing graduation and retention rates other disciplines (NASEM, 2018). Thus, understanding the most effective support mechanisms for persistence and success in computing is a pressing need.

Flit-GAP's target majors are Computer Science, Information Technology, Computer Engineering, and Cybersecurity. Both USF and FIU recently added new B.S. in Cybersecurity programs that were formerly housed as part of their IT programs. The programs align with the curricular and accreditation requirements from ACM/IEEE/AIS and ABET, respectively. Flit-GAP builds on a prior program, Florida IT Pathways to Success (Flit-Path), which focused on 1st and 2nd year students in computing and increasing engineering identity and persistence. which was led by the same group of core PIs. The Flit-Path grant was successful in increasing the retention and graduation of the cohorts when compared to a comparison group. Less than a year in the Flit-Path program, Flit-Path students had a significantly higher sense of belonging in computing and computing identity than their matched counterparts who are not in Flit-Path. Building on this success, Flit-GAP recruits rising juniors in these disciplines and enhances and supports their educational experiences through graduation from these targeted disciplines. After graduation, Flit-GAP continues to support any of these scholars that immediately pursue graduate studies at any of the participating institutions up to a combined total of four years. Overall, Flit-GAP supports a total of 150 scholars during the 5-year grant period, in three cohorts of roughly 50 students each (Years 1, 2, 3) that spans the three universities.

Program Design

The following section outlines the Flit-GAP program design including the ways the program builds on lessons learned from Flit-Path's success.

Scholarship Support and Eligibility
Flit-Path students reported the most helpful part of Flit-Path was the financial support that allowed them to reduce work hours and focus on school. Students also reported that scholarship amounts should be higher, an action that was taken by Flit-Path because of COVID, when NSF authorized increased scholarships beyond the amount stated in our proposal. Flit-GAP increases the scholarship size to provide the maximum amount allowable.

Flit-Path's requirement of full-time status (12+ credits in fall/spring) became problematic for students who needed fewer than 12 credits in their last semester to graduate. Other students had scheduling challenges

(e.g., 15 credits in one semester but 11 in the other), that threatened their eligibility. In Flit-GAP, after the first semester, the requirement for full-time status is interpreted to allow for these cases in which students are making progress toward graduation but cannot register for 12 credits in a particular semester .

Common Program Activities
Flit-GAP provides positive, peer group cohorts for junior, senior, and eventually graduate-level students. Student development and support activities combine social and educational events to help these students succeed both personally and academically. Students expressed strong satisfaction for the core activities organized by Flit-Path. Core activities and regular interaction with mentors built a strong sense of community that positively impacted retention and graduation of students as the previously mentioned impressive Flit-Path results have demonstrated. As a result, Flit-GAP relies and builds on the infrastructure and support services that benefitted Flit-Path students (e.g., orientation, socials, distinguished speaker series, strong academic advising). However, Flit-GAP emphasizes research, internship and entrepreneurship experiences to a much greater extent than was experienced during Flit-Path. Flit-GAP cohort students engage in professional pathway experiences (research, internship, entrepreneurship) because these activities (real-world experiences and strong mentorship) positively influence students' academic and professional development. There is strong evidence from the literature that these real-world experiences (Chen, 2013; Miles et al., 2005) and strong mentorship (Dickinson, 2006; Wallace & Haines, 2004) positively influence student success.

These community-building, collaborative activities between the three institutions are based upon the evidence-based activities developed during the Flit-Path Program and include: virtual Socials (such as 'Orientation' and 'Welcome Back' sessions, 'Hear from your Peers' sharing hours and 'Graduation' events); cohort Meetings; Distinguished Speaker Series; virtual Industry Tours; graduate school events (such as virtual application/scholarship/fellowship Workshops, graduate school showcases); virtual professional development Workshops; Career and Internship Fairs at each institution; the aforementioned Flit-GAP Symposium and associated student presentation workshops; Peer Mentoring of older cohort members to younger cohort members through virtual Alumni Panels; and invitations to Special Events at each institution (e.g., professional conferences, symposia, etc.). It is hoped that some of these successful activities can be sustained and scaled even after the expiration of the grant.

Pathway Activities
A key element of Flit-GAP involves offering all scholars a pathway selection, either internship, research, or entrepreneurship, which reflects their interest in pursuing either a career in industry/government, attending graduate school, or working with a small business/start-up upon graduation. Unlike Flit-Path, Flit-GAP pathway selections are a collaborative effort coordinated among the three institutions. The collaboration works on multiple fronts (1) sharing internship opportunities between institutions located in metropolitan areas with a strong presence of industry, government entities, where remote opportunities are enhanced, due to COVID, and expected to continue being enhanced after COVID; (2) offering opportunities to research pathway students to be co-advised by research mentors located in more than one institution; 3) offering entrepreneurship pathway students a 2-semester, zero-credit, shared, online entrepreneurship course hosted by UCF that culminates in a team project proposal and Symposium presentation (zero-credit courses will not extend time to graduation). Pathway experiences will enhance the sense of the learning community, encourage students to persist in their academics, help them with their capstone efforts and as such are not expected to increase graduation time.

Annual pathway experiences culminate at an end-of-spring semester, joint UCF/FIU/USF Flit-GAP Symposium that rotate annually amongst the 3 participating institutions with students attending the event in person at their 'host' institution and virtually at the other two institutions. The Symposium is a holistic, all-day event that begins with a program overview, introductions and words of advice from Advisory Board members; it features presentations by Flit-GAP scholars showcasing their experiences; the day concludes with an Advisory Board-supervised Flit-GAP scholars focus group, then a debrief from the Advisory Board to the Flit-GAP's project staff.

Education Research Plan and Progress

The education research plan involves three qualitative and quantitative components in parallel for a mixed methods convergent and holistic triangulation design, with primary and complementary methods to emphasize both generalizability and authenticity of context (Turner et al., 2017). First, a primarily qualitative interview study investigates Flit-GAP students' experiential learning experiences and perceptions of future pathways. Second, a quantitative longitudinal cohort study investigates Flit-GAP students' perceptions to look for factors impacting persistence, graduation, and career transitions. Third, a primarily ethnographic study observes the many planned interactions in the hybrid virtual/in-person cross-institutional learning community and examines the nuanced context that supports the Flit-GAP outcomes. The guiding research questions (RQ) and study designs are:

RQ1: How do students from low-income and underrepresented groups in computing conceive of their future graduate school or career pathways, and the value and costs associated with those pathways?

To date, there is little research on the factors that impact low-income and under-represented students' matriculation into computing graduate programs. Additional research helps understand how alternative forms of social capital, financial support, and programming designed to expand understanding of graduate and career pathways, all combine and contribute toward impacting their future plans and career outcomes. RQ1 is being answered via semi-structured interviews to give a nuanced level of detailed understanding and via program-wide surveys to increase the generalizability of the findings. We have conducted interviews with 16 FIU students from the first cohort and have published a paper about the forms of social, cultural, and economic capital that the students perceive regarding future career pathways (Bond-Trittipo et al., 2022).

In parallel, we have adapted the findings from the interview study into a survey protocol, also draws on prior Flit-Path surveys that focused on identity, sense of belonging, and program experience. Survey items include: (A) Resource Utilization – level to which specific economic, academic, and social supports are being used by students; (B) Experiences – relative perceived value of support received through interactions with each component of Flit-GAP; (C) Outcomes – intentions to persist in their program, knowledge of and interest in graduate school, knowledge of and interest in entrepreneurial and IT-career pathways, success in securing internships/jobs, and academic progress; (D) Background controls – demographics (e.g. gender, race, ethnicity, parental education), prior academics (e.g., high school and college GPA), and personal context (e.g. family care, employment, family member in IT). With the second-year cohort, pre- and post-surveys are being conducted with within their first 2 weeks of participation in the program, and at the end of the year (to account for potential program attrition). We have an additional paper summarizing first year cohort end-of-year survey results across all three universities under review at this conference (Kumar et al., under review), focusing on demographic and other preferential factors for students' selection of career pathways.

RQ2: How does participation in Flit-GAP impact outcomes including upper-level students' persistence, success, belonging, and perceptions of the value and cost associated with computing pathways such as graduate school? Do outcomes differ by demographic group?

Beyond simple understanding of student perceptions, a goal of broadening participation is to understand the specific impacts of programs like Flit-GAP, including difference between demographic groups. RQ2 is addressed via triangulation of the pre-post-surveys and evaluation of outcome institutional data metrics for persistence, graduation in computing, and matriculation into graduate school. The outcome metrics will be evaluated longitudinally via matched pairs to examine the impact on students. Survey outcomes will be triangulated with pre-post interview data and with institutional data for student retention, achievement, and graduation for a contextual and robust description of the impact of the programmatic interventions. This research question requires coordination with the project evaluator and will be addressed later in the project, as longitudinal cohort data takes time to assemble.

RQ3: How do the programmatic, social, economic, and institutional elements of Flit-GAP's multi-institutional hybrid learning community support these outcomes and how can they be designed to support them further?

In a post-COVID reality, many aspects of the internships, research experiences, and community building that students engage in Flit-GAP continue to be virtual, and this level of community building has been seldom assessed in education research. The multi-layered nature of the virtual Community of Practice is investigated and triangulated with the student interviews and survey results and program outcomes. Ethnographic findings highlight the nature of the novel community from the student's perspective, including multi-facetedness, sustainability, and accessible entry ways for students to develop professional pathways of their choosing. This rich description of the Flit-GAP Community of Practice enables formative improvement and broader translation by other universities to their contexts. RQ3 is addressed primarily through ethnographic observation (Emerson et al., 2011) of the multi-institutional hybrid learning community. Observations are conducted of virtual and in-person events to understand how programmatic aspects and the shared institutional contexts contribute to student outcomes (RQ2). So far, our results from observational data have only been to provide formative feedback to project PIs, but we intend to publish further on these findings in the future.

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