A Longitudinal Study to Investigate the Impact of a Service-Learning Course on Its Participants*

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***Abstract*—The Technology Ambassador's Program (TAP) was established in 2012 as an extra-curricular program and has been offered as a service learning course since spring 2016. To investigate the impact on program participants, we launched a longitudinal study in fall 2022 and surveyed the students who completed the course from spring 2016 to spring 2021. Analysis of the survey results discovered that students strongly agree that this program has provided them opportunities to conduct research, to network with other professionals in the field, and apply technical skills. Further analysis also revealed a strong correlation of these opportunities with improving soft skills and career readiness among participants. Overall, this program increased the confidence of the students and prepared them to learn new skills on their own. This paper describes the overall structure of the service learning program and presents the details of this study including the process and survey results.**

***Index Terms*—IT Education, Service Learning, Longitudinal Program Impact**

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I. Introduction

Georgia Gwinnett College (GGC) is a four-year, state funded higher education institution established in 2005. It is an open access institution with mainly commuting students. We are a campus with a diverse student population. Many of our students come from financially challenged families. Due to these factors, retention and graduation has always been a challenge from the start of our institution. Based on the survey conducted by Center for Evaluating the Research Pipeline(CERP) Computing Research Association [19] for our IT students in spring 2022, when asked about prior experience related to computing before entering college, only 8% attended workshops or training in computing (through local library or community center) and 5% had AP computing courses, which are significantly lower than similar institutions. Percent of students completing algebra II, trigonometry, pre-calc and calculus are also significantly lower than similar institutions. Overall, our students are less prepared compared to similar four-year baccalaureate awarding institutions.

In order to engage students in IT and eventually increase retention and graduation rates, we started the Technology Ambassador's Program (TAP) in 2012 as an extracurricular activity. Students in this program were guided by faculty volunteers to develop hands-on IT outreach activities, and to demonstrate the project at events such as open houses and science festivals. To make this program sustainable, we started to offer a 3-credit hour service-learning elective course in spring 2016. The course includes a project development component and a service component (see detail in Section III TAP Program Description).

The study reported in this paper focuses on how the program has impacted the service-learning students' professional development, degree attainment, and career readiness. It is a longitudinal study in that the subjects are the service-learning students who have completed the program for at least one year. We aimed that the time elapsed after the completion of the course and the life experience since then would have given these students a more accurate assessment of the program's impact than the current TAP students.

Wyatt et al. [9] remarked that broadening participation in computing (BPC) longitudinal studies "tend to focus on cross-sectional metrics (i.e., graduation rates), which do not speak to participants' growth as scholars in the program, nor to their commitment to pursuing a long-term career in a computing field. In addition, there have been limited analyses of how engagement with these programs impacts students' desire to persist in computing." Moreover, capturing longitudinal outcomes is a noted challenge [11] because of the limited resources and funding allocated toward evaluating the impact of the programs on a longitudinal scale [9], [12].

This study is an attempt to overcome the challenges mentioned above. The study was assisted by a college senior who had just completed the TAP program. We met regularly to check on progress of the data collection. We first emailed 111 previous students who took the course from spring 2016 to Spring 2021 through the email addresses on school records, followed up with LinkedIn messages and finally direct text messages. We received a total of 68 responses, and with incomplete responses removed, a total of 45 complete responses, which is 40.5% of the total number of originally contacted students and can be considered a good survey response rate. In this paper, we will share the survey results and the findings from this research.

The remaining sections of this paper discuss related work, describe the service learning course, Technology Ambassadors Program (TAP), and present the evaluation of its impact on

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program participants.

II. Related Work

Service learning is considered to be an experiential learning pedagogy and is defined as a partnership to meet the learning needs of students and the community that they serve [1]. Service learning is integrated in the computing curriculum in a variety of ways and is considered to have many benefits for students. Service learning has shown to improve students' content knowledge, their soft skills, enhanced understanding of community needs, and civic awareness [2], [3].

Service learning has been integrated in computing courses at various levels in undergraduate education. For example, [4] describes a case study implementing service learning in a software development course for junior and senior students. They describe a blended classroom with service learning components where students participate in a complete software development life-cycle project partnering with a community actor. This form of service learning in some sort of application development is the most common form of service learning embedded in the computing curriculum [5].

While not as common as the software development approach, [6] describes the integration of service learning in an online Human Computer Interaction (HCI) course where service learning is used as a means to fully engage students in a usability study through the re-design of a website. The study reports that students' engagement in their projects improved as a result of engagement with the real-world clients. The study also describes the challenges of working with community partners that have different resources, capacities and priorities and it describes the instructor's additional/invisible effort in delivering such a course.

Egan et al, [7] adopted service learning into an introductory programming course targeted to computing majors and non-major students. Partnering with a community based organization, Music Mobile, in this study students enrolled in the introductory course created entertaining and accessible animations to accompany Music Mobile's songs. In an end of the semester survey, students responded positively to the service learning project, noting it as a valuable experience. The study also reported a higher retention rate in the introductory course with a high recruitment rate in the follow-up programming course for majors, especially among women.

Outreach projects are the second most common type of service learning projects following the development projects as reported by [5]. In these types of projects students perform outreach activities to teach members of a community about some aspect of computing. For example, [1] describes how undergraduate students enrolled in a service learning course taught programming to high school students to broaden participation in computing. The school involved in this project was a high needs school with more than 80% of students needing free or reduced fee lunch. The school enrolled minoritized and refugee students representing those populations that are currently underrepresented in computing.

Service learning has also been used to attract and retain students in computing, especially women, as pro-social goals have been shown to be most important to women and first-generation students. For example, [8] discusses how computer science is perceived as a male discipline and argue that inclusion of computing as social good along with socially relevant assignments can improve participation rates of women in computing. Studies have also shown service learning to be effective in retaining students from underrepresented groups and thereby contributing to broadening participation in computing (BPC). For example, [9] describes a study conducted to evaluate the effectiveness of STARS program by analyzing a large set of participants' survey responses regarding their intentions to pursue computing. The study provides a strongly written evidence section showing that STEM identity and interest have a significant impact on persistence in STEM. STARS [10], a multi-pronged program that involves students in a combination of proven interventions (i.e. service learning, tutoring other students, building community, developing skills, etc.) has a positive impact on students' intentions to persist in computing. This study also found robust evidence that one should focus on the intensity of participation and not on the length of participation or a particular activity to increase students' desire to persist in computing careers. This research on strategies used by the well-established STARS program contributes to our understanding of what approaches are successful with engaging Black and Hispanic students.

The service learning course presented in this paper builds on this existing research and combines aspects of development projects and outreach projects as described in [5], [13]. It also adapts the recommendations made by robust studies, such as [9] in a way that responds to the needs of our students. Unlike [9], which were unable to measure students' long-term behavioral outcomes (e.g., graduate degree in computing, career in computing) and instead used an attitudinal measure of intentions to persist in computing, in this study we present our students' success outcomes in computing careers.

III. TAP Program Description

Since its inception in 2012, the Technology Ambassadors Program (TAP) has emerged as an initiative within Georgia Gwinnett College (GGC) School of Science and Technology, dedicated to nurturing the growth and development of students in the field of Information Technology (IT). Rooted in its commitment to promote inclusivity, diversity, and excellence, TAP serves to empower students to thrive academically, professionally, and personally.

At the heart of TAP's mission lies the cultivation of a diverse and resilient cohort of IT professionals. With a focus on recruiting underrepresented minorities in IT, including female, Hispanic, and Black students, TAP aims to dismantle barriers to success and foster pathways for equitable opportunities in IT. Each semester, the TAP committee selects between 10 to 15 students, forming collaborative teams entrusted with the task of leveraging diverse technologies to address educational needs and societal challenges. The journey with TAP begins

with ideation and project selection under the guidance of two dedicated IT faculty. Through an iterative process of feedback and refinement, students transform their ideas into tangible educational technology demonstrations tailored for audiences in K-12 outreach events to college-level workshops. Moreover, TAP extends its impact into academia by integrating student-led workshops into freshman-level IT courses. These workshops provide participants with hands-on, fun educational experiences designed to ignite their interest in IT while fostering an atmosphere of enjoyment and engagement. For instance, one workshop leveraged a popular gaming engine deployed on Virtual Reality headsets, offering students an immersive learning experience in fundamental Python programming concepts [14]. As TAP students execute their workshops, they actively collect data to measure the impact of their interventions in teaching the claimed concepts and elicit feedback from the audience. This feedback loop enables them to continuously refine and improve their workshop content, ensuring maximum effectiveness and relevance. The culmination of students' efforts is showcased at campus-wide research symposiums such as CREATE and STaRS, providing them with a platform to present their findings and insights. Through these presentations, TAP students bridge the gap between theory and practice, demonstrating the impact of their work on real-world challenges.

Beyond technical proficiency, TAP fosters a holistic skill set encompassing creativity, critical thinking, communication, collaboration, and leadership. Participants are immersed in a spectrum of professional development opportunities, from tech meetups to career-building workshops, fostering a culture of lifelong learning and growth. Furthermore, through their continued involvement in a student organization, students assume leadership roles, driving the program's evolution and extending its impact across the campus community.

Facilitating this transformative journey is a dedicated committee of faculty members, each playing a pivotal role in guiding and supporting TAP's initiatives. From providing instructional guidance to coordinating events, these mentors provide a needed support, empowering students to thrive in their endeavors.

At its core, TAP embodies the values of scholarship, leadership, service, and creativity espoused by our institution. Through its student-centric approach and unwavering commitment to excellence, TAP not only shapes the IT professionals of tomorrow but also catalyzes positive change within our communities.

In conclusion, the Technology Ambassadors Program (TAP) stands as a beacon of innovation and inclusivity, empowering students to transcend boundaries and realize their fullest potential in the dynamic field of Information Technology.

A. The Project Component

At the beginning of each semester, students were divided into groups of 3 or 4 members based on diversity, their availability outside of the classroom, or technology interest. In the first couple of weeks, each group will choose a technology and brainstorm ideas for their project. At least three ideas will be presented in class to receive feedback from their peers. Students will then focus on one idea to develop an educational technology demonstration suitable for K-12 and early-college events. Around mid-term, they need to demonstrate their projects at the TAP Expo event which is open to all faculty and students on campus.

Over the years, students have developed different levels of projects using a variety of software and hardware tools including Arduino, Audacity, Augmented Reality (AR) with Adobe Aero, Blender, Drone, HTML/CSS and JavaScript, MakeyMakey, Python, Processing (Java based), Pico 8, REID Chips, Raspberry Pi, Roblox, Sphero Robot, Cozmo Robot, Scratch, Tinkercad, Unity with Virtual Reality device.

B. The Service Component

Based on the project, each group develops a workshop which usually includes a presentation, step-by-step instructions for the hands-on activity, and a survey to assess the effectiveness of the workshop. At least three workshops will be conducted in the freshmen level general education IT course by the TAP students. The audience of these workshops will have the opportunity to develop a mini version of the TAP project or to work on part of the functions of the TAP project. TAP students will analyze the survey and include the result as part of the poster that summarizes their TAP experience. Their posters are presented at campus-wide research symposiums and regional or national conferences. The research component introduces the basic research methodology to students and gives them the opportunity to practice data collection and basic data analysis, which rarely appears in other IT courses at our institution. The service component also includes demonstration of the projects at local science festivals and other STEM outreach events.

IV. The Longitudinal Study Of TAP Impact

TAP has served more than 100 IT students since it has been offered as a service learning course in spring 2016. In 2022, a survey was developed to investigate the impact of TAP on students who had completed the program for at least a year. Survey questions include statements with Likert scale from 1 – 5 with 1 indicating *strongly disagree* and 5 *strongly agree* and open ended questions. The goal is to get their feedback about the TAP experience, including whether the TAP program has met their expectations, how the program has affected their desire to persist in IT and pursue graduate degrees, whether it has improved their career readiness, and what suggestions they have for improving TAP.

In spring 2023, we reached out to all the students enrolled between Spring 2016 and Spring 2021 through emails, LinkedIn, and text messages. Out of those, 65 responded and 45 completed the survey. The analysis is based on the 45 complete responses. We refer to the students who completed the survey as *alumni* in the paper. However, based on the survey results, out of the 45, 4 of them were still in college at the time of the survey.

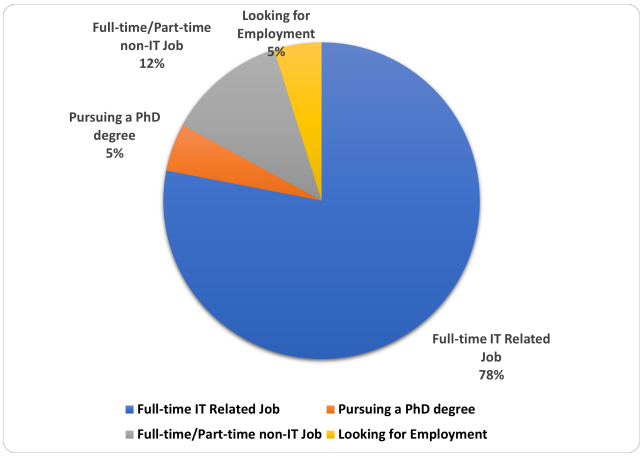

Fig. 1. Employment Status for Students Who have Graduated(N=41)

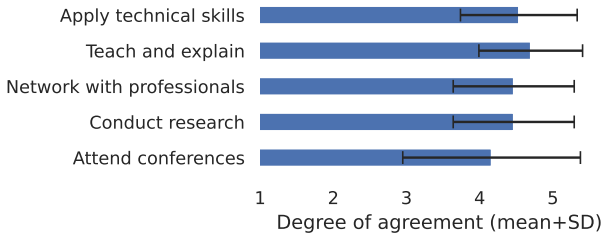

Fig. 2. Student Evaluation on the Opportunities from TAP (SD=Standard Deviation)

Figure 1 shows that 78% of the alumni from the program have full-time IT related jobs and 4.9% are pursuing a Ph.D. degree in IT related areas.

TAP has been designed so it provides our students with opportunities for growth. To assess the alumni's growth, we divided the opportunities into the following groups in the survey questions:

- opportunities to apply their technical skills to build a meaningful project (Apply technical skills)
- opportunities to teach and explain technical topics (Teach and explain)
- opportunities to network with other professionals (Network with professionals)
- opportunities to conduct research (Research)
- opportunities to attend national/regional conferences (Attend conferences)

The wording in the parentheses of each bullet are used in Figure 2. The survey asked students to evaluate each of the opportunity statements based on a 5-point Likert scale (between 1 for *strongly disagree* and 5 for *strongly agree*). Students rated highly on all the opportunities as shown in Figure 2. The average rating for each opportunity ranges from 4.20 (attending conferences) to 4.71 (teach and explain technical topics). 93% of the responses strongly agree or agree that TAP provided an opportunity to apply their technical skills to build a meaningful project.

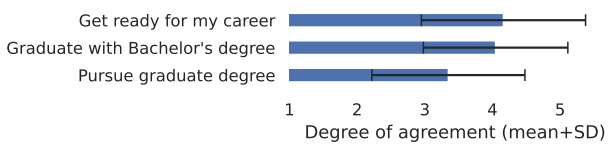

Fig. 3. TAP Impact on Career Readiness and the Pursuit of IT Degrees (SD=Standard Deviation)

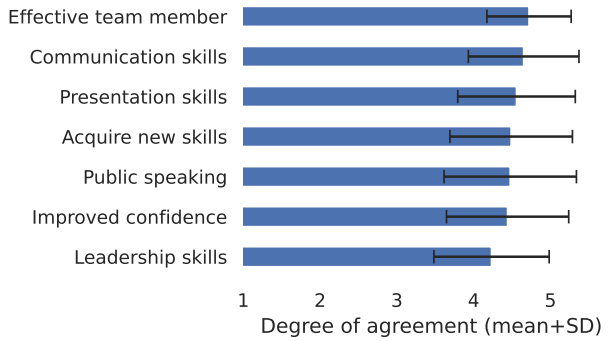

Fig. 4. TAP Impact on Soft Skills (SD=Standard Deviation)

A. *Impact on the Pursuit of IT degree and Career Readiness*

To understand the impact of TAP on career readiness and the completion of degree, we asked students to look back and evaluate the impact TAP had on them in the following areas:

- Helped me to get ready for my career
- Motivated me to graduate with a Bachelor's degree
- Motivated me to pursue a graduate degree

Figure 3 shows the average of student responses. Combining the rating of 5 (strongly agree) and 4 (agree), 84% of them said that TAP helped them to get ready for their career. 69% of them said that TAP motivated to graduate with a bachelor's degree and 42% said that TAP motivated them to pursue a graduate degree.

B. *Impact on Soft skills*

In the survey, we asked alumni to evaluate the impact of TAP on teamwork, communication, collaboration, public speaking, presentation and leadership skills. The result in Figure 4 showed that TAP has a strong impact on the soft skills as the alumni responded with high ratings to all the statements (the average rating ranging from 4.24 to 4.71). The percentages of alumni who rated "agree" or "strongly agree" with TAP's impact for each of these skills are ranging from 91% to 98%.

C. *Impact on Awareness of Community Outreach*

We used the ratings for the following three questions as indicators for TAP impact on community outreach:

- Q1: Made me interested in promoting computing to others
- Q2: Helped me understand the importance of giving back to the community and be able to participate in those outreach events

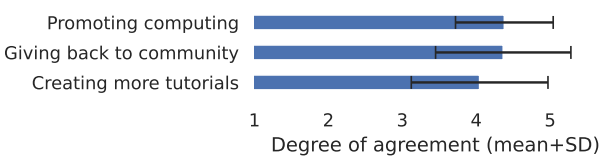

Fig. 5. TAP Impact on Awareness of Community Outreach (SD=Standard Deviation)

- Q3: Raised my interest in creating more tutorials for outreach events while I was at GGC

Figure 5 shows the responses from the survey data with average ratings for Q1, Q2 and Q3 to be 4.41, 4.35, and 4.04, respectively.

D. How TAP Opportunities Related to Soft Skill Development and Career Readiness

As shown in Figure 2, the alumni rated highly on how the TAP program gave them the opportunities to teach/explain technical topics, apply their technical skills to build a meaningful project, network with other professionals in the field, conduct research, and attend national/regional conferences.

Students also evaluated the impact TAP has them for pursuit of Bachelor's degree (69% strongly agree or agree), career readiness (84% strongly agree or agree), and soft skills, such as improved confidence (93.3% strongly agree and agree), and prepared them to acquire new skills and knowledge on their own (93.3% Strongly agree and agree), etc.

Figure 6 presents a summary of the opportunities that have been identified as correlating with soft skill development, degree completion, and career readiness from moderately to very strongly with statistical significance. The table also includes the Pearson correlation coefficients [18], with 0.4–0.59 for moderate, 0.6–0.79 for strong, and 0.8–1 very strong correlations. All identified correlations are significant at the $p < 0.01$ level (2-tailed).

We observe the following:

- Applying technical skills to build a meaningful project has a very strong correlation with students' improved confidence, preparedness to learn new skills on their own, and career readiness. It has strong correlations with development of communication and collaboration skills, likely due to the team-based nature of the TAP program
- The opportunities for networking have strong connections with several soft skill improvements and career readiness.
- Opportunities for research are strongly related to improvement of confidence and preparedness to acquire new skills and knowledge on their own. It also strongly correlates to the development of communication and collaboration skills, also likely due to the team-based nature of the program.

Interestingly, data analysis revealed that the opportunity to teach and explain technical topics does not have a moderate or strong correlation with the soft skills, career readiness, or pursuit of degrees. In fact, students give the highest average rating 4.71 to this opportunity among all five opportunities, as shown in Figure 2. It is possible that this is the most obvious opportunity that TAP provides and all TAP students must do this in their projects (i.e. almost all students would choose 5 for "strongly agree"). Therefore, it is not an effective indicator for what factors of TAP have made those impact. For some opportunities, such as applying technical skills to build a project, not everyone utilize them equally, possibly due to the team-based nature (i.e. each team member took a different role), differences in self motivations among students, or different natures of the projects that different teams chose.

Applying technical skills to build a project and explaining it to the general public, networking, and conducting research are core features of the TAP program. The strength of the program is partially validated from the strong correlation of these features with the alumni's assessment with their development of soft skills and/or career readiness through this program.

V. Discussion and Future Work

According to a recent article published in Inside Higher Ed [1], 52% of recent graduates are underemployed, which they define as having a job that does not require a bachelor's degree. This means that only 48% are adequately employed. Figure 1 shows that 82.9% of the TAP graduates that participated in the study either enrolled in graduate school in an IT-related field or currently have a job in IT, 4.9% of our TAP graduates in the study are looking for a job in IT, and 9.8% are still working on their undergraduate degree. These numbers are significantly greater than the employment percentage, 48%, mentioned above and show that our students are motivated and persistent in pursuing an IT career.

TAP offers many opportunities that are not available in other classes. For example, TAP students are given the ability to teach or present technical skills. There is a snow ball effect that occurs when students present in front of people. Not only do they attain soft skills for presenting, but they solidify their technical knowledge and thus, have a better understanding which reflects in better job interviewing skills. 91% of our students agreed that TAP gave them the opportunity to teach and explain technical topics. This may be one of the reasons why such a large percentage of our students have jobs in the IT field as opposed to the 52% of recent graduates that are underemployed [15].

It is widely acknowledged that soft skills are not often taught in higher education, while research in IT field personnel has found that soft skills such as problem-solving, teamwork, and the ability to collaborate, were deemed the most important for entry-level IT professionals [16], [17]. The TAP program has a positive impact on student soft skills. We have observed some of our most shy students gain incredible public speaking and presentation skills. The student perceptions shown in Figure 4 indicate that students learned a great deal of these invaluable soft skills while in the TAP program. When the students were asked, "What skills did you learn in TAP that other classes do not offer and contributed to your career?", 18

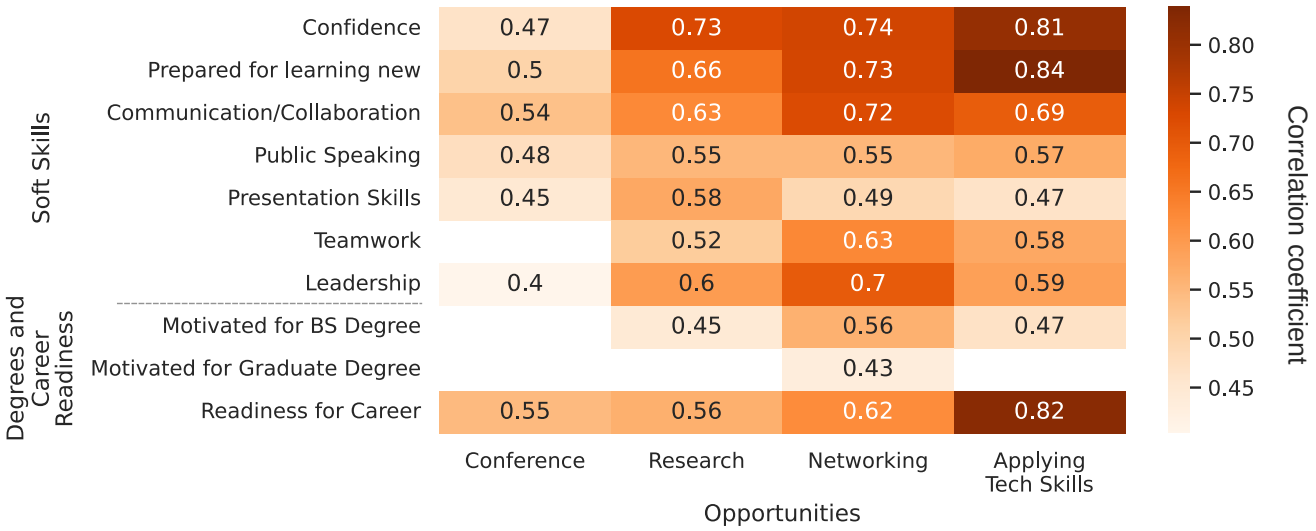

Fig. 6. Correlations between TAP Opportunities and Soft Skills and Career Readiness

of 45 participants mentioned soft skills in their responses. A few of their responses include:

- Collaboration, presentation, teaching, and patience.
- Working with a team and learning as we improved our skills to reach different audiences.
- Self sufficiency and team cooperation
- Public speaking and being able to teach others what you know.
- I feel TAP helped me with my problem solving and improvising skills which I feel helped me in life in general.

In fact, student responses indicated that TAP greatly improved their soft skills. 91% of our students attributed developing public speaking skills to TAP, 93% said TAP helped to improve presentation skills, leadership skills, confidence and self-reliance. 95% said TAP improved their ability to work in a team. And 98% said that TAP vastly improved their communication/collaboration skills.

These numbers speak for themselves, but are also supported by the correlation statistics found in Figure 6. The opportunities that we provide in our class such as research, networking and the ability to apply their technical skills to a project correlate to their improved soft skills and their career readiness. For example, the opportunity to apply their technical skills to build a meaningful project strongly correlates to their ability to learn new skills, increased confidence, and preparedness to enter the job market.

As briefly mentioned above, TAP also provides the opportunity for our students to network with other professionals in their field. This is not typical for most of their other classes and again strongly correlated to their soft skills such as confidence (.74 correlation coefficient), their ability to learn new skills (.73), communication/collaboration (.72), and leadership (.70). It also has strong correlation with their sense of career readiness (.62). However, it has only moderate correlation with students' pursuit of higher level degrees (.43).

One thing that is worth mentioning is that we already started to provide more networking events for our students to interact with our TAP alumni. However, the cohort that was given this survey was not given the same opportunity when they were students. They are the alumni coming back to serve on our alumni panels at our networking events, but when they were students they did not get this improved opportunity. It will be interesting to ask these same questions to our current and future students that are taking advantage of the increased number of networking events to compare the results. We hope to see a much stronger correlation.

We also provide the opportunity to attend and present at conferences and this opportunity does not seem to have as strong correlation with soft skills or career readiness as some other opportunities discussed above. In addition, there does not seem to be as great of an effect on their motivation to get a graduate degree. We do not know why the correlation here is weaker than the other opportunities, but we think that it might be related to our student population which is non-traditional. Many of them work outside of school to support their families and are anxious to immediately get a job right after graduation, so conferences and graduate school are seen as a delay in their ability to get a job and start earning real money. This would be a good topic for future research.

Our TAP program offers many opportunities for our students to acquire skills that they cannot obtain in any other class offered at our institution. This is just our first study on its long term effects and we plan to further this work and adjust our program accordingly based on the results to make the TAP program even more beneficial for our students.

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REFERENCES

[1] S. Banerjee and N. Mazur, "Service learning in computing: creating computer science pipeline by attracting and engaging high school students," J. Comput. Sci. Coll., vol. 33, pp. 173–174, June 2018.

[2] J. Eyler, "Reflection: Linking service and learning—Linking students and communities," Journal of Social Issues, vol. 58, pp. 517–5344, 2002. https://doi.org/10.1111/1540-4560.00274

[3] H. Farahmandpour and I. Shodjaee-Zrudlo, "Redefining service-learning for the purpose of social change within education," in The SAGE Sourcebook of Service-Learning and Civic Engagement, SAGE, Thousand Oaks, CA, 2015, pp. 47–52. https://doi.org/10.4135/9781483346625

[4] S. Robinson and M. Hall, "Combining Agile Software Development and Service-learning: A Case Study in Experiential IS Education," in Proceedings of the 49th ACM Technical Symposium on Computer Science Education (SIGCSE '18), Association for Computing Machinery, New York, NY, USA, 2018, pp. 491–496. https://doi.org/10.1145/3159450.3159564

[5] F. R. Yamamoto, L. Barker, and A. Voida, "CISing Up Service Learning: A Systematic Review of Service Learning Experiences in Computer and Information Science," ACM Trans. Comput. Educ., vol. 23, number 3, pp. 1–56, 2023. https://doi.org/10.1145/3610776

[6] L. Patricia, "Service learning: an HCI experiment," in Proceedings of the 16th Western Canadian Conference on Computing Education (WCCCE '11). Association for Computing Machinery, New York, NY, USA, 2011, pp. 12–16. https://doi.org/10.1145/1989622.1989626

[7] M. A. L. Egan and M. Johnson, "Service learning in introductory computer science," in Proceedings of the fifteenth annual conference on Innovation and technology in computer science education (ITiCSE '10). Association for Computing Machinery, New York, NY, USA, 2010, pp. 8–12. https://doi.org/10.1145/1822090.1822095

[8] N. Z. Khan and A. Luxton-Reilly, "Is computing for social good the solution to closing the gender gap in computer science?," in Proceedings of the Australasian Computer Science Week Multiconference (ACSW '16). Association for Computing Machinery, New York, NY, USA, 2016, pp. 1–5. https://doi.org/10.1145/2843043.2843069

[9] L. G. Wyatt, S. R. Fisk, C. Thompson, J. Payton, V. Cateté, A. S. Rorrer, T. Barnes, and T. McKlin, "Multi-Pronged Pedagogical Approaches to Broaden Participation in Computing and Increase Students' Computing Persistence: A Robustness Analysis of the STARS Computing Corps' Impact on Students' Intentions to Persist in Computing," in Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 1 (SIGCSE 2024). Association for Computing Machinery, New York, NY, USA, 2024, pp. 1456—1462. https://doi.org/10.1145/3626252.3630895

[10] STARS Computing Corps, "STARS Computing Corps: About Us," 2024. https://www.starscomputingcorps.org/about-us/

[11] R. J. Shavelson and L. Towne, Scientific research in education. Washington, D.C.: National Academy Press, 2002.

[12] A. S. Rorrer, T. Barnes, J. Payton, and H. Zuo, "Challenges and opportunities in evaluating broadening participation in computing: The STARS evaluation cohort model," Research on Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT), Minneapolis, MN, USA, 2019, pp. 1–5, https://doi.org/10.1109/RESPECT46404.2019.8985859

[13] S. Dekhane, X. Xu, N. Napier, R. Barakat, C. Gunay, and K. Nagel, Kristine, "Technology focused service-learning course to increase confidence and persistence in computing," Journal of Computing Sciences in Colleges, Consortium for Computing Sciences in Colleges, vol. 34, number 2, pp. 147–153, 2018.

[14] C. Gunay and R. Barakat, "Immersive gamification for education: No additional benefit gained from wearing a VR headset," in Proceedings of the 24th Annual Conference on Information Technology EducationOctober (SIGITE 2023). Association for Computing Machinery, New York, NY, USA, 2023, pp. 136—141. https://doi.org/10.1145/3585059.3611423

[15] S. Weissman, "More Than Half of Recent 4-Year College Grads Underemployed," Inside Higher Ed: University Science, 2024. https://www.insidehighered.com/news/students/academics/2024/02/22/more-half-recent-four-year-college-grads-underemployed

[16] M. E. McMurtrey, J. P. Downey, S. M. Zeltmann, and W. H. Friedman, "Critical Skill Sets of Entry-Level IT Professionals: An Empirical Examination of Perceptions from Field Personnel," Journal of Information Technology Education: Research. Informing Science Institute, vol. 7, pp. 101–120, 2008.

[17] F. F. Patacsil, and C. L, S. Tablatin, "Exploring the Importance of Soft and Hard Skills as Perceived by IT Internship Students and Industry: A Gap Analysis," Journal of Technology and Science Education. Omnia-Science, vol. 7, pp. 347–368, 2017.

[18] K. Pearson, "Notes on regression and inheritance in the case of two parents," in Proceedings of the Royal Society of London, vol. 58, 1895, pp. 240–242.

[19] Computing Research Association, Center for Evaluating the Research Pipeline. Data Buddies Survey Undergraduate Student Dataset. https://cra.org/cerp/data-buddies