BOARD # 61: Fostering STEM Identity and STEM Efficacy Through Engagement in Community Service

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Doris Espiritu is the founder of the City Colleges of Chicago (CCC) School of Engineering, the Dean of the Center of Excellence for Engineering and Computer Science and Professor of Chemistry at Wilbur Wright College. She also serves as the Senior Advisor to the Provost of CCC. Doris Espiritu is one of the first National Science Foundation's research awardees under the Hispanic-Serving Institutions (HSI) Program. She pioneered Engineering at Wright and had grown the Engineering program enrollment by 2500% within five years leading to the creation of CCC School of Engineering. Doris founded seven student chapters of national organizations including the Society of Women Engineers (SWE), the Society of Hispanic Professional Engineers (SHPE), the Society of Asian Scientists and Engineers (SASE), the National Society of Black Engineers (NSBE) and ten times Outstanding Chapter Awardee, the American Chemical Society-Wright College Chapter. Doris promotes collaboration between K-12 schools, other community colleges, 4-year institutions, non-profit organizations, and industries. Doris' current research is to design and implement practices that develop Community of Practice (CoP), Professional Identity, and Self-Efficacy to streamline transfer from community colleges to 4-year institutions.

Fostering STEM Identity and STEM Efficacy Through Engagement in Community Service

I. INTRODUCTION

Volunteering means any activity in which time is given freely to benefit another person, group or organization [1]. Engaging in volunteering, among adolescents, has been shown to correlate with enhanced social skills which enables them to connect with students of all backgrounds and interests [2]. Volunteerism has also been linked to increased civic engagement [2], improved academic aptitude [3], as well as enhanced self-esteem and happiness in adults [4]. Additionally, participating in volunteering activities related to one's degree has shown to give participants practical and applicable experiences that can benefit their career prospects [5].

Persistence in and completion of baccalaureate STEM degrees has been shown to be related to a balance of activities that includes volunteering, involvement in professional organizations, as well as service-learning [6]. Service-learning is defined as a form of experiential learning that integrates assigned projects into a course curriculum [7]. Within science, technology, engineering, and mathematics (STEM) education, service-learning and its impact on student retention and academic performance is well documented and has been researched extensively [8], [9], [10]. However, limited research has been done on the impact of volunteerism on these key performance indicators (e.g. student retention and academic performance).

This study aims to address the impact of STEM-related service activities (SRSAs) on participants' STEM identity [11] and STEM efficacy [12]. STEM identity is an individual's perception of themselves as a STEM professional [13], while STEM efficacy denotes one's belief in their ability to perform STEM-related tasks [14]. Albert Bandura's theory of self-efficacy states that individuals with a strong sense of self-efficacy will likely overcome challenges, and that there is a positive relationship between the strength of self-efficacy and the probability of successful performance [15]. For these reasons, STEM identity and STEM efficacy were selected as key metrics.

Many colleges and universities implement effective but highly resource-intensive strategies to increase STEM persistence rates [16]. In contrast to these resource intensive approaches, the current study investigates a more cost-effective strategy: volunteerism. To investigate the effects of STEM volunteering, a series of STEM-related service activities (SRSAs) were designed and implemented at Wilbur Wright College, a community college that classifies as a Hispanic Serving Institution (HSI) and serves a wide variety of student populations from all backgrounds and interests. Several of these SRSAs were implemented in collaboration with local community groups, student organizations, and academic institutions. This study hypothesizes that a participant's STEM identity and STEM efficacy will be enhanced by participating in SRSAs and that this enhancement will positively correlate with the length and recurrence of the service provided. By exploring this relationship, our research aims to contribute to the development of effective strategies for fostering a robust STEM workforce.

Our study's approach is to test the effect of participation in STEM-specific volunteerism on the key metrics of STEM identity and STEM efficacy. We speculate that increasing these metrics can foster persistence in STEM degrees. If this correlation proves true in future longitudinal studies, the findings of this paper could contribute to the necessary development of STEM workers, as some estimates suggest that millions of future STEM jobs in the United States could remain unfilled due to a lack of qualified graduates [17], [18]. The United States heavily relies on a robust workforce in STEM fields, which represents 24% of the total U.S. working population [19]. Compounded by the disproportionately low graduation rates among underrepresented minority (URM) groups and women pursuing STEM degrees, these projected unfilled STEM jobs will threaten the United States's long term economic prosperity [16]. As of 2021, Black or African American, American Indian or Alaska Native, and Hispanic or Latino individuals represented 23% of the STEM workforce, despite representing 30% of the total U.S. workforce [19]. If these underrepresented and historically underserved groups show significant increases in STEM identity and STEM efficacy as a result of participation in SRSAs, this will be strong evidence to support the rejection of our null hypothesis, that participation in SRSAs does not affect STEM identity or STEM efficacy [16].

II. METHODS

II.1 Experimental Design Overview

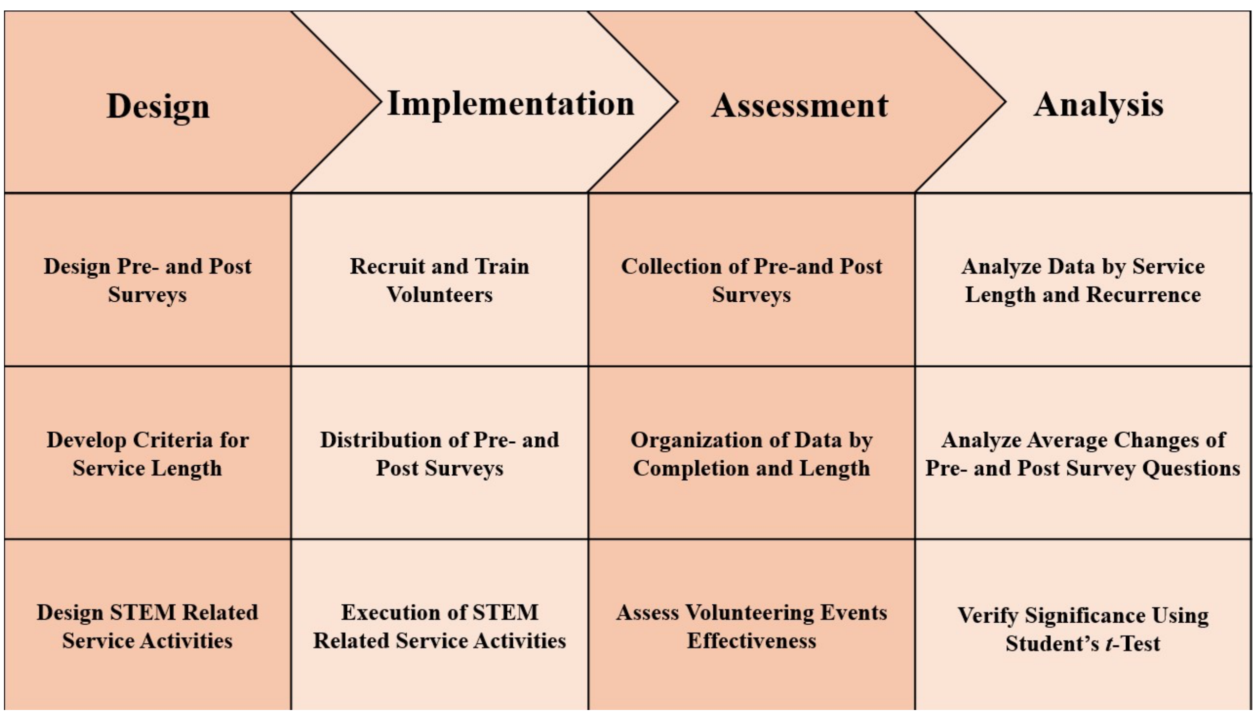

Figure 1. Overall experimental design of this project.

The impact of SRSAs on STEM identity and STEM efficacy was measured by employing pre- and post-activity surveys containing Likert scale questions.

Figure 1 shows the schematic diagram of the methods. Design phase: SRSAs of various service lengths were developed in collaboration with community partners, as well as both local and student organizations. The implementation phase involved the recruitment of volunteers for these SRSAs. Surveys were distributed to volunteers before and after each activity to measure any changes in STEM identity and STEM efficacy as a result of participation in SRSAs. In the assessment phase, surveys were collected and organized into paired data points using Microsoft Excel, this included only respondents who completed both the pre and post surveys. In the analysis phase, this data was processed further to identify trends in each SRSA service length. To determine the statistical significance of these trends, multiple Student's t-Tests using Microsoft Excel T.TEST function were performed.

II.2 Study Design

This study involved the development of a series of SRSAs on and off campus. Our study presented multiple short-term, medium-term, and long-term volunteering opportunities to students at Wilbur Wright College's Center of Excellence for Engineering and Computer Science. To measure any changes in STEM identity and STEM efficacy in SRSA participants, pre- and post-activity surveys were administered.

Volunteering Term	**Short–Term (Hour to 1 day)**	**Medium–Term (A day to 2 Weeks)**	**Long–Term (Months to Semesters)**
STEM Related Service Activities	- Science Fair Judging	- Engineering Week Volunteer	- Tutoring
	- Open House Volunteer	- American Chemical Society Demo Presentation	- Mentoring

Table 1. Examples of STEM-Related Service Activities (SRSAs).

Each SRSA was categorized into three groups based on the duration of the volunteering experience: short-term, medium-term, and long-term (Table 1).

Short-term activities are usually one-off activities that last less than one day. Some examples of these SRSAs include serving as STEM open-house ambassadors, volunteering in a student chapter of SHPE's Noche de Ciencias, serving as a judge for an early education STEM fair (K-8), participating in tabling events for STEM organizations, and assisting at other short-term STEM outreach events. These events require minimal training and preparation for each participant.

Medium-term SRSAs last from one day to a maximum of two weeks. They are longer and usually involve more preparation than short-term SRSAs and thus demand a greater time commitment from participants in this service length. Examples of these activities include participating in elementary school science demonstrations, representing a STEM organization at a state fair, and creating a robotics track for an engineering competition. These volunteering opportunities may have required participants to receive some training or take additional steps, such as attending a brief workshop or training lecture, that may extend the volunteering duration beyond a single day.

Long-term SRSAs span at least two weeks and may last several months or an entire semester. Examples of opportunities in this category include serving as a peer-to-peer mentor within Wilbur Wright College and participating in volunteering programs in collaboration with partner institutions. These participants' volunteering experience involve extensive training and require an ongoing time commitment.

II.3 Implementation

Volunteers were recruited from the Center of Excellence for Engineering and Computer Science at Wilbur Wright College. Each volunteer was provided information about various SRSA opportunities, including the nature of the activity, location, and time commitment involved. Once a participant selected an opportunity, they were asked to complete a pre-survey corresponding to the service length of the SRSA they selected. When applicable, each participant was given appropriate training for their SRSA to prepare them and guide their expectations for their respective role. For example, volunteers participating in science demonstrations for elementary school students received additional safety and operational training. Additionally, when requested by a partnering institution, volunteers completed a background check.

II.4 Assessment

Data collection involved administering pre- and post-activity surveys to all participants via Google Forms. No personal identifiable information was collected. The questions in these surveys were designed using Bandura's toolbox to assess changes in STEM identity and STEM efficacy and employed a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) to capture each participant's degree of agreeableness to each question [15], [20]. Each survey contained four questions that targeted STEM identity and STEM efficacy, with two questions measuring STEM identity and two questions measuring STEM efficacy. These questions are displayed below in Table 2.

STEM Identity		**STEM Efficacy**	
(1)	I feel like I belong in STEM and can see myself in the field.	(3)	I am confident in demonstrating my STEM abilities; I am able to contribute my knowledge in STEM to this activity.
(2)	I feel connected to the STEM community and my peers.	(4)	I feel prepared to guide and lead others through the STEM related activity.

Table 2. STEM Identity and STEM Efficacy Pre- and Post-Survey Questions Distributed to Volunteers

In addition, participants were asked questions that collected information about each participant's volunteering experience, employment status, ethnic/racial demographics, and academic grade point average (GPA). Questions, such as those regarding GPA, were self-reported by the respondents but cannot be tracked back to the respondents. Respondents were asked to respond with N/A if they did not wish to include their GPA.

II.5 Data Analysis

Participants' survey responses were initially collected in Google Sheets and transferred to Microsoft Excel for further analysis. Participants who failed to complete both pre- and post-surveys were excluded from the study, as any impact could not be meaningfully assessed in the absence of measurements before and after participation. A paired samples t-Test using the Excel 2024 T.TEST function was used to determine the statistical significance of any changes in STEM identity and STEM efficacy between pre- and post-activity surveys [21]. A *p*-value of less than or equal to 0.05 ($p \leq 0.05$) was considered statistically significant.

III. RESULTS

III.1 Demographics

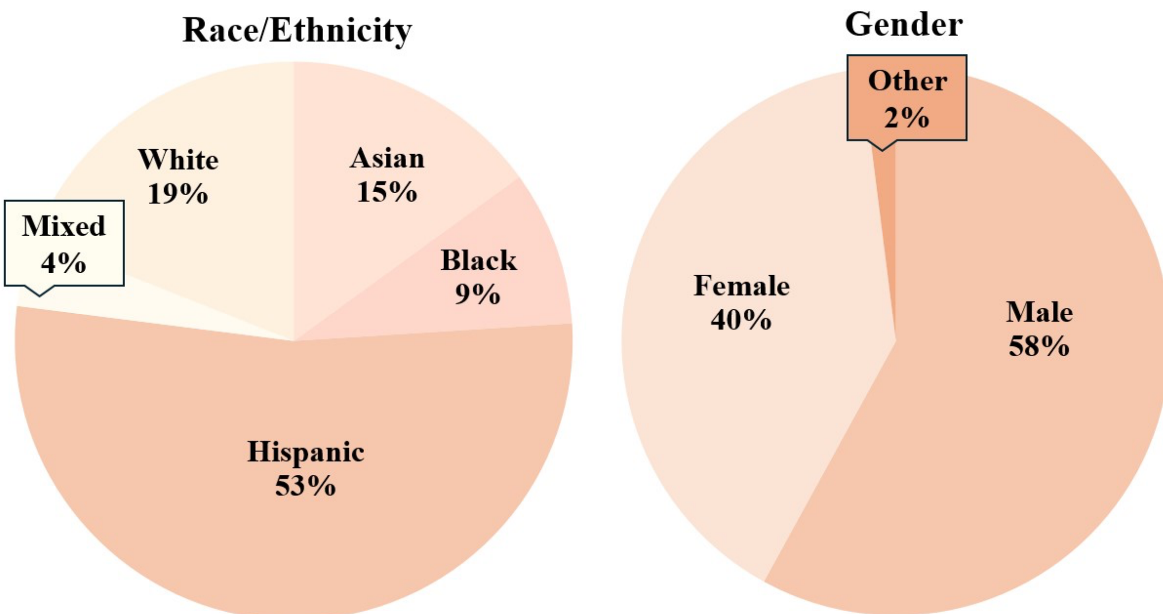

Figure 2. Demographic distribution disaggregated by race/ethnicity and gender.

Figure 2 summarizes the self-reported racial/ethnic and gender demographics. Most volunteers are Hispanic or Latino, representing 53% of participants. White is the second most reported racial/ethnic demographic representing 19% of participants. Fifteen percent (15%) of participants self-identified as Asian. Furthermore, 9% of participants self-identified as Black and 4% identified as Mixed. Figure 2 also displays the gender representation of the participants. Fiftyeight percent (58%) of our participants self-reported as male, followed by 40% as female, and 2% as other.

III.2 Results

Participants in this study can volunteer more than once across all service lengths. A pre-and post-survey was collected for each SRSA completed by the participant. Due to this design choice, it is possible that the same participant can record multiple responses. This study had one hundred and thirty-six (136) participants, with one hundred eighty-nine (189) responses of paired pre- and post-survey data. These were collected to measure and document any changes in STEM identity and STEM efficacy resulting from participation in SRSAs. The study utilized four key questions from the pre- and post-surveys, two questions measure STEM identity (Questions one (1) and two (2)), and two questions measure STEM efficacy (Questions three (3) and four (4)).

We implemented fourteen (14) short-term activities, which generated one hundred twenty-four (124) responses, seven (7) medium-term activities with forty-one (41) responses, and six (6) long-term activities with twenty-four (24) responses. In total, twenty-seven (27) SRSAs were designed and implemented.

		Short-Term (124 Respondents)			**Medium-Term (41 Respondents)**			**Long-Term (24 Respondents)**		
Question		*Pre*	*Post*	*p-Value*	*Pre*	*Post*	*p-Value*	*Pre*	*Post*	*p-Value*
STEM Identity	(1)	4.23	4.23	0.500	4.61	4.56	0.243	4.42	4.42	0.500
	(2)	4.25	4.21	0.272	4.34	4.54	0.015	4.42	4.38	0.385
STEM Efficacy	(3)	3.91	4.08	0.004	4.20	4.51	0.005	4.08	4.58	0.001
	(4)	3.90	3.96	0.195	4.22	4.32	0.189	4.04	4.54	0.005

Table 3. Pre- and post-survey results of STEM identity and STEM efficacy across short-, medium- and long-term volunteering SRSAs and displays the corresponding *p*-value for each question. Pre- and post-survey values were averaged for each question of each service length.

As shown in Table 3, STEM identity is measured through the results of questions one (1) and two (2), with STEM efficacy measured through questions three (3) and four (4). Average Likert-scale scores for individual pre- and post-survey questions of all three service lengths are recorded alongside their corresponding *p*-value. In addition, the number of respondents is listed below each service length.

One hundred and twenty-four (124) respondents were surveyed over the duration of 14 separate short-term SRSAs. A significant increase (3.91 to 4.08, $p \leq 0.05$) in STEM efficacy is recorded among these respondents (question 3), delineating an increase in participant's confidence in demonstrating their STEM abilities and applying their STEM knowledge. No statistically significant changes in STEM identity were observed in this service length.

For the medium-term service length, a total of 41 responses were collected across 7 distinct SRSAs. A significant increase (4.34 to 4.54, $p \leq 0.05$) in STEM identity is observed, showing that participation in this service length resulted in an increased sense of connection to the STEM community and their peers (question 2). Additionally, a significant increase in STEM efficacy was recorded (4.20 to 4.51, $p \leq 0.05$) in question 3. No other significant changes were recorded in this service length.

Significant increases in STEM efficacy were measured in questions 3 (4.08 to 4.58, $p \leq 0.05$) and 4 (4.04 to 4.54, $p \leq 0.05$) across 7 long-term SRSAs, with a total of 24 respondents. Specifically, question 4 shows a significant increase (4.04 to 4.54, $p \leq 0.05$) in the respondents' sense of preparedness to guide and lead others through the STEM related activity. No significant changes were observed in both questions (1 and 2) measuring STEM identity.

The significant increases in STEM efficacy were found to be proportional to the length of the service provided by the respondents. A significant increase in STEM identity was found in our medium-term service length SRSAs (question 2).

III.3 STEM Volunteering on Hispanic or Latino Respondents

To determine which racial/ethnic group benefited the most in our research, additional analysis was performed for each reported racial/ethnic group from each service length. At least fifteen (15) responses were required in order to perform a proper Student's t-Test [21]. White, Asian and Hispanic or Latino were the only racial/ethnic groups to have more than fifteen (15) respondents, but when performing a statistical test on these demographics, only Hispanic or Latino respondents showed statistical significance in both short- and medium-term service length.

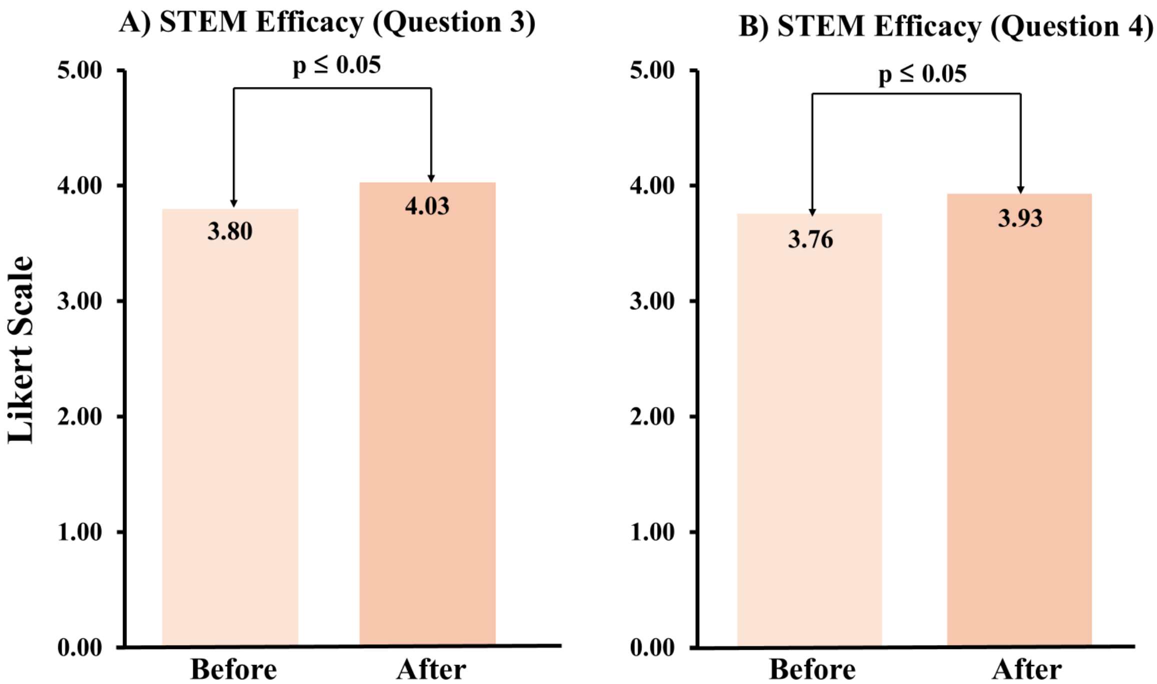

Figure 3. Hispanic or Latino respondents' results for short-term SRSAs.

Figure 3 shows the impact that short-term SRSAs have on Hispanic or Latino respondents when measuring their STEM identity and STEM efficacy. Seventy (70) Hispanic or Latino responses are recorded for short-term SRSAs. A majority of our respondents identify as Hispanic or Latino since they were recruited from Wilbur Wright College, which is a HSI. Hispanic or Latino respondents showed a significant increase in STEM efficacy as shown in questions 3 (3.80 to 4.03, $p \leq 0.05$) and 4 (3.76 to 3.93, $p \leq 0.05$). No significant changes in STEM identity were observed.

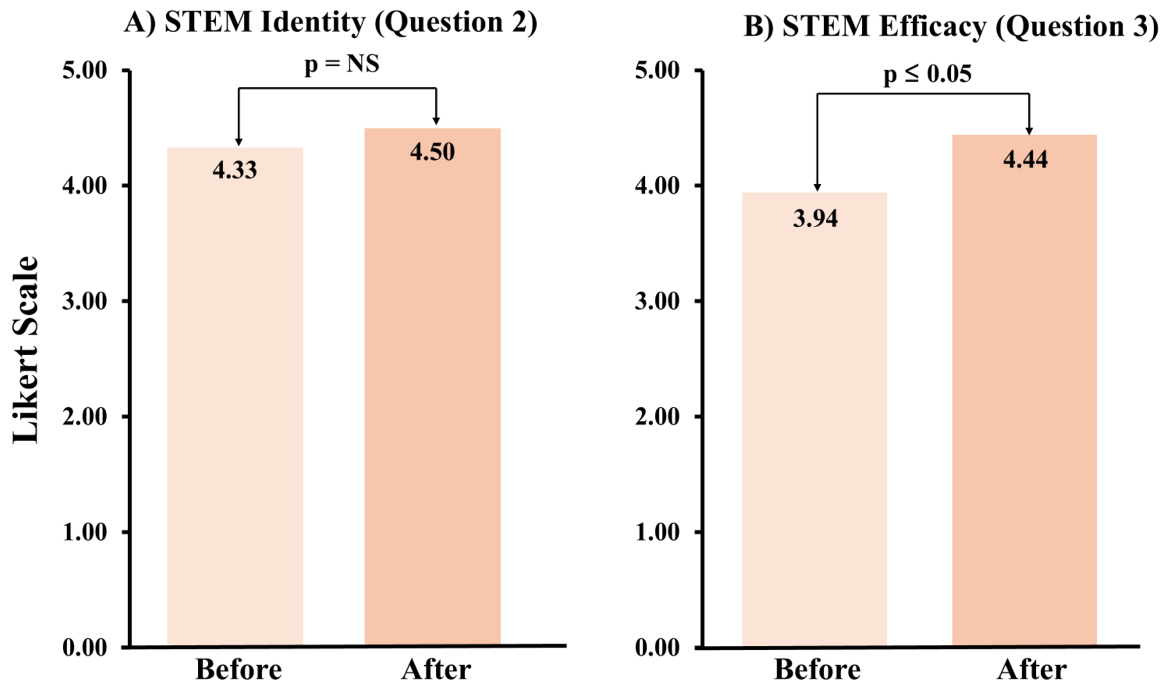

Figure 4. Hispanic or Latino respondents' results for medium-term SRSAs.

As can be seen in Figure 4 above, the medium-term service length there are eighteen (18) respondents that self-identify as Hispanic or Latino. Figure 4 shows an increase (3.94 to 4.44, $p \leq 0.05$) in question 3. There were no significant results recorded for STEM identity.

III.4 Recurrence of Service Results

Figures 5 and 6, shown below, represent our findings from respondents who volunteered more than once (91) and respondents who only volunteered once (98). Ninety-one (91) respondents, 48.1% volunteered more than once in SRSAs. In contrast, 51.9% of respondents volunteered only once.

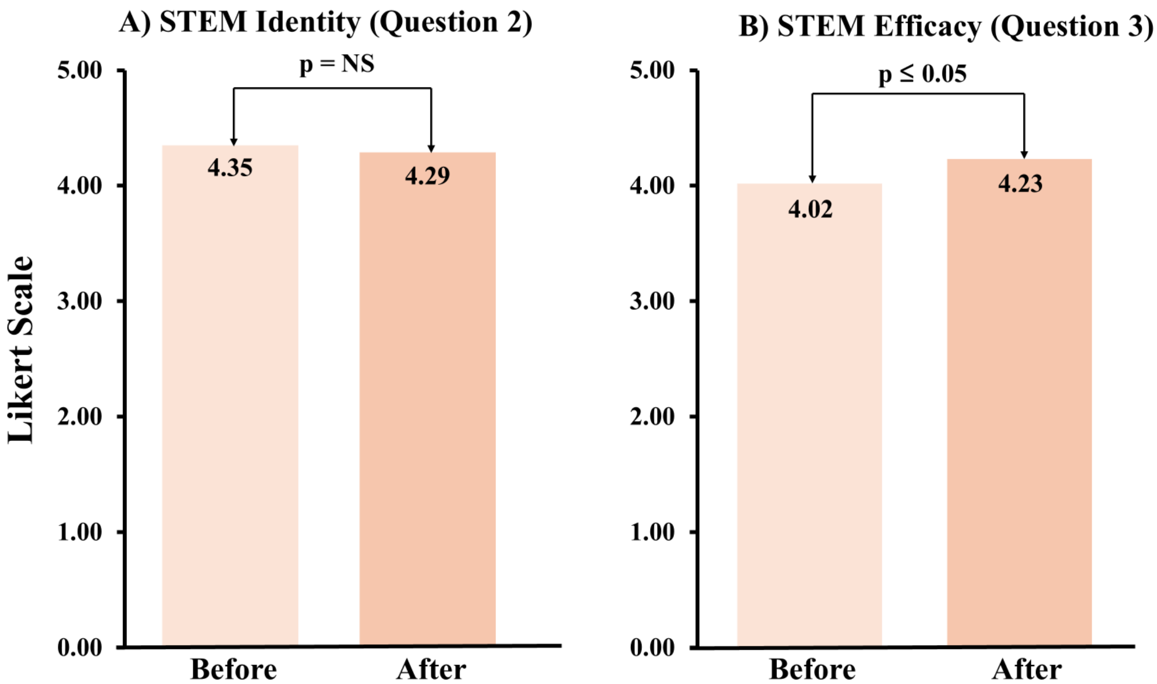

Figure 5. Results show the impact that the recurrence of volunteering in SRSAs have on respondents' STEM identity and STEM efficacy over all service lengths.

Figure 5, shown above, highlights our findings from respondents who volunteered more than once during this study. Thirty-eight (38) participants volunteered more than once which represents forty-eight percent (48%) of the responses. We hypothesize that STEM identity and STEM efficacy should increase when participants volunteer more than once. Question three measuring STEM efficacy shows a significant increase (4.02 to 4.23, $p \leq 0.05$). This demonstrates that participants experienced an increase in confidence in their ability to demonstrate their STEM abilities, and their ability to contribute their knowledge of STEM to the SRSA. No significant changes were recorded in STEM identity.

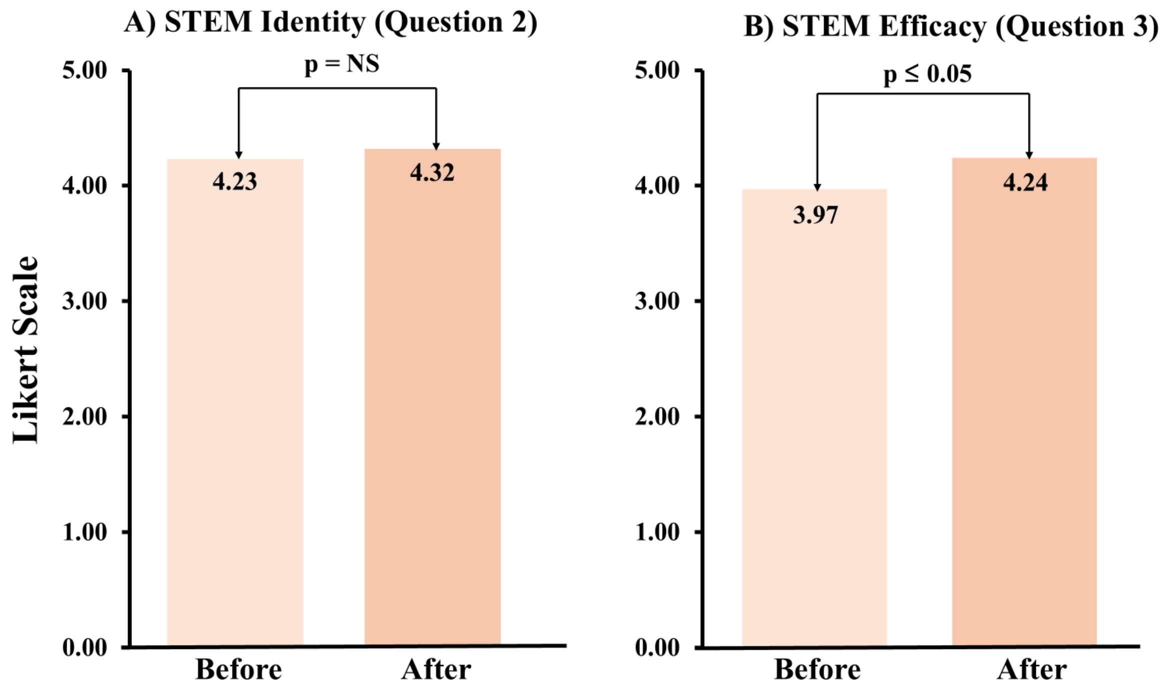

Figure 6. Respondents' STEM identity and STEM efficacy after volunteering a single time over all service lengths.

A majority of our participants (98) volunteered only once accounting for 51.9% of all responses. Figure 6 shows a significant increase (3.97 to 4.24, $p \leq 0.05$) in STEM efficacy (question 3). This shows that respondents increased in their confidence in demonstrating their STEM abilities and contribute their knowledge in STEM to the activity. No significant changes were shown for STEM identity.

IV. DISCUSSION

During this study, we tested the effects of SRSAs on volunteers in three different service lengths. We found that participation in SRSAs caused an increase in STEM efficacy regardless of service length and that the increase in STEM efficacy is proportional to the length of service provided. This agrees with our hypothesis. However, we did not find this to be true for STEM identity in our current study.

We found that short-term SRSAs did significantly increase STEM efficacy, and the participation in long-term SRSAs demonstrated a large increase in STEM efficacy. We believe that the increase in STEM efficacy observed in long-term SRSAs is due to the exposure of the participant to STEM activities over an extended period of time. No significant results were recorded for STEM identity in short-term SRSAs. We speculate that this service length is too short to have any significant impact on STEM identity. We did not find any significant changes in STEM identity for long-term SRSAs. We speculate that this lack of significant changes in STEM identity may be due to some burnout experienced by the participants in this service length, as well as pre-existing STEM identity in our participants.

Results of our medium-term SRSAs recorded significant increases in both STEM identity and STEM efficacy. We speculate that this may be the "sweet spot" for increasing both of these metrics. Additionally, it is encouraging that 99.5% of all respondents (188 out of 189) reported that they would be willing to volunteer again given the opportunity to do so. This indicates that they had a positive experience, and that participation in SRSAs has the same benefits associated with volunteerism.

The effects of recurrence of participation in SRSAs show that in both cases, participating only once, as well as participating more than once increases one's STEM efficacy. Most of our respondents (98) volunteered once. However, our results did not reveal any statistically significant changes in respondents' STEM identity. Contrary to our hypothesis, our results show a larger increase in STEM efficacy for participants who volunteer only once compared to the increase in participants who volunteer more than once. We believe that this could be due to the law of diminishing marginal utility for participants who volunteer more than once. Respondents who volunteered more than once had a higher pre-survey value on average for STEM efficacy than those who volunteered once.

Furthermore, we speculate that a sense of STEM identity could have been present in some respondents prior to participation because they were recruited from the Center of Excellence for Engineering and Computer Science at Wilbur Wright College. This program integrates students into a supportive academic environment that includes student participation in STEM activities, near-peer mentoring, near-peer tutoring, supportive faculty and staff, and social integration of students into a cohort model. These external factors positively correlate with increased STEM identity in students, and for these students to achieve high GPAs. Due to the influence of this Engineering Pathways program, our finding that 60% of respondents self-reported a GPA of 3.5 and above indicates that most participants possessed a high sense of STEM identity prior to participation. Furthermore, because more socially integrated individuals are more likely to volunteer, we speculate that our participants arrived to this study with a high pre-existing sense of STEM identity [22]. Because our participants arrived with a high sense of STEM identity, we were unable to record a significant change across most SRSAs.

V. FUTURE WORKS

Additional studies that investigate the impact of participation in short-, medium-, and long-term SRSAs are needed to further clarify our findings. Future longitudinal studies are needed to determine any relationship between participation in SRSAs and the persistence rate of students in STEM fields, particularly with respect to determining students' baseline level that corresponds to their sense of STEM identity that they come into the study with. We speculate that additional statistically significant changes in STEM identity could be observed by increasing the number of participants, as well as clarifying the question being asked (e.g. minimizing the potential for multiple interpretations).

We will continue to collect data and collaborate with additional institutions, including local and student organizations within and outside of Wilbur Wright College, to perform SRSAs and study their effects. Our current study lacks a qualitative perspective on our participants. To remedy this, we plan to conduct case study interviews. In an effort to capture the most representative picture of our participants, we will employ the Brinkerhoff Success Case method to determine which participants to interview in these case studies [23].

VI. ACKNOWLEDGEMENTS

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References

[1] J. Whittaker, B. McLennan, and J. Handmer, “A review of informal volunteerism in emergencies and disasters: Definition, opportunities and challenges,” *Int. J. Disaster Risk Reduct.*, vol. 13, pp. 358–368, Sep. 2015, doi: 10.1016/j.ijdrr.2015.07.010.

[2] C. A. Flanagan, T. Kim, J. Collura, and M. A. Kopish, “Community Service and Adolescents’ Social Capital,” *J. Res. Adolesc.*, vol. 25, no. 2, pp. 295–309, Jun. 2015, doi: 10.1111/jora.12137.

[3] A. Van Goethem, A. Van Hoof, B. Orobio De Castro, M. Van Aken, and D. Hart, “The Role of Reflection in the Effects of Community Service on Adolescent Development: A Meta-Analysis,” *Child Dev.*, vol. 85, no. 6, pp. 2114–2130, Nov. 2014, doi: 10.1111/cdev.12274.

[4] J. W. K. Yeung, Z. Zhang, and T. Y. Kim, “Volunteering and health benefits in general adults: cumulative effects and forms,” *BMC Public Health*, vol. 18, no. 1, p. 8, Dec. 2018, doi: 10.1186/s12889-017-4561-8.

[5] K. M. Fang, G. C. Lau, J. Y. Park, and P. Tchen, “Exploring Factors That Influence Student Engagement in Community-Engaged Learning Activities Within a Pharmacy Context,” *Am. J. Pharm. Educ.*, vol. 86, no. 4, p. 8637, Apr. 2022, doi: 10.5688/ajpe8637.

[6] T. C. Gilmer, “An Understanding of the Improved Grades, Retention and Graduation Rates of STEM Majors at the Academic Investment in Math and Science (AIMS) Program of Bowling Green State University (BGSU),” *J. STEM Educ. Innov. Res.*, vol. 8, no. 1, Jul. 2007, Accessed: Dec. 21, 2024. [Online]. Available: https://www.jstem.org/jstem/index.php/JSTEM/article/view/1337

[7] M. Natarajarathinam, S. Qiu, and W. Lu, “Community engagement in engineering education: A systematic literature review,” *J. Eng. Educ.*, vol. 110, no. 4, pp. 1049–1077, Oct. 2021, doi: 10.1002/jee.20424.

[8] M. R. Mason and E. Dunens, “Service-Learning as a Practical Introduction to Undergraduate Public Health: Benefits for Student Outcomes and Accreditation,” *Front. Public Health*, vol. 7, Apr. 2019, doi: 10.3389/fpubh.2019.00063.

[9] E. Schmidt *et al.*, “Increasing Student Interest and Self-Efficacy in STEM by Offering a Service-Learning Chemistry Course in New Orleans,” *J. Chem. Educ.*, vol. 97, no. 11, pp. 4008–4018, Nov. 2020, doi: 10.1021/acs.jchemed.9b01140.

[10] J. L. Newman, J. Dantzler, and A. N. Coleman, “Science in Action: How Middle School Students Are Changing Their World Through STEM Service-Learning Projects,” *Theory Pract.*, vol. 54, no. 1, pp. 47–54, Jan. 2015, doi: 10.1080/00405841.2015.977661.

[11] A. A. Farinde, B. Tempest, and L. Merriweather, “Service Learning: A Bridge to Engineering for Underrepresented Minorities,” *Int. J. Serv. Learn. Eng. Humanit. Eng. Soc. Entrep.*, pp. 475–491, Dec. 2014, doi: 10.24908/ijsle.v0i0.5579.

[12] M. Syed *et al.*, “The Role of Self-Efficacy and Identity in Mediating the Effects of STEM Support Experiences,” *Anal. Soc. Issues Public Policy*, vol. 19, no. 1, pp. 7–49, 2019, doi: 10.1111/asap.12170.

[13] S. L. Rodriguez, K. A. Hensen, and M. L. Espino, “Promoting STEM Identity Development in Community Colleges & Across the Transfer Process,” *J. Appl. Res. Community Coll.*, vol. 26, no. 2, pp. 11–22, Dec. 2019.

[14] S. Rodriguez, A. Pilcher, and N. Garcia-Tellez, “The influence of *familismo* on Latina student STEM identity development,” *J. Lat. Educ.*, vol. 20, no. 2, pp. 177–189, Apr. 2021, doi: 10.1080/15348431.2019.1588734.

[15] A. Bandura, “Self-efficacy: Toward a unifying theory of behavioral change.,” *Psychol. Rev.*, vol. 84, no. 2, pp. 191–215, 1977, doi: 10.1037/0033-295X.84.2.191.

[16] O. Oyelaran, “Improving persistence of underrepresented racial minority science majors: where to begin,” *Front. Educ.*, vol. 8, p. 1280609, Nov. 2023, doi: 10.3389/feduc.2023.1280609.

[17] N. Sellami, B. Toven-Lindsey, M. Levis-Fitzgerald, P. H. Barber, and T. Hasson, “A Unique and Scalable Model for Increasing Research Engagement, STEM Persistence, and Entry into Doctoral Programs,” *CBE—Life Sci. Educ.*, vol. 20, no. 1, p. ar11, Mar. 2021, doi: 10.1187/cbe.20-09-0224.

[18] Y. Xue and R. Larson, “STEM crisis or STEM surplus? Yes and yes,” *Mon. Labor Rev.*, May 2015, doi: 10.21916/mlr.2015.14.

[19] N. S. F. National Science Board, “Science and Engineering Indicators 2024: The State of U.S. Science and Engineering.,” National Science Foundation, Alexandria, VA, NSB-2024-3, Mar. 2024. Accessed: Nov. 05, 2024. [Online]. Available: https://ncses.nsf.gov/pubs/nsb20243

[20] A. Joshi, S. Kale, S. Chandel, and D. Pal, “Likert Scale: Explored and Explained,” *Br. J. Appl. Sci. Technol.*, vol. 7, no. 4, pp. 396–403, Jan. 2015, doi: 10.9734/BJAST/2015/14975.

[21] P. Mishra, C. M. Pandey, U. Singh, A. Keshri, and M. Sabaretnam, “Selection of Appropriate Statistical Methods for Data Analysis,” *Ann. Card. Anaesth.*, vol. 22, no. 3, pp. 297–301, 2019, doi: 10.4103/aca.ACA_248_18.

[22] J. Wilson and M. A. Musick, “Attachment to Volunteering,” *Sociol. Forum*, vol. 14, no. 2, pp. 243–272, 1999.

[23] R. O. Brinkerhoff, “The Success Case Method: A Strategic Evaluation Approach to Increasing the Value and Effect of Training,” *Adv. Dev. Hum. Resour.*, vol. 7, no. 1, pp. 86–101, Feb. 2005, doi: 10.1177/1523422304272172.

[24] S. Y. Tobar, B. M. Zalloum, A. N. Le, Y. Nicacio-Rosales, and D. J. Espiritu, “Board 53: Engagement in Practice: Strengthening Student’s STEM Identity Through Service,” presented at the 2023 ASEE Annual Conference & Exposition, Jun. 2023. Accessed: Jan. 11, 2025. [Online]. Available: https://peer.asee.org/board-53-engagement-in-practice-strengthening-student-s-stem-identity-through-service