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Combining Professional Development Activities and Service Learning/Community Service: A Scholarship-Based Project Impacting Engineering College Students

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Abstract

The authors present data on a college-level project performed with engineering undergraduate students. The project or program has community engagements, professional development activities, and general soft skill developments all as elements in the project. Students showed overwhelming support for the elements of the project and embraced the intended benefits of its elements. Student data was obtained through survey mechanisms and testimonials. This multi-year project supported findings in literature and the current knowledge base but added to it a unique combination of elements (community engagements, professional development activities, and general soft skill developments) that all homed in on improved soft skills of students (e.g., teamwork, communication with non-technical audiences, project management) and improved technical skills via open-ended community projects.

Keywords

Service-Learning, Community Engagement, Community Service, Professional Development, Soft Skills, Scholarships

1. Introduction and Background

This paper presents information on a service-learning (SL) project combined with professional development activities for engineering/computer science undergraduate students at the University of New Mexico (UNM) in Albuquerque, New Mexico, USA. UNM was awarded a five-year project from the U.S. National Science Foundation (NSF) to recruit students with unmet financial need (i.e. the differ-

ence between a student's yearly cost of attendance in college and the amount of scholarships/financial aid received including their parents' financial support) who also demonstrate academic merit to award them scholarships and engage them in career supporting activities. The project was called the NSF S-STEM (Scholarships in STEM). The academic merit was defined as a cut-off GPA of 3.00 or greater out of 4.00 point scale (i.e. 75% or higher on an average grade scale) along with positive supporting reference letters. The project was envisioned to provide the students with financial aid scholarships combined with varying professional development activities and SL towards the local community. On top of that, the participating students were divided into Learning Communities (LCs), or cohorts of interest in a specific research and educational technical area (e.g. aerospace engineering or data science). The LCs are led by faculty members from the project and engage the students, semester-over-semester, with workshops, presentations, undergraduate research work and/or internships/co-ops.

Service learning (SL) is a key component of the project. SL combines studying or education and engagement in the community. SL involves working to identify and troubleshoot difficulties faced by people in the community and is an opportunity to apply skills and education in a collaborative "real world" setting. In order to engage in SL, students or scholars either enrolled in credit hours/a course or were paid a small dollar amount as an internship. The engagement with community partners of UNM was enabled through its office of Community Engagement Center (CEC) (https://communityengagement.unm.edu/) which has a big network of community partners who reach out to CEC for different types of assistance. Our projects generally fell under the label "Peace Engineering" and in further writings below sometimes the SL or community-engagement or community-based labels are used interchangeably. Finally, it is important to understand that SL and community service (CS) are often used interchangeably in literature (Adams, 2023). However, there are some differences between them as CS is often referred to as voluntary task(s) and sometimes comes from within the legal system, whereas SL is defined as above.

The literature provides several examples of programs focusing on SL or community-based project engagement for engineering/STEM students. For example, Koh (2020), developed a senior design capstone in a small liberal arts college to address pedestrian safety in their community. Jordan (2014) did a SL project in Haiti by working with the locals there to establish a solar project that can offer sustainability for them. Schneider (2017) discussed several research and capstone projects aimed at improving efficiency and reducing operational costs at a local food bank. Frey & Atwood (2013) used a Strength of Materials course to engage students in a local middle school in hands-on activities related to concepts like buoyancy, electricity, strength of materials, and mechanics. Jordan-Bloch & Cohen (2018) used service learning to motivate girls into STEM education/careers. Che (2018) used students in a computer-aided engineering (CAE) course to construct a CAD model via ANSYS (a finite-element analysis commercial software) for an old truss bridge for traffic safety purposes. Krishnan & Nilsson (2015) en-

gaged students in community projects covering civil, mechanical, electrical, bio and the computer fields or disciplines. Ravichandran et al. (2024) presented examples of SL projects done, at a large scale for the first time in their university's history using their engineering and computer science students, and reported positive outlook by the participating students.

SL in engineering consistently shows positive effects on students' professional skills, civic attitudes, and certain affective outcomes (see literature below); however, evidence for durable technical gains and demonstrable community impact is mixed. The literature emphasizes varied assessment approaches—from self-report surveys to mixed-methods program evaluations—and calls for stronger validity, longitudinal designs, and measures of community partner outcomes.

Multiple program evaluations (notably EPICS studies and course reports) report improved teamwork, communication, project management, and design-thinking skills among engineering students engaged in SL (Immekus et al., 2005; Benning & Oakes, 2020). These are among the most robust and repeatedly observed effects across studies.

Foundational SL work (Bringle & Hatcher, 1996) and engineering reviews (Duffy et al., 2000; Bielefeldt and Pearce, 2012) document increases in students' sense of civic responsibility, ethical awareness, and motivation to apply engineering skills to societal problems. Qualitative studies highlight reflective activities as central to this shift (Choi et al., 2023).

However, as for technical learning and content mastery, evidence is mixed. Some course studies claim equivalent or modestly improved technical learning when SL is well integrated; others note tradeoffs where time spent on community coordination reduces exposure to canonical technical content (Duffy et al., 2000; Payne et al., 2023). When technical gains are reported, they are often tied to authentic, open-ended projects that demand applied problem solving.

As for personal development and attitudes, students report gains in confidence, cultural competence, and persistence in engineering majors in several studies and reviews (Mahmud and Ismail, 2024; Narong & Hallinger, 2024). However, effect sizes are often small-to-moderate and frequently based on self-report.

Lastly, as far as the community partner outcomes, relatively few studies rigorously measure community impacts. Case studies (Payne et al., 2023; EPICS program reports) point to both successes and notable failures—sustainable benefits require careful alignment of scope, long-term maintenance, and community co-design.

2. Methods and Materials

This project focuses on undergraduate engineering and computer science students as mentioned above. It started in the Spring semester of 2021 (in January 2021). The project had multiple elements: 1) scholarships for students, 2) engaging students in the community or service learning (SL) which were all done in/at non-for-profit entities, 3) providing the scholars with professional development activities, 4) opportunities for cohorting on technical areas of interest (research, education and future work interests), and 5) evaluation of project activities including

if the SL learning helped improve the communication skills of students undergoing facets of the program. The students did the SL through either credit hours (e.g. the problems course or equivalent) or through a paid internship.

The methods used in this study involve simple statistical measures such as averaging or Likert scale surveying or soliciting textual answers/replies from students on posed questions, including percentage or rate calculations. Since the study relies on self-reported data, this makes it a descriptive program evaluation.

The professional development activities covered a large range of activities: career fairs, resume critique, industry networking socials, intro to python programming, time management sessions, financial fundamentals, interview basics, MATLAB fundamentals, etc. Students were only required to attend three of these activities per semester in addition to a career fair and orientation. Thus, not all students attended all offered development activities.

Table 1 provides the number of students who have been involved in the S-STEM project/program each semester since its inception. In some years, the number of students was less than other years due to change in the staffing running the program and their aggressiveness recruiting students for the program. There were also increased scholarships given recently by the University and State of New Mexico to college students and that also reduced the interest in this particular scholarship program.

Table 1. The number of students participating in the S-STEM project/program over the semesters.

	Spring 2021	Fall 2021	Spring 2022	Fall 2022	Spring 2023	Fall 2023	Spring 2024	Fall 2024	Spring 2025
Number of Students	10	22	18	6	14	8	16	12	8

Below, the result of students' perception or likeness of the different program elements are exhibited and discussed. However, since this is a multi-year program with different cohort sizes over the year and not identical professional development activities nor identical SL projects in the community, only examples of the total collection of results are exhibited in this paper to illustrate the type of responses seen from the participants. Sometimes in a semester, not a full range of responses is obtained from all the participating students.

3. Results and Discussion

Below, results are presented, and discussed, for one component of the project/program at a time.

3.1. SL Projects

Students worked alone or together on a variety of SL projects with real-world im-

pacts. This section illustrates several community projects the students engaged in. One project involved using an infrared (IR) camera to capture images of doors and windows in a building housing a non-profit. The goal of the project was to detect areas in the building that are leaking air or needing winterization to help preserve the heat inside the building during the cold months of the year. Students took such images, for example in Figure 1 for the whole side of the building.

Figure 1. A picture of the side of a non-profit building taken using an IR camera.

The students then zoomed in on doors and windows for better seals around their perimeters. Figure 2 shows a door before applying winterization (or weather stripping) to it and after. This winterization yielded an increase in the temperature by about 10 degrees Fahrenheit.

Figure 2. Before and after images of a door that was subject to winterization for improved thermal efficiency.

Another group of students was asked by a non-for-profit organization to convert an old trailer (with wheels) to a mobile solar trailer. The solar trailer is supposed to be a trailer that can still haul things but acts also as a power source for electric or electronic devices. Figure 3 shows the students dismantling the old trailer in order to prep it for future renovation or conversion as a solar trailer.

Figure 3. A farm trailer being dismantled by students to prep it for conversion into a mobile solar trailer.

Figure 4 shows the progress made on the trailer after being fully dismantled and then reassembled and painted in preparation for solar voltaic panels installation along with electric wiring.

Figure 4. The same trailer as above after getting reassembled and painted to be ready for solar panels and wiring.

One student was involved in a project to map acequias in Albuquerque to understand their routes and a potential proposed new route. An acequia is a Spanish word with Arabic origins used historically in the USA's State of New Mexico (including the city of Albuquerque), which means an irrigation ditch or canal. A picture of a local acequia is provided in Figure 5.

Figure 5. An acequia in Albuquerque, New Mexico, USA.

The student in charge of this project used a drone (Figure 6) to map the area of the acequias from a top to investigate the possibility of adding another acequia in one area of the city. For this purpose, the student used the drone to snap images such as shown in Figure 7 to give good visuals of how the envisioned acequia will affect the current area of land and connect to existing acequias.

Figure 6. A DJI Mini 2 Drone picture from Amazon with a camera in the front.

Figure 7. A picture from the drone for an acequia in an area with a contemplated new acequia or branch.

Another student was involved in food delivery and distribution out of the Albuquerque Peace and Justice Center (a local nonprofit). This student did multitasking at the Center, i.e. was involved in different activities at the Center (e.g. website fixing), including food distribution to those who need it (see Figure 8).

Figure 8. Food boxes delivered to a not-for-profit and aided in delivery and distribution by one of the student participants in this S-STEM project.

Another student worked with a non-profit to fit their garden area with a porous tube for watering of plants as shown in Figure 9. This took a lot of planning, including finding the correct materials/supplies and tools, and execution (including the exact route of the tube and its grading).

Figure 9. The figure shows the installed porous tube and the tools used to install it for a garden watering project.

Another student created a dynamic web-based document database. A picture from this database is shown in Figure 10. The student who was a computer science

major had to learn new things about databases and how they work in reality and ended up finding the work satisfying as well as an opportunity to learn more about a different application or aspect of computers.

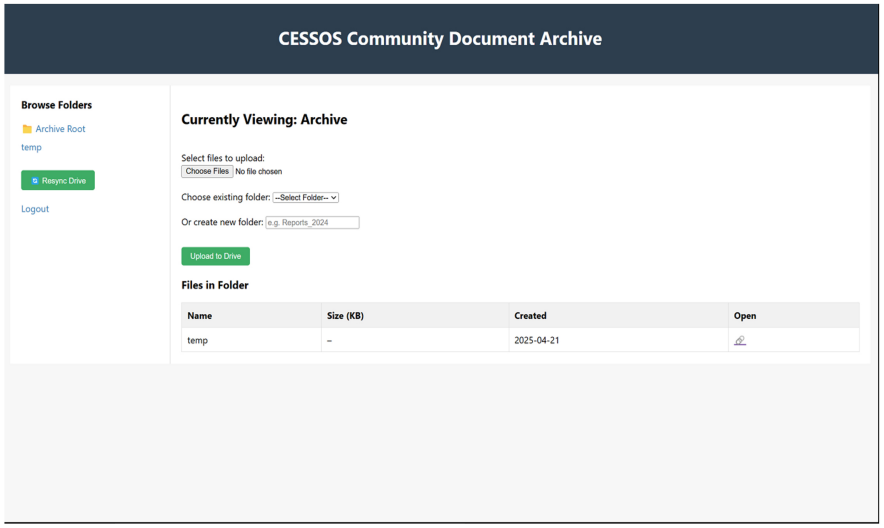

Figure 10. A web-based database development to help a non-profit with file storage and sorting needs.

3.2. Student Surveys

In addition to documenting some of the community-based SL projects students worked on, students were asked to complete a variety of surveys to gauge their feedback on program elements. For example, in Spring 2023, students participated in one of seven different community-based projects either as a problem course or as an internship. Table 2 shows the students' answers to several questions relating to their community projects. A similar table to Table 2 is given in Table 3 but for the Fall 2023 semester and without calculating percentages.

Table 2. N = 12; Due to rounding, the percentages above may not sum to exactly 100 percent. Students' survey regarding their experience with community-based projects (Spring 2023).

	Strongly Agree	Agree	Disagree	Strongly Disagree	N/A
I enjoyed working on a team with fellow S-STEM scholars.	83%	8%	0%	0%	8%
My team worked well together.	58%	25%	8%	0%	8%
The number of hours I was required to work with the community site seemed appropriate.	58%	33%	8%	0%	0%
I gained valuable experience through my participation on this project.	50%	42%	8%	0%	0%
The project I was assigned to match my interests.	17%	67%	8%	8%	0%

Continued

The project I was assigned to match my abilities.	33%	50%	8%	8%	0%
I communicated effectively with non-engineer team members.	42%	50%	0%	0%	8%
I learned from the non-engineer partners on my team.	33%	17%	33%	0%	8%
I enjoyed working with community members.	58%	42%	0%	0%	0%
The work I did as part of this project was meaningful.	50%	50%	0%	0%	0%
As a result of this experience, I want to work on more projects like this in the future.	42%	33%	17%	8%	0%
This part of the S-STEM scholars program was well organized.	42%	33%	17%	8%	0%

Table 3. N = 16; *N = 15. Students' survey regarding their experience with community-based projects (Fall 2023).

	Strongly Disagree	Disagree	Agree	Strongly Agree	N/A
I enjoyed working on a team with fellow S-STEM scholars	0	0	4	12	0
My team worked well together	0	0	5	11	0
The number of hours I was required to work with the community site seemed appropriate	0	3	8	5	0
I gained valuable experience through my participation in this project*	0	0	7	7	1
The project I was assigned to match my interests	0	4	5	7	0
The project I was assigned to match my abilities	0	1	8	7	0
I communicated effectively with non-engineer team members	0	0	8	7	1
I learned from the non-engineer partners on my team	0	0	7	7	2
I enjoyed working with community members	0	0	6	9	1
Engineering can benefit society	0	0	6	10	
The work I did as part of this project was meaningful	0	0	7	8	1
As a result of this experience, I want to work on more projects like this in the future	0	3	2	10	1
This part of the S-STEM scholars program was well organized	1	6	4	5	0

As Table 2 indicates, the majority of participants enjoyed working on a team with fellow S-STEM scholars; 91% (83% "Strongly Agree" and 8% "Agree") of the students expressed their satisfaction. One student selected "N/A". With regards to student satisfaction with teamwork, 58% of students strongly agreed and 25% agreed that their team worked well together, showing 83% of satisfaction with teamwork cumulatively. However, one student was unsatisfied with their teamwork experience, and one student selected "N/A" as their response. Furthermore, 91% (58% "Strongly Agree" and 33% "Agree") of students believed that the number of hours they were required to work with the community site seemed appropriate. One student disagreed, implying that the number of required hours to work with the community site was not suitable for them.

Nonetheless, 50% strongly agreed and 42% agreed that they obtained valuable experience through their participation in S-STEM, although one student believed that they did not gain such an experience out of participation in S-STEM. The high level of satisfaction with the S-STEM program might partly be because of the self-declared match between students' interests and abilities and the project to which they were assigned. Most (17% "Strongly Agree" and 67% "Agree"; 84% cumulatively) students (n = 10) expressed that the project they were assigned to match their interests, while only two students believed that the project they were assigned to did not match their interests. Those numbers are consistent with whether participants believe the project they were assigned to match their abilities. 83% (33% "Strongly Agree" and 50% "Agree") of participants believed that the project they were assigned to match their abilities, while the same two students had the opposite feedback.

Interacting with and learning from non-engineering community partners was an important part of the project. Interestingly, all but one of the students (n = 11) stated that they had effective communication with non-engineer team members. The one student that did not agree selected the "N/A" option for their response. More specifically, while 50% of respondents agreed with the statement, 42% showed strong agreement with the statement for which their feedback was asked. While four students believed that they did not learn significant things from non-engineer partners on their team(s), 50% did. One student responded that the question was not applicable to them, and one student failed to respond completely. All of the students (n = 12) enjoyed working with community members. More specifically, 58% (n = 7) strongly agreed that they enjoyed working with community members.

One of the goals of the S-STEM program is to build up the next generation of peace engineers by teaching them the value of engineering to communities and society. All (100%) of the students believed that their work was meaningful, with an even split between "agree" and "strongly agree". While nine students reported that they want to work on more projects like this in the future as a result of this experience, three students showed reluctance to do so. Finally, while 75% of students felt the community engagement experiences were well organized, 25% (n =

3) believed that this part of the S-STEM was not well organized.

At the end of the academic year (end of the Spring semester), a colloquium is held where all the S-STEM team members (faculty, staff and student scholars) join (with food served) to put a cap at the academic year work for the project. Specifically, it is a chance for the students to showcase the work they have been putting into community projects throughout the year or semester. Table 4 shows the responses from students after the colloquium was held at the end of the Spring 2024 semester. As can be seen in the table, the vast majority of students felt positive about the different questions in the survey. For the project organizers, such overwhelming positive feedback is always a good thing in terms of validating elements in the project.

Table 4. Students' survey regarding the colloquium held at the end of the Spring 2024 semester.

	Strongly Agree	Agree	Disagree	Strongly Disagree	N/A
This event was informative	55%	45%	0%	0%	0%
I enjoyed hearing about fellow scholar's experiences during the colloquium	64%	27%	9%	0%	0%
I enjoyed sharing my experiences with fellow S-STEM scholars	45%	36%	9%	0%	9%
Hearing about fellow scholars' future career plans was helpful for thinking about my own career plans	55%	36%	9%	0%	0%
I liked having the opportunity to share my future career plans with others	55%	36%	0%	0%	9%
I interacted with fellow students at this event	55%	45%	0%	0%	0%
The interactions I had with fellow students were enjoyable	64%	36%	0%	0%	0%
I interacted with non-students (mentors, professionals, etc.) at this event	27%	64%	0%	9%	0%
The interactions I had with non-students were enjoyable	55%	36%	0%	0%	9%

3.3. Student Testimonials

In addition to the surveys, students have provided many testimonials about the different elements of this project. Most of the testimonials were positive but there was a small percentage that showed displeasure with the execution of certain elements. Such feedback is important for the team to work on shoring up any perceived lacking in the execution of the project/program. The testimonials below are not all inclusive to cover more than four years of program execution.

- "I would like more communication so that the students can stay on top of things."
- "Just have more time to work on the project with the assigned groups."
- "It was nice to work with the community and to learn about local non-profits."
- "It was nice to do something outside of engineering"
- "[I] found that, even though there can still be improvements, overall the project has been fulfilling both as a student of engineering and as a person more generally."
- "A greater sense of engineering's role in community support. Getting to spend time with non-engineers to hear about their needs and how we could assist them was very insightful."
- "I have enjoyed partnering with people in my community to help others. It's been rewarding and encouraging."
- "It was a pleasure to give back to them and be able to help and at the same time improve my engineering skills by identifying challenges, thinking of solutions, planning, evaluating alternatives, cost estimation, choosing the best approach, and achieving goals using problem-solving skills."
- "Doing something to help the community felt more rewarding that doing something to help myself and I enjoyed that."
- "I feel that overall it was fulfilling to aid the community and their needs despite the fact that it was not a necessarily challenging task. Every year I am reminded that it is not about what we are helping with rather that we are helping and meeting needs no matter what that might be."
- "I learned how important community service is for the betterment of struggling people and that a profound impact can be made on a community with little expertise and technical know-how required."
- "The time frame for this project felt a little short, due to the availability of the community partners."
- "…Also it helped my sense of community grow because of all the lovely people I have interacted with."
- "Learning the importance of impact on the communities around us."
- "I have enjoyed getting to work with other engineering students on the service-learning project, especially when we are able to collaborate to solve problems."
- "It has been fulfilling to help the community."
- "It helped me by offering a unique community engagement experience which leverages my engineering skills. This real-world experience has helped me get more comfortable with working with others and it has added/will add to my development as an engineering student. The experience is also unique as the community engagement part of the program is a rarity when considering most engineering internships."

Overall, the students felt satisfaction from working with community projects and helping people in the community despite any difficulties in the execution of such community projects (whether it was communication with community partners, time management, lack of financial resources to get projects completed, etc.).

3.4. Professional Development

Students were offered several opportunities for professional development every semester. As mentioned above, a student is not mandated to attend all of them but are required to attend a career fair, the orientation at the beginning of the semester and three professional development sessions in a semester. Table 5 shows the responses of students in Fall 2024 to these sessions. The last line in the table shows how many students commented on the session atop the column.

Nine students attended the NSF S-STEM Fall 2024 Orientation; this session had the greatest number of attendees. Out of nine students, seven (78%) found the session to be informative and were glad they attended. Five students (56%) found the session to be useful, engaging and also provided a comprehensive understanding of the topic. Four students (44%), though, said they would have liked to have learned more.

Table 5. Student survey on professional development sessions (Fall 2024).

	NSF S-STEM Fall 2024 Orientation	Manage Your Time	Intro to Python-PART 1	Intro to Python-PART 2	Financial Fundamentals	Resume Critique/Mock Interviews	Leadership in Engineering
Session was informative	7	4	2	2	2	2	4
I'm glad I attended	7	2	1	1	2	3	6
Session was useful	5	2	2	2	4	1	4
Session was engaging	5	2	1	1	2	0	4
Session provided a comprehensive understanding of the topic	5	3	1	1	3	0	3
I would have liked to learn more about the topic	4	1	1	1	1	0	2
N	9	4	2	2	5	3	7

The session "Manage Your Time" had four participants. All four students found the session to be informative while half of the students (N = 2) found it to be useful, engaging, and were glad that they attended.

Only two students attended "Intro to Python-Part 1" and "Intro to Python-Part 2". Students rated these two sessions the same for each item. Both students found these sessions to be informative and useful while one student found it to be engaging, were glad that they attended, and said the session provided a comprehensive understanding of the topic. One student would have liked to learn more on the topic.

Five students attended "Financial Fundamentals"; this session had the third largest number of attendees. Two students (40%) found the session to be informative, engaging, and were glad that they attended. Four students (80%) found it to

be useful while three (60%) reported that the session provided a comprehensive understanding of the topic. Only one student (20%) expressed that they would have liked to learn more about this session.

Three students attended "Resume Critique/Mock Interviews". Two (67%) of these students found the session informative, while one (33%) found it to be useful. All three students were glad that they attended the session. None of the students, though, reported that the session was engaging or provided a comprehensive understanding of the topic, yet none wanted to learn more, either.

Finally, seven students attended "Leadership in Engineering", making it the second most well-attended. Out of the seven students, four (57%) agreed that the session was informative, useful, and engaging. Six students (86%) were glad that they attended while three (43%) reported that it provided a comprehensive understanding of the topic. Two students (29%) would have liked to have learned more about the topic.

Table 6 is similar to Table 5 albeit for Fall 2023 instead and not the same set of professional development events. However, this table is similar to its predecessor in the sense that students overall liked or enjoyed the sessions and learned something from them to help further their careers. The session with the lowest rating was the one involving design of presentations.

Table 6. Student survey on professional development sessions (Fall 2023).

	ACED Soft Skills Session: Persuasive Storytelling, Influencing without Authority	Graduate School Preparation & Funding	Designing & Developing Presentations	LC Speaker: NASA Ames Research Center, Manager of Robotics	Landing an Internship	Resume Critique by Professionals and Mock Interviews	Leadership in Engineering	ACED Tech Skills Session: Advanced Project Management	Financial Fundamentals
Session was informative	4	4	0	9	5	2	3	3	5
I'm glad I attended	1	4	0	7	1	3	3	1	2
Session was useful	4	5	2	7	2	3	3	2	3
Session was engaging	2	3	0	7	1	2	2	0	3
Session provided a comprehensive understanding of the topic	2	2	0	4	2	1	0	0	2
I would have liked to learn more about the topic	1	2	0	4	1	1	2	0	0
N	7	8	4	10	6	4	5	6	5

Some students also provided testimonials about the career development activities they participated in:

- "I enjoyed learning the basics on coding through Python. I also enjoyed listening to an engineer and their journey in their engineering career in leadership and their recommendations on how to improve."
- "The Financial Fundamentals was a good talk. I knew some of the topics being discussed but I also didn't know some things regarding finance. This is good to help students be aware of things regarding finance."
- "For the Leadership in Engineering I enjoyed learning from a professional in the field what goes into every aspect of leading a team and the thought process necessary for doing so successfully…"
- "I liked the workshop on time management especially starting of the semester it helped me stay organized through the semester…"
- "…the career and professional development fair was a great opportunity to meet with professionals in the field in person, get advice on my resume, and connect to them."
- "I attended the Networking Social, I liked the amount of company representatives at this event and the overall vibe was non intimidating and laid back."

There is evidence from the literature that professional development (PD) activities such as the ones reported in this paper have positive impacts on students and their careers. For example, Wilkie and Rosendale (2024) found that virtual/mock interviews increase confidence, reduce anxiety, and that video review + feedback give even larger gains. Also Olewnik et al. (2021) found, using mixed-method studies where professional engineers rated student performance on mock interviews, that student performance improved after scaffolded practice and reflective activities. McGunagle and Zizka (2020) found that an employer-perspective review, identifying recurrent skill gaps, supports the rationale for career-preparation workshops and communication-focused PD. Also Zwolak et al. (2018) demonstrated links between networking/social integration and persistence in STEM and thus provided a strong rationale for networking events and mentorship programs (similar to what was embarked on in our current paper).

3.5. Improved Communication

Engineering and computer science students are notorious for being "nerds" and not having smooth or even a lot of communication skills or soft skills in general as they tend to be more technically focused. As mentioned above, one of the elements for this project/program is to hopefully see an uptick in the communication levels or soft skills of the students as a result of working with ordinary people in the community as well as taking professional development skills that serve such purpose. Below, it is demonstrated using student testimonials and surveys that students appreciated the NSF S-STEM project for helping them communicate better and to different audiences.

As can be seen in **Table 7** and **Table 8**, almost all the students at the end of Fall

2022 thought that participation in the S-STEM project/program helped improve their communication skills (whether oral or written). The explanation for this stems from the fact that the technical-oriented student had to communicate with non-technical members of the community which is a different type of communication than they are used to at the University.

Table 7. Student participants' levels of confidence with oral communication (after or post participation in the project/program). This was data from end of 2022.

N = 11	Very confident	Confident	Somewhat confident	Not at all confident
Orally explaining concepts about the engineering project in an accessible way	8	2	1	
Asking for input with project design details	10	1		
Asking for input on the operation and maintenance of the project	10	1		
Asking for input on changes to the project	9	2		
Asking for input on the project schedule	9	2		

Table 8. Student participants' levels of confidence with written communication (after or post participation in the project/program). This was data from end of 2022.

N = 11	Very confident	Confident	Somewhat confident	Not at all confident
Explaining concepts about the engineering project in an accessible way in writing	7	4		
Asking for input with project design details in writing	8	3		
Asking for input on the operation and maintenance of the project in writing	8	3		
Asking for input on changes to the project in writing	8	2	1	
Asking for input on the project schedule in writing	7	3		

Table 9 involved surveying the students about any improvement in their oral and written skills as a result of their engagement in community projects and dealing with ordinary (i.e. non-technical) folks in our society. Most students found good or excellent effect of the projects on their communication skills, with the exception of a couple of students who did not feel such effect on them. Although

this is not hard evidence of the effect community engagement has on student's communication skills, it nonetheless provides important data in the literature to support this notion or belief that community engagement can play an important role in well-rounding an engineer or computer scientist and make them better communicators.

Table 9. A student survey of how much the community engagement projects have contributed to the strengthening of their oral or written communication skills. This was data from end of 2022.

Rating Scale	Oral Skills (N = 11)	Written Skills (N = 11)
10 = Very much	1	1
9	1	0
8	5	1
7	2	2
6	0	2
5	0	3
4	1	0
3	0	0
2	0	1
1	0	0
0 = not at all	1	1

The following are specific student testimonials talking about the importance of communication and the improvement in communication encountered by the students as part of the project:

- "Public speaking opportunities, mentoring younger scholars."
- "I developed verbal and nonverbal communications skills, tested my time management skills, executed personal courage to ask questions. I was given an opportunity to incorporate conflict management throughout the project."
- "I think this experience taught me a lot about patience and communication. You aren't always going to get what you want right away, and its ok as long as you have a plan of action."
- "Experience, improved communication skills and problem-solving skills, and exposure to real world challenges."

The observations above regarding improvements in communications with SL or community projects are consistent with those reported in the literature elsewhere. For example, a 2024 systematic review of STEM service-learning in higher education found that many STEM SL studies report improvements in students' "essential skills" including communication (oral and written), critical thinking and teamwork (Mahmud and Ismail, 2024). Another study by Vogelgesang and Astin (2000) found that, using a large comparative study analyzing national stu-

dent data, both community service and formal SL were associated with greater self-reported gains in writing skills and critical thinking after controlling for background characteristics; SL effects on writing were stronger than generic community service. A paper by Najmr et al. (2018) on a SL chemistry course (students designed and taught experiments to K-12 audiences) used analysis of student reflections and course artifacts and concluded the experience helped students develop both written protocols and oral teaching/communication skills. Lastly, across engineering and STEM programs (EPICS, cross-disciplinary K-12 outreach, biomedical engineering projects, etc.) students commonly report—and instructors commonly observe—gains in: 1) translating technical concepts for lay audiences, 2) writing clearer protocols/reports targeted at external partners, and 3) increased confidence in public presentations (Naik et al., 2020).

4. Conclusion

This work presented information about a comprehensive undergraduate project in engineering that combined scholarship support, professional development activities, community engagement projects or service learning (SL), support for academic/research interest of the student scholars and working to improve the communication skills (especially oral) of the students. This unique combination of elements in a project boded well for improvement in students' communication, their improved look at the engineering profession in society, and the camaraderie between the students. Overall, the student feedback was positive or very positive, though there were some negative ratings concerning organizational structure (see **Table 3**), mismatch of a community projects with the skill set of a student or a student not benefiting from the furnished career development activities. In addition to the positive numbers and statistics, there was a plethora of positive student testimonials. It is therefore further concluded that this combination of elements is a good recipe to recommend for overall improvement of students' soft skills and technical skills (sharpened with open-ended community projects). Future iterations of this program could incorporate partner feedback or measure community impact, thus addressing a known gap.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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