IUSE: Scaffolded Projects for the Social Good - Framework Development and Early Impact Assessment

Chad A. Williams, Stan Kurkovsky, Michael Goldweber, Nathan Sommer

1 Introduction and motivation

Computing education has increasingly recognized the value of experiential learning through real-world projects [1]. Service learning, defined as "a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities" [2], offers a significant promise for computing programs. Research shows that participation in service-learning projects strengthens students' interest in computing careers, especially among female and minority students [3],[4]. Students benefit academically through improved abilities to apply knowledge [5], [6], increased persistence [7], [8], and enhanced self-efficacy [9],[10].

Despite these benefits, service learning remains under-utilized in computing programs [11],[12]. Instructors face significant barriers when attempting to integrate community-based projects into their curricula. Partner identification proves challenging, as does vetting projects for feasibility within academic constraints. Timeline misalignment between semester-bound courses and real-world project needs creates ongoing difficulties. Additionally, managing multi-semester continuity to ensure effective knowledge transfer between student teams continuing each other's work also presents substantial challenges [13], [14].

The Scaffolded Projects for the Social Good (SPSG) framework addresses these barriers through a systematic approach built on studio-based and agile development principles. This NSF IUSE-sponsored collaboration between two institutions has developed and piloted a flexible, low adoption threshold framework that enables student teams to work on meaningful projects focused on the social good across multiple semesters. This work presents the framework's key components and reports early evidence of its effectiveness based on qualitative analysis of student survey responses from Spring 2025 at Central Connecticut State University (CCSU).

2 The SPSG framework

The SPSG framework emerged from over ten years of experience running multi-semester software engineering projects at CCSU's Software Engineering Studio, which has facilitated over 80 distinct projects engaging more than 720 students since 2014. The framework provides structure while maintaining flexibility, allowing teams to adapt to evolving requirements and different institutional contexts [14].

2.1 Core framework components

The framework organizes projects into four phases: inception, elaboration, development, and transition. During inception, instructors work with project partners to negotiate scope and assess feasibility using a standardized rubric [15]. This rubric evaluates projects across eight dimensions including alignment with course goals, student skill relevance, workload manageability, and requirements clarity. Elaboration involves team formation, working agreements, and requirements engineering. Development proceeds through iterative sprints with partner interaction. Transition prepares for delivery to the partner or handoff to the next team.

Critical to multi-semester success is the framework's emphasis on knowledge transfer practices including comprehensive documentation, deployment guides, limited initial support to successor teams, and a structured near-peer mentoring approach that helps students build confidence while developing problem-solving capabilities [16].

2.2 Multi-institutional implementation and instructional scaffolding

Rather than prescribing specific training content, SPSG provides a structural framework enabling instructors to successfully integrate service-learning projects into their existing software engineering courses. The four-phase lifecycle and agile sprint structure create natural opportunities for just-in-time instruction aligned with students' immediate project needs. For example, requirements elicitation techniques become relevant when students are actively gathering partner requirements during elaboration.

The framework's embedded reflection mechanisms serve dual purposes: supporting student metacognition and providing formative assessment opportunities. Sprint retrospectives, required at each iteration, prompt students to examine what worked, what didn't, and what to change. These structured reflections make student thinking visible to instructors, enabling targeted feedback on both technical and professional development. Similarly, the project feasibility rubric and partner negotiation process guide instructors in setting appropriate scope while teaching students about stakeholder management and constraint-based design.

At CCSU, the framework is embedded in both Software Engineering and Senior Project courses, with projects typically spanning one to four semesters. At Xavier University (XU), it has been adapted for courses in a smaller department within a liberal arts setting. This flexibility demonstrates that SPSG functions as an adaptable scaffold rather than a rigid curriculum, allowing instructors to maintain their pedagogical approaches while gaining structure for managing community-based projects.

The project has produced a comprehensive publicly available toolkit including structure guides, instructor guides, the project feasibility evaluation rubric, and code management resources. These materials support adoption by instructors at other institutions facing similar challenges.

3 Methodology

To assess early impact, we conducted a survey of students who participated in SPSG courses during Spring 2025. The survey included both Likert-scale questions and open-ended prompts designed to capture students' experiences, learning outcomes, and awareness of computing's social dimensions.

3.1 Participants and data collection

Survey responses were collected from 41 students at CCSU who completed SPSG projects during Spring 2025. While SPSG is actively implemented at both institutions, XU did not yield a sufficient number of responses for meaningful qualitative analysis. This paper therefore reports qualitative findings from CCSU only, with combined multi-institutional analysis planned for future work. Participants were enrolled in computer science courses at CCSU where SPSG projects were integrated into the curriculum. Following approved IRB protocols, students completed a pre-survey at the beginning of the semester and a post-survey at the end. The pre and post surveys included Likert-scale quantitative questions as well as questions requiring open-ended text responses. The results reported here focus on post-survey open-ended (Q9–Q16); earlier questions (Q1–Q8) captured quantitative Likert-scale data and are reserved for future mixed-methods reporting.

Q9: Based on what you have seen in the projects in this class, what do you see as the biggest opportunities for technology to create positive social change?
Q10: Describe a situation where you had to balance technical and social considerations in your work and how did you resolve that balance?
Q11: Based on what you have seen in the projects in this class, what unique challenges can arise in addressing the social impact aspects of computing projects?
Q12: How has the work in this class influenced your career goals and aspirations?
Q13: Please share briefly about any skills or abilities that you feel have developed or advanced through your participation in this program.
Q14: What would you identify as the most profound ways in which your skills, knowledge, and beliefs have changed through your participation in this program?
Q15: We are really interested in knowing more about ways that you feel you have changed as a result of your participation. Please share briefly about any things you feel you are more aware of or have more understanding about that you attribute to your participation in the program.
Q16: What would you identify as the most profound ways that your skills, knowledge, and beliefs have changed through your participation?

To minimize undue influence, a different principal investigator administered surveys, and instructors saw de-identified results only after the semester. Data were collected via Qualtrics and de-identified for privacy and longitudinal analysis. This analysis relies on student self-reported perceptions, which may be influenced by social desirability bias or self-assessment limitations. However, open-ended responses provide unique insights into students' lived experiences and metacognitive awareness.

3.2 Analysis approach

We conducted formal qualitative analysis using a codebook developed from established theoretical frameworks. Transformative Learning Theory [17], [18], [19] guided codes for fundamental shifts in worldview and professional identity. The Service Learning Reflection Framework [20], [21] structured assessment of reflection depth: descriptive (reporting), analytical (examining meaning), and articulated (synthesizing and projecting forward). ACM Socially Responsible Computing [22], Service Learning literature [23], and critical consciousness theory [24] informed codes for technology's societal impacts, community needs, complexity awareness, and positionality in design. The codebook also included codes that emerged inductively during pilot coding, capturing themes such as growth mindset awareness and team dynamics understanding.

All responses were reviewed, systematically coding 263 distinct responses using a codebook that included 35 codes organized into categories: technical skills, professional competencies (collaboration, communication, adaptability), cognitive and awareness dimensions (reflection depth, growth mindset, complexity awareness), social consciousness (social good opportunities, social balance, technology impact awareness), and transformative learning indicators. Each response could receive multiple codes when appropriate. We calculated inter-rater reliability and resolved discrepancies through discussion, maintaining detailed audit trails throughout the process to ensure transparency and reproducibility. Co-occurrence patterns were tracked to understand how different outcomes related to each other in student experiences.

4 Results

4.1 Technical and professional skill development

Technical skill development emerged as the most frequently reported outcome, appearing in 36.9% of all coded responses. Students specifically identified growth in agile methodologies, programming languages, frameworks, and software development practices. What makes this finding particularly significant is not the technical skills themselves, but how students connected them to their own learning processes. Technical skill codes co-occurred most frequently with analytical reflection (35 instances) and growth mindset awareness (28 instances). Students weren't just listing technologies they learned; they were reflecting on how they learned them and recognizing their capacity to continue learning, further developing metacognition skills. This pattern suggests the SPSG experience is developing self-directed learners rather than simply training students in specific technologies.

The data also shows strong development of collaborative and professional competencies. Collaboration skills appeared in 15.2% of responses and consistently co-occurred with both technical skills (17 instances) and communication skills (7 instances). Students experienced teamwork as integrated with their technical work rather than as a separate activity. Communication skills were evident in 11.0% of responses, particularly concentrated in questions about skills development (Q13: 31.4%) and navigating technical and social tradeoffs (Q10: 23.3%). Adaptability emerged in 8.0% of responses, with students recognizing their ability to "adjust with it, learn and apply the skills I have developed in something that is not directly related to my expertise." This adaptability, co-occurring most frequently with growth mindset awareness (38.1%), suggests that students not only recognize the need to adapt but connect it to a broader belief in their capacity to learn and grow when confronted with unfamiliar challenges.

4.2 Reflection and social awareness

The depth of student reflection represents a particularly notable outcome. Half (50.0%) of assessed responses demonstrated analytical reflection, moving beyond description to examine meaning and causal relationships, while 7.1% achieved articulated reflection that synthesized learning and projected it forward. The reflection depth varied significantly by question type: Q15, which explicitly asked students about changes in awareness and understanding, elicited 81.5% intermediate-to-advanced reflection, compared to Q10's skill-listing question which produced 42.9% purely descriptive responses. This suggests that when directly prompted to examine their own cognitive changes, students engage in sophisticated self-reflection.

Additionally, 82.4% of students identified specific opportunities for technology to create positive social change, demonstrating that the social good framing successfully helps students envision technology as a force for societal benefit. Students recognized opportunities in areas such as healthcare access, education, environmental sustainability, and community organization. This high recognition rate indicates that the framework effectively develops students' capacity to connect technical capabilities with social needs.

4.3 Areas requiring further investigation

Several areas show limited evidence of impact based on this limited sample and require additional investigation. Transformative learning, as defined by Mezirow's theory, represents fundamental shifts in worldview or professional identity that go beyond skill acquisition. We looked for evidence of disorienting moments, critical examination of beliefs, fundamental shifts in professional identity, or transformed perspectives. These deep transformational indicators appeared in only 12.4% of responses to questions about profound change, with most appearing zero or only once across the entire dataset. This contrasts with students' frequent demonstration of growth mindset awareness, recognizing their capacity to learn and develop new skills. While growth mindset represents meta-cognitive development, transformative learning represents deeper shifts in fundamental assumptions about technology, society, and professional identity. This raises questions about whether single-semester SPSG projects provide sufficient time and intensity for such deep transformation to occur.

Similarly, awareness of broader social dimensions remains limited. Codes capturing understanding of technology's societal impacts, community assets and needs, and systemic approaches to social problems were virtually absent from student responses. Students appear to interpret "social considerations" primarily as interpersonal team dynamics rather than broader societal implications (appearing in only 16.7% of Q10 responses). Finally, 6.5% of responses explicitly indicated no change, suggesting the specifics of the project may be a factor in impact or that the SPSG experience may not reach all students equally.

5 Discussion and implications

The early evidence suggests that the SPSG framework successfully develops technical competencies integrated with reflective practice and collaborative skills. The strong co-occurrence between technical skill development and both analytical reflection and growth mindset awareness indicates that the framework creates conditions for meaningful learning rather than mere skill acquisition. Students are developing meta-cognitive awareness about their learning processes, a crucial foundation for continued professional growth.

The framework effectively develops professional competencies such as collaboration, communication, and adaptability, addressing industry needs for graduates in team-based, rapidly changing environments. The authentic context of working with real community partners creates natural opportunities for developing these competencies in an integrated fashion. However, the limited evidence of transformative learning and deeper social awareness suggests areas for framework refinement. The distinction between students' strong recognition of social good opportunities (82.4%) and their limited articulation of broader social dimensions indicates a possible gap. Students can identify where technology might help, but may not deeply understand the social contexts, power dynamics, or systemic factors surrounding those opportunities. This suggests the need for more explicit instruction and reflection prompts around social dimensions beyond interpersonal team dynamics. The variation in reflection depth by question type offers important pedagogical insight. Students demonstrated deeper reflection when prompted to examine awareness and understanding changes compared to listing skills. This suggests that strategic question design, both in surveys and in ongoing course reflections, can elicit more sophisticated thinking from students.

5.1 Conclusion and next steps

The SPSG framework demonstrates early effectiveness in developing integrated technical, professional, and reflective competencies through multi-semester community-based projects. The framework successfully addresses key barriers that prevent instructors from integrating service learning into computing curricula by providing structured yet flexible approaches to partner engagement, project feasibility assessment, and multi-semester knowledge transfer.

This qualitative analysis is part of a larger mixed-methods assessment. Future work will incorporate instructor evaluations, partner assessments, and quantitative metrics to triangulate findings. We are investigating factors that moderate impact across students and whether multi-semester participation produces deeper transformative learning.

The framework and associated toolkit remain openly available to support adoption by other institutions. Our ongoing work focuses on making the framework more accessible while maintaining the rigor necessary for meaningful student outcomes and community impact.

Acknowledgements
This work was supported in part by NSF awards DUE-2315322 and DUE-2315323.

References

[1] G. Tembrevilla, A. Phillion, and M. Zeadin, "Experiential learning in engineering education: A systematic literature review," Journal of Engineering Education, vol. 113, no. 1, pp. 195–218, 2024.

[2] S. Seifer and K. Connors, Faculty Toolkit for Service-Learning in Higher Education. Learn and Serve America's National Service-Learning Clearinghouse, 2007.

[3] M. Papadimitriou, "High school students' perceptions of their internship experiences and the related impact on career choices and changes," Online Journal for Workforce Education and Development, vol. 7, no. 1, p. 8, 2014.

[4] Google, "Women who choose computer science–what really matters: The critical role of encouragement and exposure," 2014.

[5] P. K. Linos, S. Herman, and J. Lally, "A service-learning program for computer science and software engineering," in *Proceedings of the 8th annual conference on Innovation and technology in computer science education*, 2003, pp. 30–34.

[6] B. J. Rosmaita, "Making service learning accessible to computer scientists," in *Proceedings of the 38th SIGCSE technical symposium on Computer science education*, 2007, pp. 541–545.

[7] S. Dekhane, X. Xu, N. Napier, R. Barakat, C. Gunay, and K. Nagel, "Technology focused service-learning course to increase confidence and persistence in computing," *Journal of Computing Sciences in Colleges*, vol. 34, no. 2, pp. 147–153, 2018.

[8] F. D. Richard, B. Berkey, and H. M. Burk, "Motivation and orientation: Faculty perspectives on development and persistence in service learning and community engagement," *Journal of Community Engagement & Higher Education*, vol. 14, no. 1, 2022.

[9] J. Payton, T. Barnes, K. Buch, A. Rorrer, and H. Zuo, "The effects of integrating service learning into computer science: An inter-institutional longitudinal study," *Computer Science Education*, vol. 25, no. 3, pp. 311–324, 2015.

[10] R. N. Reeb, S. F. Folger, S. Langsner, C. Ryan, and J. Crouse, "Self-efficacy in service-learning community action research: Theory, research, and practice," *American journal of community psychology*, vol. 46, no. 3, pp. 459–471, 2010.

[11] R. W. Connolly, "Is there service in computing service learning?" in *Proceedings of the 43rd ACM technical symposium on Computer Science Education*, 2012, pp. 337–342.

[12] N. Abu-Mulaweh and W. Oakes, "Student learning in computing-based service-learning," in *2018 IEEE Frontiers in Education Conference (FIE)*. IEEE, 2018, pp. 1–7.

[13] D. Bargar, A. Gordon, J. Plumblee, J. Ogle, C. Dancz, and D. Vaughn, "Increasing Student Development Through Multi-Level Immersive Learning: Clemson Engineers for Developing Countries Case Study," *International Journal of Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship*, vol. 11, no. 2, pp. 55–71, Oct. 2016.

[14] S. Kurkovsky, M. Goldweber, C. A. Williams, N. Sommer, "Scaffolded projects for the social good: Broadening participation in service learning for computing curricula," in

Proceedings of the ACM Global Computing Education Conference 2025, Gaborone, Botswana, October 22–25, 2025.
[15] S. Kurkovsky, C. A. Williams, M. Goldweber, and N. Sommer, "External projects and partners: Addressing challenges and minimizing risks from the outset," in Proceedings of the 2024 Innovation and Technology in Computer Science Education, July 8–10, 2024, Milan, Italy.
[16] C. A. Williams, S. Kurkovsky, M. Goldweber, N. Sommer, "Navigating Multi-Semester Service Learning in Software Engineering: Strategies for Success," in Proceedings of the 2025 IEEE Frontiers in Education Conference, Nashville, TN, November 2–5, 2025.
[17] J. Mezirow, *Transformative Dimensions of Adult Learning*. San Francisco: Jossey-Bass, 1991.
[18] J. Mezirow, "Transformative learning: Theory to practice," New Directions for Adult and Continuing Education, vol. 1997, no. 74, pp. 5–12, 1997.
[19] J. Mezirow, "Learning to think like an adult: Core concepts of transformation theory," in Learning as Transformation: Critical Perspectives on a Theory in Progress, J. Mezirow and Associates, Eds. San Francisco: Jossey-Bass, 2000, pp. 3–33.
[20] S. L. Ash and P. H. Clayton, "The articulated learning: An approach to guided reflection and assessment," *Innovative Higher Education*, vol. 29, no. 2, pp. 137–154, 2004.
[21] P. H. Clayton and M. Ash, "Generating, deepening, and documenting learning: The power of critical reflection in applied learning," *Journal of Applied Learning in Higher Education*, vol. 1, pp. 25–48, 2009.
[22] H. J. C. Ellis, G. W. Hislop, M. Goldweber, S. A. Rebelsky, J. L. Pearce, P. Ordonez, M. Pias, and N. A. Gordon, "Computing for Social Good in Education," ACM Inroads, vol. 15, no. 4, pp. 47-57, Nov. 2024.
[23] J. Eyler and D. E. Giles Jr., Where's the Learning in Service-Learning? San Francisco: Jossey-Bass, 1999.
[24] P. Freire, Pedagogy of the Oppressed. New York: Continuum, 1970.