CISing Up Service Learning: A Systematic Review of Service Learning Experiences in Computer and Information Science

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The benefits of service learning in computer and information science (CIS) are believed to be significant, ranging from providing students with real-world experiences to retaining students to positively impacting community partners. Although there are many benefits of service learning, the CIS domain does impose unique costs for integrating service learning into the curriculum. Yet there is little systematic research to help the CIS community understand best practices for maximizing benefits while minimizing costs. Experience reports about service learning courses in CIS have appeared in the literature annually since 2000, and thus we address this gap in knowledge by conducting a systematic review and content analysis of 84 experience reports from the *The ACM Guide to Computing Literature*. We synthesize the current state of service learning in CIS as well as derive recommendations for best practices and future research directions.

CCS Concepts: • **Social and professional topics → Computer science education;**

Additional Key Words and Phrases: Service learning, experiential learning, authentic learning

ACM Reference format:
Fujiko Robledo Yamamoto, Lecia Barker, and Amy Voida. 2023. CISing Up Service Learning: A Systematic Review of Service Learning Experiences in Computer and Information Science. *ACM Trans. Comput. Educ.* 23, 3, Article 37 (September 2023), 56 pages.
https://doi.org/10.1145/3610776

1 INTRODUCTION

The benefits of service learning, a genre of experiential education meant to balance benefits of service for the community and learning for the student, have long been heralded across the post-secondary curriculum. Educators design course-based learning experiences that center around authentic, real-world problems; require communication and teamwork with stakeholders inside and outside of the classroom; and demand inquiry and critical thinking from students [86]. Student outcomes typically include increased knowledge of course content and skills, enhanced understanding of community needs, concern for the welfare of others, development of professional identity, and civic awareness [50, 51]. More specific to **Computer and Information Science (CIS)**, the **Accreditation Board for Engineering and Technology (ABET)** and the two main professional societies (ACM and IEEE Computer Society) advocate the inclusion of these "soft skill" goals in the CIS curriculum to produce a high-quality, professional, and diverse computing workforce [2, 69].

This work was funded by the National Science Foundation (award #1920851).
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1946-6226/2023/09-ART37 $15.00
https://doi.org/10.1145/3610776

In addition to the development of students' knowledge and professional skills, service learning is promoted as an evidence-based practice for retaining college students (e.g., [59]), particularly those from historically under-represented backgrounds [110].

Although there are no empirical data about the prevalence of service learning courses in CIS disciplines, experience reports about them have appeared in the literature annually since 2000. These experience reports of CIS service learning suggest that a striking diversity of learning experiences are being rolled out across the CIS curriculum, from introductory programming courses (in which students mentor high school students for an hour of code) to data science courses (in which students analyze the large datasets of community organizations) to upper-division courses (in which students design and develop information systems, websites, or software). Service learning experiences have the potential to positively impact students across the wide range of audiences and learning objectives of the CIS curriculum. Yet service learning in CIS does not come without costs to many or even all stakeholders. These costs to stakeholders may stem from common cultural assumptions that computing necessarily creates positive change [38] to community organizations often being under-resourced in technology, technical expertise, and time (e.g., [14, 74, 78, 96, 148, 150]) to challenges in scoping development projects to be finished within a term's time frame [129]. Learning from existing experiences with service learning—both benefits and costs—is an invaluable way of bootstrapping effective course design. Yet to our knowledge, there has not been any systematic review of these experience reports of service learning in CIS.

We address this gap by conducting a content analysis of experience reports of service learning in CIS to synthesize the current state of service learning in CIS as well as to derive recommendations for best practices and future research directions. We first review related research about service learning in CIS. Then, we detail our methods for constructing and analyzing the corpus of experience reports. Finally, we interleave results of our analysis with discussion of their implications—from why authors report conducting service learning to when and where service learning appears in the CIS curriculum to what forms service learning takes to whose voices are involved in CIS service learning. We conclude with reflections about influence in service learning experiences and the path from costs and benefits to mutual reciprocity in the design of CIS service learning.

2 RELATED WORK

2.1 Benefits and Costs of Service Learning in CIS

Abundant research highlights the benefits of service learning for students, from curricular academic outcomes to career development to personal and social outcomes. These outcomes are reported in several meta-analyses that are not specific to the fields of computing: the review by Eyler [50] of 136 studies from 1993 to 2000 highlights how service learning stands to be beneficial to the institution and student but often to the detriment of the instructor, particularly due to lack of resources; the review by Yorio and Ye [156] of 57 studies from 1993 to 2010 found that service learning has a positive effect on students' understanding of social issues, personal insight, and cognitive development; and the meta-analysis by Celio et al. [30] of 62 studies zeroed in on recommended service learning practices that improve student outcomes, such as having explicit goals that link to the curriculum, involving the community partner throughout the project, and encouraging reflection through either individual or group activities [30].

Service learning is promoted in CIS for benefiting a range of goals. CIS educators often select service learning projects to attract and retain students in their majors, especially women and students who are members of minoritized groups (e.g., [7, 110, 114, 118]). Another goal of service learning in CIS is the development of professional skills, preparing students for the workforce through real-world experience (e.g., [39]). Integrating these goals into curriculum helps departments meet the demands of ABET accreditation and maintain curricular currency with ACM/IEEE guidelines [2, 69]. For example, the ACM/IEEE *Computing Curricula 2013* strongly recommends that departments require all students to experience between 11 and 16 required hours in the "Social Issues and Professional Practice" knowledge area, preferably in an authentic context, to avoid reinforcing the belief that technical work is free from social, ethical, and professional concerns [69]. Researchers have found that students who have participated in service learning have better knowledge acquisition compared to their peers who did not participate in service learning [16].

The preponderance of literature about service learning in the CIS curriculum is through *experience reports*, which offer an overview of course design and lessons learned from the perspective of the faculty member who taught the course, based typically on a single iteration of the course. A few of the experience reports provide additional data about the student experience collected via student surveys, reflection assignments, or course evaluations, which mostly reflect a positive experience in terms of skill development and experiences with the community partner [13, 24, 32, 108, 121, 152]. Far fewer of these experience reports provide data about the community experience, although some infer that they have benefited from service learning based on the number of partners who continued to engage with the course over multiple semesters [23, 38, 40, 67, 115]. Service learning is also believed to benefit the instructor and the institution by forging strong connections with the local community [37]. However, little evidence of rigorous evaluation of CIS service learning experiences is offered (exceptions include several works [41, 99, 104, 106]) to provide a strong empirical basis for understanding the benefits of CIS service learning for either students, instructors, or community partners.

CIS educators often select service learning projects with the goal of attracting and retaining students in their majors, especially members of historically minoritized groups (e.g., [7, 110, 114, 119]). Students who desire to positively impact society are less likely to pursue a STEM degree program, and many believe that pursuing a technology-related career is at odds with their pro-social goals [19, 45]. Research in CIS suggests that when curriculum is personally meaningful, students are more likely to be attracted to and remain in a degree program, and that pro-social goals are more important to first generation students and to women [8, 54, 73, 90, 131]. Although men and women have similar pre-college preparation, men are more likely than women to choose college degree programs for their money-making potential [48, 66, 127, 154]. Thus, incorporating service learning projects may demonstrate to students that they can make an impact with their degree, which may function both to attract students with pro-social goals and retain them.

Despite the benefits of service learning, such educational experiences also come with costs to many of the stakeholders involved [28, 72, 134, 140], particularly community partners: software and hardware can be costly; partners must oversee students' access to facilities, may not have time to discuss requirements or evaluate prototypes, and may lack resources for maintenance or updates; and students may neglect proper documentation [38, 129, 134]. The frequent lack of technical expertise of community partners may result in a knowledge asymmetry favoring the opinions of CIS stakeholders [38, 129]. Community partners may have scarce resources for providing a liaison who can interact with students to ensure that the nature or scale of the project is appropriate. In addition, scoping projects appropriately to be finished within a term's time frame can be especially difficult, resulting in what Rosmaita [129] calls the "non-delivery problem." In the partner's view, "a failed project is clearly of no use . . . it removes the 'service' from 'service learning"' ([129], p. 542). Even when students are able to deliver a product, students are not obligated to help with ongoing maintenance after the conclusion of the course. More generally, computing fields may be overly committed to the idea that computing technologies necessarily create positive change for community partners [38]. Harmon et al. [60], for example, argue that technology rhetoric can shame community organizations into believing that they need more technology, although it may not be an appropriate solution.

On top of cultural beliefs, the demands of ABET accreditation may pressure educators and departments to privilege the professional development of students over benefits to community partners and over the potential cost to educators in terms of workload and time spent in cultivating relationships with community partners. Like the general service learning scholarship, it is likely that CIS service learning projects focus disproportionately on student outcomes. As Connolly [38] argues, "It is typically assumed in published accounts on computing service learning that by providing free labor for a non-profit organization, service learning projects are by definition of benefit to the recipients" (p. 337). Relatedly, instead of considering community partners as equals, some students perceive their work as charity or develop a condescending attitude toward the community partners [74, 101]. These perceptions not only have the potential to harm community partners but also cost students the opportunity to cultivate responsible civic selves [51]. As previous research has demonstrated, there are many potential benefits of service learning, but these need to be balanced with possible harms. The experience reports in the CIS literature offer insight from individual courses into how instructors have worked to elevate the benefits of service learning while reducing the harms.

A wide range of articles characterize service learning experiences in CIS; however, there is a need to more systematically understand the benefits and costs of service learning within CIS, especially in an attempt to ensure more equitable benefits for stakeholders. A systematic, integrative review of the literature will help the Computer Science (CS) education community understand how service learning is conceptualized and enacted within the discipline [112]. In this article, we present a comprehensive characterization of the current use and experience of service learning in CIS through a systematic literature review of service learning experience reports. Our guiding research questions include the following:

- What are the articulated motivations for engaging in service learning?
- What are the characteristics of service learning courses in CIS, such as types of students, subject areas, instructor characteristics, and types of community partners?
- What types of projects are described as part of the service learning experience? How are these assessed in terms of student outcomes and fulfilling community partner expectations and needs?
- What are recommended best practices based on authors' experiences in conducting service learning courses?

3 RESEARCH METHODS

We conducted a systematic literature review as outlined by Petticrew and Roberts [112]: (1) identified a set of guiding research questions, (2) determined search criteria to construct the corpus of articles, (3) identified articles that met the search criteria, (4) screened the identified articles based on inclusion criteria, and (5) critically appraised the articles and synthesized the findings.

We used keywords to build our corpus but also approached the literature with a broad and inclusive view of service learning. We did not exclude studies on the basis of quality, approach, strict definitions, or dates. For example, if an author described a course as service learning, even if it did not fit an empirical definition of service learning, we included it in our corpus. Our goal was to build a comprehensive corpus of the state of service learning in CIS as described by the authors of these experience reports. The result of our search was a corpus of 84 peer-reviewed publications that report on one or more service learning experiences in CIS in higher education.

3.1 Constructing the Corpus

We began compiling our corpus of texts by searching the ACM Digital Library for the keywords "service learning," "community-engaged learning," and "community engagement." We selected these keywords based on the keywords used in related research on service learning. We explored the possibility of additionally using the keywords "experiential learning" and "project-based learning," but exploratory searches using these keywords resulted in texts about courses that only rarely involved a community partner, which was an important component of our focus; as a result, we restricted our search to the three more targeted keywords listed previously. In our initial search of the ACM Digital Library, the keywords "community-engaged learning" and "community engagement" did not yield any articles for inclusion in the corpus that were not already found under the "service learning" keyword. We therefore limited our subsequent searches to the keyword "service learning."

To capture a broader sample of publications across all computing venues, we expanded the scope of our search beyond the Digital Library's default setting to the *The ACM Guide to Computing Literature* (an approach also taken in other works [15, 46]). This expanded search ensured that we surveyed the "most comprehensive bibliographic database focused exclusively on the field of computing," including all ACM proceedings as well as other proceedings such as Frontiers in Education, the International Computer Science Education Research Conference, and other venues related to computing and education. We did not use additional databases such as IEEE Xplore to build our corpus because we wanted to constrain our search to CIS-related courses rather than including more engineering-oriented courses.

We constructed our corpus in 2020 and included publications through the end of 2019. At this time, the keyword "service learning" resulted in a total of 325 articles in *The ACM Guide to Computing Literature.* The first author screened these abstracts using the following inclusion/exclusion heuristics:

(1) The article has been published in a peer-reviewed venue (i.e., not a panel, workshop, poster, or extended abstract).
(2) The article discusses a service learning experience from a first-person point of view that
  (a) Has a learning objective related to CIS
  (b) Is delivered in an institution of higher education (college/university level)
  (c) Was offered for credit.

Only 188 of these articles met our inclusion criteria based on a screening of the abstracts. These 188 articles were then further screened by a full text read of the article by the first author. Any unclear cases were resolved by discussing with other authors. Using the same inclusion/exclusion criteria noted earlier, this screening resulted in an additional 91 articles being excluded. Our final corpus consisted of 84 articles (see Appendix A for a complete list of all articles in the corpus). We tracked all articles through all phases of the screening process in a spreadsheet, noting the title, abstract, inclusion/exclusion decision, and (if relevant) the reason for exclusion.

3.2 Developing a Coding Scheme

To develop our coding scheme, we drew salient features from the research literature on service learning and utilized the research questions stated previously to identify high-level categories of interest: publication information (including venue, date published), instructor information (including gender, department, and type of university), motivations for employing service learning, class characteristics (including subject, types of students, and other related information), information about community partners, information about the course itself (including type of project, assessment process, and outcomes), and reported lessons learned.

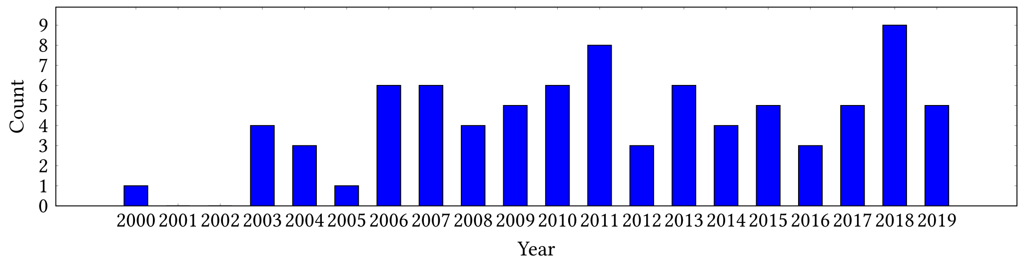

Fig. 1. CIS service learning experience reports.

The research team developed a coding scheme by randomly sampling and open coding 20 articles. All authors worked together beforehand to identify the high-level categories of interest listed earlier. The first author then conducted open coding on those 20 articles to confirm whether or not data relevant to each category was prevalent enough across the corpus to warrant coding as well as to inform the granularity with which we would reliably be able to code data. All authors then worked with the open coding from the 20-article sample to determine (a) which categories had a constrained enough set of repeated options to warrant specific codes for the categories and what those specific codes should be, and (b) which categories lacked the consistency of codes and would necessitate open coding across the full corpus.

To code the full corpus, the first author created a Google form with questions for each of the coding categories. Coding categories with a fixed list of specific codes were entered via multiple choice questions (e.g., class characteristics: undergraduate course, graduate course, mixed, something else, or not mentioned). For coding categories with open-ended response possibilities, we pasted the relevant text into a text field for subsequent analysis. For example, for motivations for employing service learning, the first author copied and pasted text that spoke to the authors' motivation for conducting service learning and then inductively coded this information into categories (civic outcomes, development of soft skills, etc). For nearly all categories, we also included "not reported" as a code since there is a lack of uniformity with the information provided by the reports and a "what else" category to capture any unanticipated codes. The research team met weekly to discuss articles or categories in which there was any uncertainty about a code. More specific details about our coding process are described, as relevant, in the related results sections.

3.3 Data Analysis

Once all of the articles were coded, data were downloaded to a spreadsheet for analysis. For categories with multiple choice codes, we counted instances of each code in a category. For open-ended responses, we inductively and iteratively coded the data until we developed coding schemes for each of the categories. For these open-ended response categories, the analytic process is described in more detail in each relevant results section.

4 OVERVIEW OF THE CORPUS

The first article in the corpus was published in 2000. Since then, there has been a relatively steady production of service learning experience reports (M = 4.42 per year, SD = 2.29) with no significant trends over time (Figure 1).

The majority of articles related to service learning have been published in *Proceedings of the ACM Technical Symposium on Computer Science Education* (SIGCSE, N=27) and *Journal of Computing Sciences in Colleges* (JCSC, N=13). Other venues containing more than two publications in the corpus included the *Information Technology Education Conference* (SIGITE, N=6), *Journal of*

Computing Sciences in Colleges (JCSC, N=5), *Southeast Regional Conference* (SE, N=3), *Transactions on Computing Education* (TOCE, N=3), and *International Conference on Design of Communication* (SIGDOC, N=3). The remaining publications are distributed across venues that only included one or two instances of a service learning publication (N=16).

These experience reports were predominantly written from first-person accounts of the instructor (N=82) and were descriptive in nature, although there was a lack of uniformity among the information included and the amount of detail offered by the experience reports. In the following sections, we organize our results by describing *why* authors decided to conduct service learning, *where* and *when* these experiences are happening, *what* forms these experiences took, and *who* participates in service learning experiences in CIS.

5 *WHY* SERVICE LEARNING IN CIS?

In the following, we first provide information related to the objectives and motivations for engaging in service learning and then offer a discussion and implications for this subset of the results.

5.1 Objectives and Motivations for Implementing Service Learning

For half of the service learning experience reports (N=42), the authors provided an explicit explanation as to why they decided to implement service learning. We derived the objectives by searching for explicit definitions of service learning and extracting themes from these definitions. For the motivations, we coded reasons provided as to why authors decided to implement service learning. We identified four objectives of service learning:

(1) Enhancing the student's learning experience by providing hands-on experiences that integrate course learning goals with real-life experiences (N=38);
(2) Helping with community needs (N=31), in which 13 papers referred to this type of service to the community as "community service";
(3) Developing students' civic responsibility and engagement (N=8); and
(4) Building a mutually beneficial relationship with the community partner, where the community partner and students' needs are both weighed equally through the service learning course (N=8).

In an experience report about a web publishing class with a service learning project that involved creating websites for local nonprofits, Chaytor [32] offered a definition that encompasses all four of the components of service learning noted previously:

> *Service Learning is a form of experiential education in which students engage in activities that address human and community needs together with structured opportunities intentionally designed to promote students learning and development. Reflection and reciprocity are key concepts of service learning.*

The first two objectives, providing real life experiences and helping with community needs, are mentioned frequently throughout our corpus. Although frequently emphasized in the CIS service learning literature (e.g., [10, 30, 33, 74, 113]), the objectives of increasing civic responsibility and engagement and building mutually beneficial relationships with community partners were seldom mentioned in our corpus.

Our thematic analysis also identified seven motivations for engaging in service learning. Authors typically mentioned more than one of the following: service learning can provide holistic learning experiences that help students develop real-world skills (N=53); it can help the community by fulfilling a need (N=30); it can develop and strengthen student soft skills such as presentation, communication, and teamwork skills (N=27); it can increase representation and diversity in

STEM-related fields (N=23); it can help retain students in STEM fields (N=12); it is resonant with the university's mission (N=9); and it helps fulfill the ABET [2] accreditation requirements (N=6).

Liu and DeBello [85] offer one of the more multifaceted rationales for engaging in this pedagogy:

> *AS-L [Academic Service Learning] has been identified to facilitate developing meaningful connections between students, faculty, and community that will result in retention. Gallini and Moely reported that AS-L enhances students' engagement with their studies, the university and community, and the likelihood of their continuing studies at the university (retention) while they persist until successfully completing their degree. Students who participate in service-learning tend to engage with the community outside of the university and have a better understanding of community problems, and work better with people of diverse backgrounds. Faculty who use service learning have reported the new aura it creates in their learning environments as it enhances traditional learning techniques by increasing student interest and engagement in the course content while teaching new problem solving skills, and making the teaching and learning experience more enjoyable for both faculty and student.* (p. 3)

A few authors mentioned motivations for engaging in service learning that addressed specific barriers and/or educational needs. For example, Al-Khalifa [4] integrated a service learning option (i.e., not all students had to complete it) for a female-only Information Technology (IT) program in Saudi Arabia. Due to gender segregation, female students often have few or no opportunities to collaborate with male students. This service learning opportunity enabled female students to interact with male clients to address this barrier. Both the students and community partners stated that they had a positive experience.

5.2 Discussion

The authors of service learning experience reports emphasize the importance of hands-on experience and helping the community. The authors typically focused on characterizing how the course was designed to support the hands-on experience of students; however, they often do not describe the short- and long-term impact of these projects on the community. Although some of the reports discussed the importance of building relationships and mutual goals with community partners, there was a lack of explicit description of how service learning projects benefited all stakeholders. Given the literature suggesting that more so than other fields CIS service learning might create significant costs for community partners (e.g., [38, 101]), the omission of details in these experience reports about the short- and long-term impacts of CIS service learning on community partners demands more scholarly attention. These omissions may be a form of publication bias, in which authors presume that the CIS reviewers and audiences for which they are writing are likely to care less about community impact than student impact and thus under-report benefits to their community partners. Alternately, or in addition, faculty might be prioritizing student outcomes over community partner outcomes (e.g., see [51, 101, 129, 135]); if so, it may inhibit the goal of cultivating socially responsible selves who actively care for others [51].

Learning objectives in the more general service learning scholarship also emphasize the development of students' civic engagement [129]. A significant body of scholarship has shown that service learning can develop social awareness, a desire to make an impact on the community or society, civic skills, and appreciation of diversity [62]. Yet only a few of the articles in the corpus highlighted civic engagement as an important outcome of their course (e.g., [4, 20, 42, 87]). Dark [42], for example, designed an information security management course in which students developed a comprehensive information security risk assessment for a community partner. The course objectives included increasing students' civic responsibility, addressed through assignments in which

Table 1. Distribution of Institutions Represented in the Corpus

	Public	Private	Public-Private	Total
Research Universities	42 (1 minority serving)	14 (4 religious)	1	57
Undergraduate-Only Institutions	3	9 (3 religious; 2 minority serving)	0	12
Technical Colleges	0	2	0	2
Total	45	25	1	71

information systems technology students worked together with educational technology students to research and understand the impact of pertinent standards and regulations, as well as the legal and public relations implications of privacy and security issues.

6 *WHERE* AND *WHEN* IS SERVICE LEARNING IN CIS?

In the following section, we characterize and reflect on *where* the service learning experiences are occurring (i.e., what type of university and what department) and *when*, or the length of the service learning experience (i.e., a summer-long class, a semester, a quarter, a week).

6.1 Universities and Departments Offering Service Learning Experiences

For all of the publications in the corpus, we coded the types of universities at which the first authors worked at the time of publication. We assume that these universities are likely the sites for the service learning experiences being reported, but this information was not specified in the articles we reviewed. Table 1 shows the institution types of instructors in the corpus: the first authors worked at 45 public, 25 private, and 1 public-private university. Of all institutions, 57 were research universities, 12 were undergraduate-only institutions, and2 were technical colleges. Seven first authors also worked at religiously affiliated institutions and three at minority-serving institutions.

Most of the first authors worked at U.S. institutions (N=51). Other first authors worked at universities in Spain (N=2), as well as Canada, Chile, Denmark, India, Japan, Philippines, Saudi Arabia, and Taiwan (N=1 for each remaining country).

Most of the service learning experiences described in the corpus were taught by faculty housed in departments of CIS, including CS (N=70), IT (N=9), and information science (N=1). Although all courses focused on CIS-related learning objectives by virtue of our inclusion criteria, some courses were taught by faculty from other departments, including English (N=2; technical writing), mechanical engineering (N=1; robotics to a class for both CS and ME students), and business (N=1; technology assistance for senior citizens).

6.2 External Resources for Projects

Some of the articles mentioned resources that were available to different stakeholders to provide assistance or support for the service learning experience (N=41). Examples of these resources included university service learning offices (N=18), mentors available for students (N=3), equipment (i.e., laptops, computers, software; N=4), funding sources such as government grants or grants from the university service learning office (N=9), or being part of the STARS Computing Corps, an NSF-funded program for broadening participation in computing, or Purdue University's EPICS service learning program (N=4). For example, Brinkman and Diekman [19] reported that their service learning course was part of a scholarship program that offered tuition benefits for minoritized students, to help increase the diversity of students in their CS program.

6.3 When Service Learning Experiences Appear in the Curriculum

Most of the service learning experiences in the corpus were offered at the undergraduate level (N=65), with 8 specifically designated at the lower-division level, 24 designated at the upper-division level, and the remaining 34 unspecified undergraduate courses. Some of the courses were cross listed for both graduate and undergraduate students (N=12), two courses were exclusively offered for graduate students, and one was exclusive for non-degree-seeking students (i.e., students who had completed undergraduate degrees and were planning to enroll in graduate school). Four of the articles did not mention when or at what level the course appeared in the curriculum.

6.4 Duration of Service Learning Experiences

Most of the service learning courses described being taught in one term (i.e., one semester or quarter; N=65). The rest of the classes spanned either more than one term (N=7), less than a term (i.e., a summer term, a spring break, or a couple of weeks; N=6), or their duration was not mentioned (N=6). Some of the more unique configurations included the service learning course of Burns et al. [24] that spanned multiple semesters with different students each semester. The authors argued that this configuration is more representative of real-world software engineering projects and that the solutions created would be more impactful since the work was not constrained to one semester. Gestwicki [56] took another unique "studio" approach, allowing students to choose different levels of commitment to the service learning project via variable credit enrollment. Al-Khalifa [4] included an optional service learning project in lieu of the final exam, whereas Hsin and Ganzen [64] offered a CIS service learning alternative spring break for extra credit.

6.5 Discussion

Most (89%) service learning experiences were authored by faculty from U.S. institutions. We assume that this is a significant form of publication bias within the specific journals and publication venues in our corpus and possibly a more general form of publication bias within service learning literature. We would love to see research explore how cultural values outside of the United States shape a broader diversity of service learning experiences for students. In addition, 80% of service learning experiences reported in this corpus occurred in Ph.D.-granting universities. Although the proportions of Ph.D.-granting to non-Ph.D.-granting institutions are likely to be different in different countries, in the United States, for example, only 11% of colleges and universities are Ph.D. granting, whereas 72% of the U.S. subset of the corpus were authored by instructors from Ph.D.-granting universities. There could be various explanations for this trend—for example, Ph.D.-granting universities could have more resources and better infrastructure for supporting service learning (e.g., community engagement offices or other university-wide resources). Such resources can be integral for the design and implementation of service learning classes [63]. Additionally, faculty, especially tenure-track faculty who work at Ph.D.-granting universities, may be more incentivized to publish due to how they are evaluated in their jobs. Finally, we were surprised by the relative paucity of experience reports from either religiously affiliated or minority-serving institutions, as these types of institutions often have explicit commitments to social good [68]. Only 5% of the reports in the corpus were authored by faculty from institutions with social good missions, whereas they make up 10% of institutions of higher education in the United States. In general, to diversify the current literature, more research needs to be conducted to understand the prevalence and nature of CIS service learning in institutions outside of the United States, in non-Ph.D.-granting institutions, and in religiously affiliated and minority-serving institutions.

Service learning experiences are reported as being designed and delivered at different levels of the curriculum. Although many reports did not offer specific details about whether they were targeted at the upper- or lower-division level, those that did report emphasized service learning experiences at the very beginning and end of the undergraduate curriculum. It is unclear whether students have fewer service learning opportunities in the middle of their degree program or if these are under-reported in experience reports. As experiences that are socially meaningful and often relevant for reaching a variety of personal goals, service learning courses can help retain students [7, 110, 114, 118]. However, offering service learning only at the beginning of a curricular program may unintentionally function as a "bait and switch" approach, giving students a personally meaningful experience to get them in the door, but not continuing to satisfy their social justice needs or nourish their sense of civic duty through formal learning experiences. Contrastingly, having to wait until the end of a program to participate in service learning opportunities may result in students not enrolling or in attrition to programs where those interests can be better satisfied.

Some of the experience reports in the corpus reported on courses in which students from all levels of seniority were invited to participate (e.g., [70, 75, 88]). These courses employed ladder mentoring, pairing lower-division students with upper-division students so that they could help each other develop communication and technical skills. For example, Kafai et al. [70] used a cascading mentorship program in their service learning course, where undergraduates reported that this technique helped them develop "life skills" such as the ability to "think on one's feet, adapting as needed, setting clear and realistic boundaries, and using small-talk as a way to get to know others and develop a relationship" (p. 103). More research exploring the potential value of multi-level service learning experiences would be valuable.

7 WHAT IS SERVICE LEARNING IN CIS?

Using the knowledge areas published by ACM's Joint Task Force on Computing Curricula and the IEEE Computer Society [69], we characterize the primary knowledge areas that were supported by the service learning experiences in the corpus. We then categorize the different projects presented into three types: development, outreach, and (socio)technical support. Finally, we discuss gaps and opportunities for what service learning could be in CIS.

7.1 Knowledge Areas of Courses Incorporating Service Learning Experiences

We coded each service learning experience based on the primary knowledge area that could be inferred based on the title of the course and, if offered, the type(s) of project(s) described, using the 18 knowledge areas published by ACM's Joint Task Force on Computing Curricula and the IEEE Computer Society [69]. In four instances, papers reported on projects undertaken by more than one course or supporting projects so diverse that we coded the same paper under more than one primary knowledge area. Most of the courses' primary knowledge areas were related to *software engineering* (N=29), with a subset serving as capstone experiences (N=4). Thirteen of the classes focused on *software development fundamentals* (e.g., introductory programming). Sixteen classes focused on *platform-based development*, including robotics, web development, and game design. Seven classes predominantly focused on *social issues and professional practice*, although nearly all papers in the corpus noted the inclusion of learning objectives related to this knowledge area. The remainder of the courses focused on *information management* (i.e., databases; N=7), *Human-Computer Interaction (HCI)* (N=6), *information assurance and security* (N=3), *graphics and visualization* (N=2), *systems fundamentals* (N=1), and *operating systems* (N=1). Because the service learning experiences characterized across the corpus extended beyond CS courses, we also coded four papers as reporting on *IT* projects (N=4), in which students provided technical support (e.g., helping clients with software upgrades).

7.2 Types of Projects and Outcomes for Service Learning

We identified three types of projects that characterized the diversity of genres of service learning experiences in CIS: development, outreach, and (socio)technical support projects (Table 2). To derive the project types, we inductively and iteratively coded each of the project descriptions and assessment methods identified in the corpus. In the following, we describe each project type, offer an exemplar of a course that supported each project type, and characterize the lessons learned as reported by the authors (Table 5). Eighty-one of the experience reports described projects that fit into a single category; three of the papers described projects that consisted of a combination of categories to better fit the needs of the community partner. We also characterize the distribution of these project types among required and elective courses (Table 3) as well as the seniority level of the students (Table 4).

7.2.1 Development Projects. The majority of projects reported in the corpus (N=49) focused on the development of software for the community partner. In all cases, students were required to produce a prototype or working code that was assessed primarily by the instructor of the course (N=49). Most software development projects were part of a required class (see Table 3) for upper-division students (see Table 4). Examples of software development include designing a guided tour using a mobile app, developing databases to help the community partner track scheduling or inventory information, designing websites, or developing educational games. Software development projects were most commonly assessed by evaluating the tangible artifact that was produced, through presentations, reflection essays, written reports, and/or peer evaluations. Only five of these projects reported using feedback from community partners to evaluate the students' performance. For the majority of these projects, the community partner's experience was not assessed (N=38), and for those that were, informal feedback was the most common assessment method reported (N=8). Compared to the other categories described in the following, the scope of development projects tended to be larger and sometimes distributed over multiple terms, with handoffs to different student teams working on different aspects of the project.

Exemplar Course Supporting Development Projects. Reiser and Bruce [124] designed a year-long service learning experience that was distributed across three different CS courses based on HCI, database management systems, and systems integration. Students in each of the classes were required to use their specific areas of expertise to develop a mobile guided tour of a local arboretum's exhibition garden. The instructors worked closely with the exhibition garden's curator to develop course objectives and design specifications for the project, which included a need for the students to understand the physical constraints of the arboretum.

Each course was responsible for a different aspect of the project. The database students were responsible for the content of the tour (e.g., plant data, exhibit data, and architectural data). The HCI students conducted user testing at the arboretum and at a local public elementary school to communicate to the systems integration and database students about how people were interacting with the technology that was being designed. In response, the systems integration and database students iterated on their designs to ensure that they would be easy to use for community members. In addition to learning objectives specific to their courses, all three classes had learning objectives of improving students' communication and project management skills.

Lessons Learned in Supporting Development Projects. Of the 49 articles that focused on development projects, 24 of them provided recommendations or lessons learned. Half of the authors of these works mentioned the importance of relationship building among all stakeholders (n=12). More tactically, the authors emphasized the importance of regular communication, especially as it relates to building trust with the community partner [6, 107]. For example, Bloomfield et al. [13]

Table 2. Description of Project Types

Project Type and Related Citations	Description	Student Assessment	Community Partner Assessment
Development **(N=49)** [4, 5, 9, 11, 13, 17, 21, 22, 24, 25, 29, 32, 36, 43, 49, 57, 71, 80, 84, 85, 88, 89, 92, 102–105, 107–109, 116, 120–122, 124, 128–130, 134, 136, 139, 141–144, 146, 151–153]	Unspecified software development (N=5) Information system development (N=10) Data development (N=8) Database development (N=8) Website development (N=5) Educational game development (N=5) Mobile app development (N=4) Web-based system (N=3) Development of open source projects (N=1)	Prototype and/or working system (N=19) Presentation (N=16) Reflection essay (N=13) Report (N=10) Peer evaluation (N=9) Student survey (N=8) Community partner feedback (N=5) Exam (N=4) Participation (N=2) Interview (N=2) Not mentioned (N=14)	Informal feedback (N=8) Survey (N=1) Interview (N=1) Not mentioned (N=39)
Outreach **(N=20)** [3, 19, 23, 31, 35, 41, 44, 47, 64, 67, 70, 75, 94, 106, 111, 113, 115, 125, 145, 155]	Programming workshops (N=6) Robotics workshops (N=5) Teaching basic computing skills (N=5) Mentoring programs (N=3) Co-design workshops (N=1)	Reflection essay (N=8) Event attendance (N=6) Student survey (N=6) Report (N=5) Participation (N=4) Informal feedback (N=3) Not mentioned (N=4)	Survey (N=4) Interview (N=3) Informal feedback (N=1) Not mentioned (N=12)
(Socio)technical support **(N=12)** [20, 34, 42, 52, 55, 77, 82, 83, 93, 100, 117, 138]	Provide IT support for hardware and software issues (N=5) Audit current systems to check for security weaknesses (N=2) Consulting for community partner (N=2) Develop security reports (N=1) Develop a full-service manual for a product (N=1) Creating visual representation of social justice issues (N=1)	Report (N=6) Project completion (N=6) Reflection essays (N=4) Participation (N=3) Community partner feedback (N=2) Not mentioned (N=1)	Informal feedback (N=3) Interview (N=1) Survey (N=1) Not mentioned (N=7)

Table 3. Required Versus Elective Course Based on Project Type

	Development	Outreach	Support	Total
Required Class	19	1	2	22
Elective	5	9	1	15
Not Mentioned	25	10	9	44

Table 4. Seniority Level Based on Project Type

Seniority	Development	Outreach	Support	Total
Lower	2	4	2	8
Upper	21	1	1	23
Not mentioned	26	15	9	50

Table 5. Lessons Learned Based on Project Type

Project Type	Lesson Learned
Development (N=24)	Emphasize relationship building skills (N=12) Be aware of time commitment (N=9) Consider long-term maintenance of project (N=3)
Outreach (N=10)	Make time to recruit students and partners (N=4) Empower students to take charge (N=3) Be mindful of time commitments (N=4)
(Socio)technical (N=5)	Importance of community partner buy-in (N=4) Use formative evaluation methods (N=1)

mentioned that the level of involvement of the community partner with the student was positively related to successful projects, especially for projects that were highly technical. Some authors suggested that involving community partners early in the project is critical for positive interactions later on [17, 43, 57]. Others suggested searching for local community partners so that the students could better understand the partner's work through site visits [6, 17]. Some authors also recommended that service learning instructors embrace ambiguity and flexibility, as projects tend to evolve in unexpected ways (n=9; e.g., [13, 132]). Other authors warn that instructors should consider the intense time commitment that service learning may require of them so that they can be adequately prepared [6, 84, 88]. Finally, some authors recommended that instructors help community partners and students think about long-term maintenance, or how the project can continue evolving after the student completes the course [13, 24, 88].

7.2.2 Outreach Projects. Students engaged in outreach projects set up workshops, expositions, or other events to teach members of a community about some aspect of computing (N=20). Most of the students who participated in these courses were lower-division students (see Table 4). These courses were also more likely to be elective rather than required (see Table 3). Students were assessed through reflection essays, curriculum design documents, written reports, and/or surveys about their experiences with the workshops. Pollock et al. [113] emphasized the value of outreach projects for helping students reflect on concepts they learned in the classroom through teaching community members. Students were also able to see the impact of their teaching on the communities they worked with. The majority of these articles did not mention how the experience of the community partner was assessed (N=12), and for those that were, surveys were the most common method. Some of these projects did not span an entire term but rather took place within a couple of weeks or during a shorter summer term.

Exemplar Course Supporting Outreach Projects. Kafai et al. [70] designed a service learning course with the goal of broadening participation in CS. They employed what they referred to as a "cascading model," where service learning undergraduate students mentored high school students. This course was co-taught by CS faculty and a Ph.D. student from the Department of Education. Students first learned about educational theories; issues surrounding CS education; and how to use educational technologies such as Scratch, Lilypad Arduino, or Python. As part of their deliverables, students created lesson plans consisting of fun and educational programming projects for their mentees. These lesson plans were executed during a week-long intensive computing camp for high school students. The service learning course of Kafai et al. [70] employed one of the most systematic evaluation plans of all courses reported in the corpus. To understand the impact of the service learning experience, undergraduate and high school students completed pre- and post-surveys rating their confidence with computing and their satisfaction with the computing camp (undergraduates were also asked to rate their satisfaction with the course overall). The undergraduates also participated in a formal post-interview regarding their experience. The survey data revealed a positive experience for both undergraduates and high schoolers. The authors reported that the undergraduate students indicated that they were able to develop life and relationship building skills. The researchers also found a positive, significant relationship between participating in the camp and interest in pursuing or continuing in a computing discipline.

Lessons Learned for Supporting Outreach Projects. Of the 20 articles reporting on outreach projects, 10 articles provided recommendations and/or lessons learned by the authors. Most of these lessons centered around challenges in organizing the outreach events. For example, some authors mentioned recruitment challenges (N=4), both in recruiting community partners [35, 47] and recruiting students to the service learning class [19, 70]. Some authors (N=3) stressed the importance of instructors empowering students to take charge of the planning of the workshop(s) [47, 115], which can be helpful in increasing the engagement of the community partner participants [67]. In addition, some authors (N=4) warned that each aspect of the project may take more time than expected, so instructors should carefully consider how much time each aspect will take for all stakeholders [35, 44, 115, 126].

7.2.3 (Socio)Technical Support Projects. (Socio)technical support projects were the least common type of service learning project (N=12) and focused on providing the community partner with information or support regarding some technical aspect of their organization, such as developing security risk reports, providing IT support, or developing an IT strategic plan. The courses in which (socio)technical projects were embedded typically catered to lower-division students (see Table 4). Students were assessed mainly through their deliverables to the community partner, which typically consisted of a written report or a presentation, their reflection essays, participation, and feedback from the community partner. The community partner's feedback about their experience was mostly obtained through informal feedback.

Exemplar Course Supporting (Socio)Technical Projects. Lincke [82] designed a network security service learning course in which students performed a security audit for a community partner. The students were first required to learn about the audit process and to learn more about the organization they elected to work with. Prior to sharing their audit plans with the community partner, the instructor made sure that the student's plans took into consideration the organizational context, including its policies, procedures, and areas of concern. The instructor created a rubric to evaluate the clarity and effectiveness of the audit report. The rubric emphasized having a transparent process that clearly explains to the community partner their security risk. The instructor obtained feedback from the students through a survey and from each community partner through a phone call. Most students and community partners indicated that this was a positive experience.

Lessons Learned for Supporting (Socio)Technical Projects. Of the 12 (socio)technical support projects, five of the experience reports provided lessons learned. Four of these articles highlighted the importance of having buy-in from the community partner, particularly as it relates to the purpose of the service learning class [20, 52, 82, 93]. Brooks [20] stressed the importance of understanding the needs of the community partner and communicating clearly with them about how the student project will help meet these needs. Lincke [82] indicated that one of the challenges of getting the process started was that the community partners were not clear on what the project consisted of, which led to the creation of revised, clearer customer solicitation letters for future iterations of the class. McCrigler [93] recommended the use of formative evaluation methods to ensure that the project aligns with the goals of all stakeholders. These evaluation methods can be used throughout the term to make adjustments as needed and to ensure that the needs of all parties are represented in the final product.

7.3 Discussion

Service learning in CIS supports learning across a diversity of knowledge areas via a diversity of different project types: development, outreach, and (socio)technical support. For example, development projects, most often found in software engineering and capstone courses, emphasized the development of complex prototypes for organizations through the application of advanced CS concepts, such as software engineering and platform-based development. Outreach projects and (socio)technical support projects, which were most often found in introductory programming courses, furthered basic computational concepts by providing a context in which students could engage with social issues and professional practice, an important and highly valued knowledge area in the ACM/IEEE report [69]. These social and professional practices were cultivated through assignments that required students to learn about the organizational content as part of requirements gathering, by seminars to discuss the ethical implications of computing, and by preparing and coaching students on how to conduct formal presentations back to the organization. Developing a tangible artifact was the most common type of project for service learning. These projects were often completed by upper-division students since they required more technical knowledge and experience. More research is needed to evaluate whether a short-duration project (e.g., a quarter or a semester) is sufficient to meet the needs of the community partner. It may be that outreach or socio(technical) projects could be more impactful over the long term for the community partner, but that these experiences may not be as beneficial or interesting for more advanced students.

Although some CIS knowledge areas were well represented, such as platform-based development, information management, and HCI, others were either not highlighted or only marginally mentioned, such as algorithms and complexity, architecture and organization, computational science, discrete structures, graphics and visualization, intelligent systems, networking and communications, operating systems, parallel and distributed computing, programming languages, and systems fundamentals. Some of these knowledge areas might be a more challenging context for designing service learning experiences, with learning objectives that cater toward being more supportive of developers than end users. Yet these knowledge areas could allow service learning projects to focus instead on contributing to open source projects (e.g., see [88, 92]). Other courses in these knowledge areas might take inspiration from the capstone management system project of Li et al. [81], with projects that support the course or other students across campus (e.g., having students in a programming languages course design a programming language for specific populations of students, like digital humanities students).

Other knowledge areas—especially computational science—surprised us in their absence from the corpus, as they seem like rich contexts for service learning. Nonprofit organizations, for example, are increasingly pressured by funding agencies to collect increasingly large amounts of data (e.g., [61, 137]), often about some of the world's most pressing social and environmental problems. Yet these organizations are typically under-resourced in their ability to analyze and use those data [12, 14, 26, 27, 79, 95, 97, 98, 147, 149]. The needs of some of the organizations could well be served by students in computational science courses.

Significantly, nearly all service learning courses reported multiple cross-cutting knowledge areas, including *social issues and professional practice*. The ACM/IEEE report [69] emphasizes that courses should not necessarily be designed to silo knowledge areas, and this goal was met by nearly all courses in this corpus. The content of service learning in CIS seems to succeed, then, in being of high impact.

8 *WHO* PARTICIPATES IN SERVICE LEARNING EXPERIENCES IN CIS?

In this section, we characterize the stakeholders involved in CIS service learning experiences and report on which stakeholder voices are reported to have influence in service learning experiences at key stages in the course, particularly during project selection.

8.1 Instructors Offering Service Learning Experiences

The majority of the service learning reports (N=82) were written from a first person account of the instructor of the course. In the cases where we could identify the primary instructor for the course (N=71), we used names and affiliations to attempt to derive additional demographic information about instructors that teach and publish about service learning courses. We looked for demographic information from the publication itself, as well as from publicly available websites and CVs. We coded the gender of the instructor only if pronouns were used in any of the data sources. Twenty-three of the instructors identified as women, 22 identified as men, and 39 did not use pronouns. Nearly everyone who conducted a service learning course was a tenure track professor (N=63). We were unable, based on publicly available information, to reliably infer the rank of the instructors at the time the courses were taught. Eight of the authors were not in a tenure track position and were instead instructors, senior lecturers, or Ph.D. students.

Some of the articles explicitly characterized the role of the instructor with respect to the service learning experience (N=22), including project manager (N=10), mentor (N=4), facilitator (N=3), coordinator (N=3), or advisor (N=2). Instructors generally took responsibility for deciding project scopes, making sure objectives were met, assigning teams, and coordinating with community partners.

8.2 Student Characteristics

Twenty-two of the articles explicitly mentioned that they welcomed students from different departments to increase the breadth of the project deliverables. Examples of other departments that participated in the CIS service learning courses included those related to business, education, psychology, mechanical engineering, and public affairs. Two of the courses focused on developing different learning objectives for students from different departments with the goal that the students would combine their expertise to work together on the service learning project. For example, Pulimood et al. [116] combined journalism and CS students to develop a "web-based system that

Table 6. Project Selection Process

Who Selected the Project?	Process of Selection
Community partner and student (N=35)	Organizations present their needs and the students select who to work with (N=33) Community partner offers different projects and the students apply to work on a specific project (N=2)
Instructors (N=8)	Instructor provides a list of possible projects and the students choose from them (N=5) Instructor assigns project to the student (N=3)

manages and provides information about potentially polluted properties” (p. 32). The CS students were tasked with creating the system, whereas the journalism students assessed social aspects that would affect the implementation of such a system.

8.3 Community Partners

All but 4 papers identified at least one community partner. Community partners included nonprofit organizations (N=26), grade schools (N=19), informal education centers (N=5), universities (N=5), industry partners (N=4), prisons (N=2), and the open source community (N=1). Of the papers that reported the location of their partners (N=73), 64 reported local partners (i.e., in close proximity to the institution), 2 had regional partners, 5 reported that their service learning partners were international (e.g., Haiti, Brazil, Honduras), and 2 reported both local and international partners.

8.4 Project Selection

We analyzed how projects were selected (Table 6), documenting if the articles included information regarding which stakeholders had input in project selection. Of those articles that did report how the project came to be selected (N=43), 35 of the courses supported project selection based on input from both the community partners and the students. In 33 of these cases, organization members presented their needs (although not necessarily specific projects) to the students and the students selected an organization to work with (e.g., see [49, 92, 116]). In two cases, the community partner presented both their needs and offered project possibilities; the students were then able to either select a project based on their interest [144] or apply to work on a specific project [29]. Carter [29] also detailed an extensive application process where students developed resumes, cover letters, and proposals to apply for specific projects.

In the eight remaining cases in which the method of project selection was reported, the instructor was the primary stakeholder involved and typically served as an intermediary between the students and community partners; the instructor negotiated the projects with the community partner and then presented them to the students. In three instances, the instructor assigned the project to the students [17, 19, 105]. In other cases (N=5), the instructor provided a list of needs from different organizations and students were able to select [67, 82] or rank the projects based on their interests [36, 107, 130]. Forty-two of the papers did not mention how the project was selected.

8.5 Relationships in Service Learning

We also coded references to how relationships with community partners were established. Of papers that reported this information (N=35), the instructors (N=12) or the partners themselves (N=10) were the ones most likely to reach out. University service learning offices (N=6) were also likely to reach out to different organizations, and in some cases, there were liaisons (other organizations in the community; (N=2)) who collected a repository of possible organizations and reached out to potential community partners. Some instructors had a previous relationship with partners (N=4). In only one instance, students were responsible for reaching out to potential partners. Forty-one of the papers did not report on the origin of the relationship.

Community partners were involved in the course to differing degrees. Some courses did not require much involvement from the community partner (e.g., [44]); however, other courses required a more involved partnership between student and community partner, such as the student and community partner developing a joint presentation as a final deliverable for the course [100]. Burns et al. [25] more explicitly discussed trying to balance community partner involvement without overburdening them. Their students worked with primary school teachers to develop educational games. Students had to learn how to present their ideas to the teachers and how to incorporate feedback while limiting the times that students had to meet with the teacher.

Slightly less than half of the articles (N=34) reported the methods and frequency in which the students and the community partner interacted. A portion of those articles (N=19) noted that students communicated with community partners only once or a couple of times during the term, particularly during milestone updates (N=11), project presentations (N=6), or as a one-time planning meeting (N=3). In only two instances, the students and the community partner signed an agreement articulating expectations for the project, including how often the students would update the community partner and what role the community partner would play throughout the project. Eleven of the articles mentioned that students held regular meetings with the community partners, including both e-mail updates and in-person check-ins throughout the term. In two cases, student communication with the organization was limited or nonexistent, primarily to respect the time of the community partner. Either it was the professor's responsibility to communicate with the organization (no student communication; [17]) or student liaisons reached out to the organization to update them on project progress [136].

8.6 Discussion

Most service learning experiences were led by tenure-track professors, which makes sense, given that most were published by authors from Ph.D.-granting universities. Further, although most authors did not self-identify their gender on their websites, of those who did, 23 self-identified as women and 22 self-identified as men. This gender distribution of faculty teaching service learning courses is far different from the overwhelmingly male faculty in CIS disciplines [157], suggesting that women faculty are more likely to teach or publish about service learning courses and to take on additional invisible labor, as they do more generally in the academy [123].

Service learning experiences vary greatly; some provide students with specific disciplinary skills, whereas others cater to students from a variety of departments. Encouraging CIS majors to interact with students from other majors can be integral for the development of soft skills [5, 11, 25] and for developing a better understanding of different perspectives and impacts of technology that is being developed [99, 116, 124]. Additionally, service learning with students from other majors appears to be a fruitful approach for helping students develop an understanding of ethical and diversity issues within CIS, which is an important component of CIS education [53, 58].

The most common community partners consisted of local nonprofit organizations or primary schools. Working with the local community promotes student connections with their surrounding community [133, 156]; helps the instructor, institution, and community build reciprocal partnerships that serve the local public [18]; and makes service learning more accessible by allowing students to visit the site to better understand the organization [13, 24, 88].

The most common iteration of project selection consisted of students and community partners working in some capacity to select a project. Mostly, these projects were pre-selected by the community partner, which implies that the project was designed to meet an identified need; however, it is hard to determine how community partners scoped and decided on an appropriate project for varying levels of technical expertise among undergraduate students. The level of involvement of community partners also varied throughout the term, with some partners providing weekly feedback to some having almost little to no input. Some authors noted that they limited communication with community partners to respect their time. More research from the perspective of community partners about their preferred level of involvement would inform the development of effective practices that could be used by instructors and students.

9 DISCUSSION: FROM COST/BENEFIT TO MUTUAL BENEFIT AND RECIPROCITY

Service learning is often characterized as a mutually beneficial experience for all stakeholders involved. Yet there is significant variation in what is articulated or accepted as constituting *mutual beneficiality*. Notably, in the CIS corpus, only eight experience reports cited mutual benefit as one of the goals of their service learning experience, and only 31 indicated that one of their goals was to help with community needs.

Our analysis of service learning experience reports demonstrated great variability in the experiences and relationships among stakeholders. Nurturing partnerships among stakeholders is an integral component of service learning, as "service learning partnerships, if not carefully designed and nurtured, risk being harmful to one or more participants" ([18], p. 107). Bringle and Clayton [18] indicate that at a minimum, service learning relationships should support *thin reciprocity*, or ensure that all stakeholders benefit in at least a small way. However, they argue that the ideal goal is to develop *thick reciprocity*, or building equitable partnerships in which all stakeholders learn from one another, participate in the design of learning experiences, and share voice and power.

To unpack the variability in our corpus and to better understand the kinds of CIS service learning experiences that supported thick reciprocity [18], we identified three project phases, characterized by most of the articles in the corpus, in which there are different relationships among stakeholders and different costs and benefits for each stakeholder, particularly related to their influence and voice in the experience: (1) designing the course, (2) implementing the service learning project, and (3) evaluating the experience.

9.1 Phase 1: Designing the Course

Across the corpus, the voice of the instructor was dominant during the course design phase—they generally decided on course objectives, structured the course, solicited community partners, and brainstormed possible projects. In only a small number of instances, the community partner was brought into this process to help establish mutually beneficial outcomes. For example, Sanderson and Vollmar [134] noted that the most important step in ensuring a successful project consisted of the instructors meeting with community partners before the course began to discuss their needs and to establish realistic goals, arguing that this should not be the student's responsibility; rather, the instructor should work with the community partner to ensure mutual understanding of the scope of the project. Despite the fact that the community partner was mentioned as playing a part in the design of the course, their involvement was often not explained in great detail. Partner involvement primarily consisted of providing possible projects or a description of needs so that the instructor could arrange the schedule to ensure that sufficient progress is made. Although the National Service-Learning Cooperative indicates that service learning experiences should involve "youth voice in selecting [and] designing . . . service-learning projects" [1], none of the experience reports discussed the students' role in designing service learning projects. The only exception to this was the use of student evaluations to redesign aspects of future iterations of the course.

The student needs may have been collectively represented by the objectives and motivations that guided the development of the class. As our findings suggest, most instructors engaged in service learning to improve their students' understanding of real-world problems and to help them develop soft skills while providing a service to the community. Despite highlighting the importance of providing a service, we observed few direct mentions of specific objectives for the community partner, other than simply providing them with a product, suggesting a more passive involvement from community partners. However, without clear goals and objectives from the community partners, it is difficult to achieve thick reciprocity and the potential for increasing costs to stakeholders rises [18].

Furthermore, none of the reports in the corpus noted workload issues of community partners during the design phase. Yet prior research has noted that "one of the more time-consuming aspects of the work of [nonprofit] volunteer coordinators is envisioning opportunities and planning for the work of volunteers" [150]. The level of involvement of community partners varied either by design (i.e., the instructor designed for the involvement to be limited) or because of time and expectation constraints. Some of the lessons learned reported by the authors of the papers indicated that some community partners had limited time to devote to the project, with some community partners greatly limiting their involvement by the end of the project [92, 153]. This introduces a tradeoff between giving voice to the community partner while also respecting their limited time. Understanding mutual benefit from the perspective of community partners likely means being more attuned to their workload concerns throughout the process.

The weighting of the instructors' voices overshadowed others' during the course design phase; however, so did their workload. In a few instances, authors reported inviting other stakeholders to assist during this phase—for example, a university's community outreach office or intermediary nonprofit organization sometimes helped in identifying community partners (e.g., [11, 87]). The availability of resources seemed to be dependent on the type of university and the existence of a service learning office within the university. Service learning offices, often called *community outreach offices*, can help instructors connect with community partners and faculty who may be interested in service learning and may have resources for best practices [63, 76]. These external resources are believed to be helpful in encouraging new faculty to try service learning and motivating instructors to continue on with their service learning class [76]. Some authors in our corpus also reported receiving funds to help with the cost of supplies, to compensate the community partner(s), or to hire a teaching assistant. Having funding, mentorship, or other types of resources available were reported as positively influencing the relationship between the instructor and the student, the instructor and the community partner, and the instructor and their respective institution.

Overall, few authors noted the use of any external resources that would ease the additional labor involved in designing and setting up a service learning course for themselves and for community partners. Perhaps, again, this is a form of publication bias; authors or reviewers did not believe that readers would value this information and thus it was omitted. However, being transparent about the additional workload involved in service learning in this phase is an essential form of transparency, helping to start a conversation about invisible labor for all stakeholders and to give readers and instructors data and ideas about what resources to ask for and how to weigh the benefits and costs of engaging in service learning. Being forthright about what resources were used and were considered helpful might help others feel more empowered to adopt this high-impact pedagogy. Finally, highlighting the additional labor required for designing and maintaining a service learning class may be important information to share with university officials so that resources can be more readily available and to help recognize and acknowledge the service that is being performed by instructors.

9.2 Phase 2: Implementing the Project

In the project implementation phase, the instructor typically introduces the community partner(s) and/or the project(s) to the students, discusses deliverables and expectations, and to varying degrees manages the project(s) throughout the term.

The extent of the relationships among instructor, community partner, and student/student teams were dependent on the level of involvement of the community partner, the complexity and type of project, and how the class was designed. These relationships can be thought of as existing on a continuum ranging from weak to strong ties. For example, Mertz and McElfresh [100] showcased a strong relationship between student and community partner; the student and community partner had to work closely together to develop sustainable solutions to address IT problems faced by the community partner. In contrast, the students described in the work of Brannock et al. [17] had a one-time meeting with the community partner to find out their needs in developing a clicker for the classroom environment, making this a weak tie between student and community partner. In this case, however, the class was designed this way so that this limited interaction provided the students with enough information to develop their project. More research should evaluate how important the strength of the tie is in meeting the class objectives for the students and for the community partners and how the strength of the tie is related to mutual beneficiality. We would expect that a stronger tie would lead to better outcomes and a more mutually beneficial relationship, but it could be that certain course designs are well suited for weaker ties between student and community partner.

Although instructors and community partners can establish expectations for the term during Phase 1, some level of flexibility and communication among all stakeholders is needed, since projects may progress in unexpected ways. Strong communication and adaptability is integral for ensuring that the process of implementing the project and the final outcome is as beneficial as possible for all stakeholders [18]. For example, the service learning course of Mertz [99] emphasized the important of students and community partners working closely together so that there could be knowledge transfer (i.e., the students could learn about the organizational context, and the organization could learn about how to better use existing technologies). The goal of this knowledge transfer was so both stakeholders could build sustainable solutions, and students could develop strong communication skills, which has been shown to have a positive impact in students' long-term professional development [5, 11, 25].

The crux of Phase 2 centers on the project type. Additional research could evaluate the different workloads and levels of involvement required based on project type, particularly as it relates to ensuring the best outcomes and benefits for all parties involved. Some authors suggested that multi-semester projects [23, 38, 40, 67, 84, 115], especially for development projects, offered the best experiences for both students and community partners. In this case, students are able to work on what most closely resembles a real-world project and community partners benefit from a final product that has been iterated, tested, and refined through various semesters. Researchers suggested that this approach is the optimal to support equitable service learning partnerships [18, 23, 84]. However, incorporating multi-semester projects requires coordination among multiple instructors and community partners and the use of university resources and support, which may not always be realistic. In addition, students can be dissatisfied with projects that they do not themselves complete [65].

9.3 Phase 3: Evaluating the Experience

The impact of the service learning experience is evaluated in Phase 3, which often happens after Phase 2 but was sometimes reported as an ongoing process throughout the course or service learning experience. Most experience reports focused primarily or exclusively on how students were assessed—most commonly through the use of reflective journals (i.e., often exploring the impact of their development projects, workshops, or other course deliverables), completion of project milestones, and the project deliverable. Some of the authors assessed the impact of the service learning experience on the student's intent to pursue future CIS courses (e.g., [67, 115]) or pre- and post-surveys on their overall confidence in the course outcomes (e.g., [25, 41, 70]). These assessments were most typically developed and administered by the instructor. With few exceptions (e.g., [25, 29, 49, 100, 103]), community partners rarely contributed to the assessment of students.

Only a few of the articles reported assessing the impact of the project on the community organization. Most of these assessments consisted of informal feedback where the instructor spoke to the community partner about their experiences and only a couple instances involved a more formal evaluation, either through structured interviews (e.g., [107, 132]) or survey instruments (e.g., [4, 70, 100]). This dearth of information about the impacts of service learning on community partners may, again, be an example of publication bias—with either authors or reviewers leaning toward the omission of such data. But it may also reflect a prioritization of students' experiences over the experiences of community partners, which has been documented as a challenge in service learning [51, 101, 129, 135]. The lack of information from the community partners' experiences makes it difficult to understand the positive or harmful impact of the service learning experience.

One focus for assessment that seems particularly critical for service learning in CIS—particularly for development projects—is longitudinal or longer-term assessment, which could be thought of as the impact of the service learning experience on the community partner and the sustainability of the service learning experience. Across the corpus, several authors noted the importance of developing prototypes or deliverables that can be maintained by the community partner after the students' participation ends (see [24, 84]). For example, as mentioned in Phase 2, Linos et al. [84] developed multiple semester-long projects where community partners could have more input into the projects and more opportunities to provide feedback on how the projects were affecting their organization. Another way to address the maintenance problem could be to explicitly weave in sustainability as part of the service learning goals, as was done in the technology consulting service learning course of Mertz [99]. Explicitly creating a plan and working with the community partner from Phase 1 could be a way to ensure the sustainability of service learning projects.

Longer-term assessment of the impact of service learning on students was also entirely missing from the corpus. The genre of experience report that has emerged in CIS typically sets its unit of analysis on a given service learning course or experience. As such, the articles typically bracket their assessment of students' experiences to their experience in the course, which is not surprising given the individual course structure of post-secondary education. Yet research has found that service learning is a high-impact pedagogy and can contribute to retention in CIS fields [7, 110, 114, 118]. The lack of research that tracks students' progress makes it difficult for the field to determine which types of experiences and at what point of the program may be the most effective.

9.4 Implications

Overall, the stakeholders' experiences discussed with most detail in the experience reports were those of the instructor and the students—the community partner's voice is largely missing from the corpus. This resonates with what other researchers have found: educators often design for maximizing student outcomes at the expense of community organizations [65, 101, 129, 135]. This asymmetry limits benefits to both communities and students, since privileging students' personal advancement inhibits the goal of cultivating socially responsible selves who actively care for others [51]. In addition, when a project does not include authentic interaction with a client, the student may not actually acquire professional skills and an ethic of care [74]. To shift from an experience of thin reciprocity to thick reciprocity, service learning educators should not only stress course objectives, but they should also strongly emphasize cultivating strong partnerships with students and community partners to promote equity across service learning experiences.

Bringle and Clayton [18] recommend that to promote *thick reciprocity*, service learning courses should have clear and measurable outcomes; be strengths and assets focused; balance power among all stakeholders; share credit; and encourage open communication, mutual trust, and respect. Instead of service learning just being a course, there is an emphasis on service learning moving beyond that and really focusing on building sustainable, respectful, and equitable relationships. Some of the authors from our corpus suggested ways to achieve this: encouraging students from different backgrounds and majors to enroll in a service learning course to bring different perspectives and to encourage communication and respect among different fields [116]; establishing multi-term projects where community partners can work closely with groups of students and with instructors to develop sustainable projects [84]; or not focusing on building technology but rather building soft skills and helping community partners develop their own sustainable solutions [99].

Community partners may be perceived as lacking the technical knowledge to create their own solutions [38, 129]; however, community partners have invaluable knowledge that is imperative for the design of sustainable and workable solutions. Elevating the community partner as an expert and integrating their expertise into the course design could be a helpful way to address students being condescending or helping students shift their view of thinking that they are simply engaging in charity work [101]. Giving students input into the design of service learning courses could also be a helpful way to mitigate some of these harmful attitudes.

10 LIMITATIONS AND FUTURE WORK

Our systematic literature review and content analysis of experience reports of service learning in CIS provides numerous insights about the diversity of ways that service learning is implemented and integrated in CIS curriculum in higher education. This research also reveals a number of gaps and opportunities for the field to further diversity its service learning offerings. Yet we remain cognizant that the corpus does not represent all service learning experiences—only those that were written up and accepted for publication. Numerous forms of publication and outcome bias [91] may have influenced the content of the corpus and, as a result, the characterization of service learning that we offer here. We have noted numerous possibilities of publication bias in our discussion—bias in the countries where this pedagogy is reported, in the types of universities represented, in the gender of instructors, and the types of outcomes that are reported. Other forms of publication bias may also limit the generalizability of this work. For example, it could be that only instances of positive experiences with service learning are the ones that are published. There could be other service learning courses that presented challenges or were not successful that are not found in the published literature. Other forms of publication bias might influence what is reported in the cases. For example, authors may discuss the benefits and successes of service learning while not necessarily discussing some of the challenges or less favorable outcomes that they faced. As such, we may only be exposed to a partial story of service learning by relying on experience reports rather than research or evaluation studies conducted by more objective observers.

One benefit of identifying the limitations and potential sources of publication bias is that we can help shape the way that service learning experiences are reported in the literature. As authors, we can be intentional about discussing resources, challenges, and benefits or the lack thereof to community partners. As reviewers, we can be more inclusive of the voices and experiences that are accepted into publication venues. As editors and program committee members, we can reach out to stakeholders whose voices are missing and solicit reports of under-represented experiences to our venues. We could utilize the three-phase approach (i.e., designing the course, implementing the project, and evaluating the experience) as a way to capture and organize the various voices that are currently missing from the literature.

The publications about service learning in CIS are also by and large experience reports. Strikingly, there is relatively little empirical work about service learning in CIS, particularly in comparison to other fields. This may reflect the relative age of the discipline—that this body of work has yet to establish itself. It may also reflect another form of publication or funding bias.

11 CONCLUSION

Service learning is a high-impact pedagogy with a robust footing in and an incredible potential for enriching education in CIS. Although there are ample potential benefits, particularly for students and the diversity of student populations, the potential costs cut across stakeholders—from the unusually high workload required of instructors to the time and maintenance demands often asked of community partners to the potential for beliefs about the 'inevitable rightness' of technical solutions to mask students' civic benefits.

This research has served to take an empirical pulse of service learning in CIS to better understand how this pedagogy is being enacted in the curriculum of higher education—characterizing the why, where, when, what, and who of CIS service learning—and how various instantiations of service learning have navigated costs and benefits among stakeholders.

In this research, we contributed results from the first systematic review of 84 experience reports, spanning 20 years of service learning in CIS. Our results included the following:

- *Why*: Most authors reported that they engage in service learning to help their students develop real-world skills, to increase their civic engagement, and to fill a need in the community. However, despite these altruistic motivations, there was less emphasis on how to effectively fill this need in the community and how to assess the short- and long-term impacts of service learning experiences.
- *Where and when*: Most of these experience reports were authored by instructors at Ph.D.-granting universities in the United States. These courses were primarily designed for the very beginning or end of the undergraduate curriculum, suggesting a need for more research or reports of service learning experiences at all levels of the undergraduate curriculum. Most of these courses spanned one term; however, there is some evidence suggesting that multi-semester courses may help in the development of thick reciprocity. However, there are certain logistics, such as time commitments, resources, and transferability of skills from term to term, that may make multi-semester projects more challenging and less accessible for stakeholders.
- *What*: CIS service learning courses supported a diversity of knowledge areas along three project types: development, outreach, and (socio)technical. There are knowledge areas that were missing or only marginally mentioned in our corpus, presenting an opportunity to integrate service learning in more areas of the curriculum and in ways that could encourage more interdisciplinary work. There is also an opportunity to examine which types of projects are more sustainable and which ones lead to more mutually beneficial outcomes.
- *Who*: The majority of community partners consisted of local nonprofit organizations or primary schools. Working with local partners provides the opportunity for students and faculty to give back to the local public and makes learning more accessible. Community partners, whether local or not, differed in the amount of time they were asked to devote to the project. There is a need to design service learning experiences where the level of involvement is sufficient to establish strong relationships but does not exceed the capacity of any stakeholder.

Our analysis also suggested best practices to support thick reciprocity during each of three different project phases:

- *Designing the course*: Include the student and community partner in the design phase of the course, as this can help ensure that their needs and goals are represented in the course outcomes, assignments, and deliverables. If possible, employ the use of external resources, such as community outreach offices, funding, and mentorship, which can alleviate the additional labor involved.
- *Implementing the service learning project*: To support the best outcomes possible for all stakeholders, in addition to focusing on the technical aspects of the course, be intentional about nurturing and supporting communication and adaptability between students and community partners.
- *Evaluating the experience*: Because there is a lack of comprehensive assessment of the impact of service learning experiences, especially for community partners and for all stakeholders over the long term, ensure that there is a method to obtain feedback so that stakeholders have a voice in providing input and shaping future service learning experiences.

Our research also suggests directions for future research, including conducting more empirical research on how best to assess service learning experiences for all stakeholders; how different project types may lead to the formation of different kinds of relationships and opportunities for students, community partners, and instructors; and how to reduce the invisible labor that is often associated with service learning.

With rare exception, experience reports paint a picture of service learning experiences characterized by weak reciprocity at best, with little reporting devoted to privileging the voices of or benefits to community partners. It is our hope that the discussion offered here can inspire more research about service learning in CIS, particularly research that supports faculty in identifying and using effective practices that reduce the time commitment to them, continue to offer high-quality experiences to students, and take into greater account the needs and views of community partners.

APPENDIX

A CORPUS

We present the 84 papers that comprised our corpus, along with the citation, project type, project description, course subject, what kind of deliverable was provided for the community partner, and what type of assessment methods were used (Table 7).

Table 7. The 84 Papers That Comprised Our Corpus

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Adams, J. B., & Runkles, E. (2004). "May we have class outside?": Implementing service learning in a CS1 curriculum. Journal of Computing Sciences in Colleges, 19(5), 25–34.	Outreach	Teach inmates basic computer skills	Intro to CS	Not mentioned	Reflection essays, student survey
Al-Khalifa, H. (2010, Oct.). Overcoming gender segregation in service learning projects: A case from Saudi Arabia. In Proceedings of the 2010 ACM Conference on Information Technology Education (pp. 121–124).	Development	Developed a fully fledged website with free hosting for any nonprofit organization that serves the community	Web applications engineering	Prototypes	Project deliverable, student survey, weekly progress report
Anderson, R. E., Borriello, G., Martin, H., & Black, L. (2009). Capstone projects as community connectors. Journal of Computing Sciences in Colleges 25(1), 116–122.	Development	Developed a system to help local Native American artists and indigenous people of Mexico sell art (students from Heritage communicated with the artists, whereas UW students developed the platform)	Capstone design experience	Prototypes	Not mentioned
Anderson, R. J., Anderson, R. E., Borriello, G., & Pal, J. (2010, March). An approach to integrating ICTD projects into an undergraduate curriculum. In Proceedings of the 41st ACM Technical Symposium on Computer Science Education (pp. 529–533).	Combination	Designing a transportation information system	Capstone design course	Presentation, expo	Presentation, student survey, panel of expert feedback

(Continued)

Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Bartholomew, K. W. (2017). A risky business: Managing and mitigating risks for service-learning projects for an information systems capstone two-course sequence. Journal of Computing Sciences in Colleges, 33(2), 68–76.	Development	Development of information system using agile methodology	Systems analysis and design (capstone)	Prototypes	Not mentioned
Becker, D., & Hecker, C. (2011). Student engagement through applied learning: The "live" business partnership model. Journal of Computing Sciences in Colleges, 26(5), 275–282.	Development	Develop software and hardware products	Systems analysis and design; web application development	Prototype	Not mentioned
Bloomfield, A., Sherriff, M., & Williams, K. (2014, March). A service learning practicum capstone. In Proceedings of the 45th ACM Technical Symposium on Computer Science Education (pp. 265–270).	Development	Developed databases to help create schedules or to track houses that have been built	Software engineering based capstone	Prototypes	Student survey
Brannock, E., Lutz, R., & Napier, N. (2013, Oct.). Integrating authentic learning into a software development course: An experience report. In Proceedings of the 14th Annual ACM SIGITE Conference on Information Technology Education (pp. 195–200).	Development	Created a web-based clicker to replace physical clickers	Software development (level 1)	Prototypes	Project deliverable, demonstration

(Continued)

Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Brinkman, B., & Diekman, A. (2016, Feb.). Applying the communal goal congruity perspective to enhance diversity and inclusion in undergraduate computing degrees. In Proceedings of the 47th ACM Technical Symposium on Computing Science Education (pp. 102–107).	Outreach	Deliver hands on coding experiences before and after school at local elementary schools	Intro to CS	Not mentioned	Not mentioned
Brooks, C. H. (2008). Community connections: Lessons learned developing and maintaining a computer science service-learning program. ACM SIGCSE Bulletin, 40(1), 352–356.	(Socio)technical support	Upgrading and maintaining community labs, developing informational resources, direct client education	Computers and society	Prototypes	Reflection essays, blog, develop toolkit
Bruce, R., & Reiser, S. (2006, March). Aligning learning objectives with service-learning outcomes in a mobile computing application. In Proceedings of the 44th Annual Southeast Regional Conference (pp. 590–595).	Development	Developed a mobile tour for an arboretum	Database management systems; human computer interface; systems integration	Prototypes	Not mentioned
Buckley, M., Kershner, H., Schindler, K., Alphonce, C., & Braswell, J. (2004, March). Benefits of using socially-relevant projects in computer science and engineering education. In Proceedings of the 35th SIGCSE Technical Symposium on Computer Science Education (pp. 482–486).	Development	Augmented a communication device for children, those who are visually impaired and cognitive impaired	Software engineering capstone	Prototypes	Not mentioned

(Continued)

Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Burns, R., Eugene, W., Barnes, T., Chandler, S., Harwell, M., & Omokaro, O. (2014). Reflections from a computational service learning trip to Haiti. Journal of Computing Sciences in Colleges, 29(3), 43–50.	Development	Software design process (developed for an unfamiliar platform, design new paradigms, and program in a new language/framework)	Not mentioned	Prototypes, presentation, expo	Reflection essays, presentation, peer evaluation, community organization feedback, quizzes/labs
Burns, R., Harvey, T., & Pollock, L. (2012, June). An experience report on cross-semester student critique and action in an integrated software engineering, service learning course. In Proceedings of the 2012 1st International Workshop on Software Engineering Education Based on Real-World Experiences (EduRex) (pp. 21–24).	Development	Software design process (developed for an unfamiliar platform, design new paradigms, and program in a new language/framework)	Software engineering	Prototypes, presentation	Reflection essays, presentation, peer evaluation, community organization feedback
Burns, R., Pollock, L., & Harvey, T. (2012, Feb.). Integrating hard and soft skills: Software engineers serving middle school teachers. In Proceedings of the 43rd ACM Technical Symposium on Computer Science Education (pp. 209–214).	Outreach	Engaging young women from Haiti in computational thinking	Software engineering	Not mentioned	Student survey
Carter, L. (2011, March). Ideas for adding soft skills education to service learning and capstone courses for computer science students. In Proceedings of the 42nd ACM Technical Symposium on Computer Science Education (pp. 517–522).	Development	Statistical analysis, data mining, network implementation, database creation, curriculum design	Software engineering	Prototypes	Presentation, updates on class wiki

(Continued)

Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Chang, C. J., Lin, C. Y., & Chiu, K. C. (2019, Aug.). Bridging distances with life reviews: A study on intergenerational learning in the History Alive program. In Proceedings of the 2019 3rd International Conference on E-Society, E-Education, and E-Technology (pp. 101–104).	Outreach	Students helped seniors digitize their life stories	Corporate social responsibility	Not mentioned	Student feedback responses
Chaytor, L. (2003, Oct.). Urban empowerment: A successful example of service learning. In Proceedings of the 4th Conference on Information Technology Curriculum (pp. 226–230).	Development	Create websites for small businesses	Web publishing	Prototypes	Informal feedback
Christensen, K., Rundus, D., Perera, G., & Zulli, S. (2006). CSE volunteers: A service learning program to provide IT support to the Hillsborough County school district. ACM SIGCSE Bulletin, 38(1), 229–233.	(Socio)technical support	Provide IT support to school district (hardware and software)	Not mentioned	Not mentioned	Status e-mails
Christiansson, J., GrÃűnvall, E., & Yndigegn, S. L. (2018, Aug.). Teaching participatory design using live projects: Critical reflections and lessons learnt. In Proceedings of the 15th Participatory Design Conference: Full Papers—Volume 1 (pp. 1–11).	Outreach	Development of a live project to learn more about the co-design process	Design	Prototypes, expo	Reflection essays, project deliverable, group oral exam; project reports

(Continued)

Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Cicirello, V. A. (2013). Experiences with a real projects for real clients course on software engineering at a liberal arts institution. Journal of Computing Sciences in Colleges, 28(6), 50–56.	Development	Develop a system to geolocate and visualize historical data; develop a web-based system to support inventory	Software engineering	Prototypes	Reflection essays, presentation, exam, project deliverable, peer evaluation
Dahlberg, T., Barnes, T., Buch, K., & Rorrer, A. (2011). The STARS alliance: Viable strategies for broadening participation in computing. ACM Transactions on Computing Education, 11(3), 1–25.	Outreach	Outreach for different groups to promote computing	Computing leaders seminar	Outreach program	Reflection essays, student survey, online event report
Dark, M. J. (2004, Oct.). Civic responsibility and information security: An information security management, service learning course. In Proceedings of the 1st Annual Conference on Information Security Curriculum Development (pp. 15–19).	(Socio)technical support	Provide information security risk assessment consultation to school corporations	Information security risk assessment class	Prototypes	Not mentioned
Davis, J., & Rebelsky, S. A. (2019, Feb.). Developing soft and technical skills through multi-semester, remotely mentored, community-service projects. In Proceedings of the 50th ACM Technical Symposium on Computer Science Education (pp. 29–35).	Development	Develop non-mission critical software for local nonprofits	Software development	Prototypes	Not mentioned

(Continued)

Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Dekhane, S., Xu, X., Napier, N., Barakat, R., Gunay, C., & Nagel, K. (2018). Technology focused service-learning course to increase confidence and persistence in computing. Journal of Computing Sciences in Colleges, 34(2), 147–153.	Outreach	Pick a technology and create an app for a non-stem audience	IT	Workshops	Reflection essays, peer evaluation
Dodds, Z., & Karp, L. (2006). The evolution of a computational outreach program to secondary school students. ACM SIGCSE Bulletin, 38(1), 448–452.	Outreach	Outreach for high school students	CS	Outreach program	Not mentioned
Egan, M. A. L., & Johnson, M. (2010, June). Service learning in introductory computer science. In Proceedings of the 15th Annual Conference on Innovation and Technology in Computer Science Education (pp. 8–12).	Development	Created an animation and interactive game for nonprofit organization	Intro to CS	Prototypes, design document	Presentation, project deliverable, design document
Feather-Gannon, S., Coppola, J., Daniels, C., Hale, N. L., Mosley, P., & Taylor, A. (2013). The evolution of successful service-learning courses in the computing curriculum: From infancy to innovation. Journal of Computing Sciences in Colleges, 28(6), 109–116.	(Socio)technical support	Help a community-based organization with troubleshooting, hardware, software needs	General CS	Prototypes	Reflection essays, student survey

(Continued)

Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
García-Peñalvo, F. J., & Llorens-Largo, F. (2015, Oct.). Design of an innovative approach based on service learning for information technology governance teaching. In Proceedings of the 3rd International Conference on Technological Ecosystems for Enhancing Multiculturality (pp. 159–164).	(Socio)technical support	Development of an IT strategic plan	Strategic management of IT	Presentation	Presentation, exam, project deliverable
Gestwicki, P., & McNely, B. (2016). Interdisciplinary projects in the academic studio. ACM Transactions on Computing Education, 16(2), 1–24.	Development	Development of educational video games	Software development	Prototypes, presentation	Reflection essays, presentation, project deliverable, periodic retrospective assessment
Hsin, W. J., & Ganzen, O. (2008). Computer literacy in international service learning at Park University. Journal of Computing Sciences in Colleges, 23(4), 163–167.	Outreach	Teaching a community in Brazil basic computing skills	Computer literacy	Not mentioned	Not mentioned
Jin, W., & Xu, X. (2019, April). Near-peer led workshops on game development for broadening participation and diversity in computing. In Proceedings of the 2019 ACM Southeast Conference (pp. 39–45).	Outreach	Near-peer outreach activities in the form of workshops for game development	Intro to computing	Workshop, outreach program, presentation, product	Informal feedback

(Continued)

Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Kafai, Y., Griffin, J., Burke, Q., Slattery, M., Fields, D., Powell, R., Grab, M., Davidson, S., & Sun, J. (2013, March). A cascading mentoring pedagogy in a CS service learning course to broaden participation and perceptions. In Proceeding of the 44th ACM Technical Symposium on Computer Science Education (pp. 101–106).	Outreach	Undergrads developed educational software projects and created lessons plans for them, which were held at workshops	Intro to CS	Workshop, outreach program	Student survey, post interviews after workshop experience
Kawell, G. (2007). Concepts to real world implementation via service learning. ACM SIGCSE Bulletin, 39(4), 113–116.	Development	Database to help school track IT equipment	Operating systems and networking	Presentation	Reflection essays, presentation, journaling through WebCT
Kim, H. J., Coluntino, D., Martin, F. G., Silka, L., & Yanco, H. A. (2007). Artbotics: Community-based collaborative art and technology education. In Proceedings of the ACM SIGGRAPH 2007 Educators Program (pp. 6–es).	Outreach	Mentoring high school students in arts and robotics	Artbotics (computing + art)	Expo, art exhibit	Project deliverable, participation in two exhibits; two essays
Lane, L. (2018, Aug.). Iteration for impact: exploring design thinking & designing for social change in client projects. In Proceedings of the 36th ACM International Conference on the Design of Communication (pp. 1–6).	(Socio)technical support	Creating visual representations of social justice issues	Document design course	Presentation	Reflection essays, project deliverable

(Continued)

Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Li, Z., Tian, X., Li, L., Yang, M., & Han, M. (2019, Sept.). Practice what you preach—Building a capstone management system as undergraduate IT capstone projects. In Proceedings of the 20th Annual SIG Conference on Information Technology Education (pp. 126–131).	Development	Development of an information system	IT capstone course	Expo, final deliverable decided with partner	Presentation, project deliverable, community organization feedback, poster session; deliverable includes project plan, Gantt chart, milestone presentations, final presentation, final report; peer evaluation
Lincke, S. J. (2007). Network security auditing as a community-based learning project. ACM SIGCSE Bulletin, 39(1), 476–480.	(Socio)technical support	Security audit part of a system for local organizations	Network security	Presentation	Project deliverable, community organization feedback
Lincke, S. J., & Hawk, S. R. (2015, Sept.). The development of a longitudinal security case study. In Proceedings of the 16th Annual Conference on Information Technology Education (pp. 49–54).	(Socio)technical support	Develop a system of security for a doctor's office	Information security	Prototypes	Project deliverable, informal feedback

(Continued)

Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Linos, P. K., Herman, S., & Lally, J. (2003, June). 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 (pp. 30–34).	Development	Create web-based educational software to teach grade school children Spanish	CS and software engineering	Prototypes, progress reports, responsibility forms, semester goals, and documentation	Reflection essays, presentation, project deliverable, peer evaluation, community organization feedback, mid semester interview; attendance; self-progress assessment
Liu, Y., & DeBello, J. E. (2018). Academic service learning in undergraduate and graduate computer science courses to foster engagement and real world experience. Journal of Computing Sciences in Colleges, 33(3), 135–140.	Development	Creation of a database for searching movies; scratch day; creation of an informational pamphlet on internet security	Database design and data warehousing	Prototypes, expo	Not mentioned
Lopez, D., Franquesa, D., Navarro, L., Sanchez, F., CabrÃĬ, J., & Alier, M. (2015, Oct.). Participatory learning process through ICT4D projects. In Proceedings of the 3rd International Conference on Technological Ecosystems for Enhancing Multiculturality (pp. 553–557).	Combination	Reuse workshop to refurbish and repair second hand; develop complete ICT system; healthcare systems	ICT4D	Not mentioned	Not mentioned

(Continued)

Table 7. Continued

Citation	**Project Type**	**Project Description**	**Course Subject**	**Deliverable to Community Partner**	**Assessment Method**
MacKellar, B. K., Sabin, M., & Tucker, A. (2013). Scaling a framework for client-driven open source software projects: A report from three schools. Journal of Computing Sciences in Colleges, 28(6), 140–147.	Development	Develop open source volunteer scheduling software for nonprofits	Web application development	Prototypes, expo	Not mentioned
Mankoff, J. (2006, April). Practical service learning issues in HCI. In Proceedings of CHI'06 Extended Abstracts on Human Factors in Computing Systems (pp. 201–206).	Development	Web access to database systems	HCI	Prototypes	Individual assignment
Marmorstein, R. (2011, June). Open source contribution as an effective software engineering class project. In Proceedings of the 16th Annual Joint Conference on Innovation and Technology in Computer Science Education (pp. 268–272).	Development	Contributions to open source community	Software engineering	Project deliverable	Project deliverable, student survey, project proposal
McCrigler, B. (2017, Aug.). Learn by doing . . . it wrong: Lessons from seven years of industry-led service learning. In Proceedings of the 35th ACM International Conference on the Design of Communication (pp. 1–7).	(Socio)technical support	Develop a full-service manual for a product	Technical communication	Full-service manual	Community organization feedback

(Continued)

Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
McLean, M., Susko, T., Harlow, D., & Bianchini, J. (2017, Oct.). Dancing robots: A collaboration between elementary school and university engineering students. In Proceedings of the 7th Annual Conference on Creativity and Fabrication in Education (pp. 1–4).	Outreach	Gender-neutral, collaborative dancing robot workshops (engage in engineering design)	Intro to engineering graphics	Prototypes, expo	Not mentioned
Mertz, J., & McElfresh, S. (2010, March). Teaching communication, leadership, and the social context of computing via a consulting course. In Proceedings of the 41st ACM Technical Symposium on Computer Science Education (pp. 77–81).	(Socio)technical support	Solving organizational problems using IT solutions	Technology consulting in the community	Presentation, consulting report	Presentation, project deliverable, description of client's organizational context
Murphy, C., Sheth, S., & Morton, S. (2017, March). A two-course sequence of real projects for real customers. In Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education (pp. 417–422).	Development	Develop an information system using agile methodology	Software engineering	Final report; handoff documentation so other students can continue the project	Project deliverable
Neyem, A., Benedetto, J. I., & Chacon, A. F. (2014, March). Improving software engineering education through an empirical approach: Lessons learned from capstone teaching experiences. In Proceedings of the 45th ACM Technical Symposium on Computer Science Education (pp. 391–396).	Development	Develop a platform to allow recording, representation, and distribution of information during urban emergency situations; also develop software to input, analyze, and share location data from wildlife	Software engineering	Prototypes, presentation, presentation at the end of each sprint	Presentation, project deliverable, have course grading distribution

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Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Ohashi, Y., & Yamachi, H. (2017, January). Developing evaluation criteria for a service-learning course in computer science education. In Proceedings of the 5th International Conference on Information and Education Technology (pp. 53–57).	Development	Develop information-based educational activities	Information education activities	Not mentioned	Student survey, monthly activity journal, final report, monthly meetings with professor
Olsen, A. L. (2008). A service learning project for a software engineering course. Journal of Computing Sciences in Colleges, 24(2), 130–136.	Development	Update current software for community partners	Software engineering	Prototypes, user manual	Project deliverable, peer evaluation, schedule of deliverables; documentation; personal evaluation
Osborne, R. B., Thomas, A. J., & Forbes, J. R. (2010, March). Teaching with robots: A service-learning approach to mentor training. In Proceedings of the 41st ACM Technical Symposium on Computer Science Education (pp. 172–176).	Outreach	Students meet with school-age children to work on robotics exercises	CS, education	After-school sessions, Science Days, competitions, teacher workshops	Reflection essays, peer feedback on reflections

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Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Pastel, R., Seigel, M., Zhang, W., & Mayer, A. (2015). Team building in multidisciplinary client-sponsored project courses. ACM Transactions on Computing Education, 15(4), 1–23.	Development	Create scientist-sponsored citizen science mobile apps	User interface design and implementation; CS/human factors	Prototypes	Reflection essays, presentation, project deliverable, student survey, project management documents; student survey to figure out how to improve course
Patricia, L. (2011, May). Service learning: An HCI experiment. In Proceedings of the 16th Western Canadian Conference on Computing Education (pp. 12–16).	Development	Redesign of a webpage by engaging in usability work	Web design	Prototypes	Reflection essays, project deliverable, peer feedback
Payne, B. R. (2014). Teaching Android and iOS native mobile app development in a single semester course. Journal of Computing Sciences in Colleges, 30(2), 176–183.	Development	Development of mobile apps and games	Mobile app development	Prototypes	Project deliverable
Pearce, J. L. (2011). Requiring outreach from a CS0-level robotics course. Journal of Computing Sciences in Colleges, 26(5), 205–212.	Outreach	Robotic demos with 2–4 year olds and pre-teens	Intro to robotics	Outreach program	Project deliverable, student survey

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Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Pollock, L., Atlas, J., Bell, T., & Henderson, T. (2018, Feb.). A computer science study abroad with service learning: Design and reflections. In Proceedings of the 49th ACM Technical Symposium on Computer Science Education (pp. 485–490).	Outreach	Creation of web-based learning games with local children and teachers in a foreign country	Learning game development; field experiences in teaching CS; computer ethics	Prototypes, coding camps	Reflection essays, project deliverable, peer evaluation, deliverable—computational artifact; lesson plans
Pollock, L., Mouza, C., Atlas, J., & Harvey, T. (2015, Feb.). Field experiences in teaching computer science: Course organization and reflections. In Proceedings of the 46th ACM Technical Symposium on Computer Science Education (pp. 374–379).	Outreach	Co-plan and co-teach computing lessons with a practicing teacher	Intro to CS teaching methodology	Prototypes	Reflection essays, project deliverable, 30% journal; 20% portfolio; 20% in-class participation; 20% mock teaching/presentations; 10% final reflective essay
Pulimood, S. M., Pearson, K., & Bates, D. C. (2016, Feb.). A study on the impact of multidisciplinary collaboration on computational thinking. In Proceedings of the 47th ACM Technical Symposium on Computing Science Education (pp. 30–35).	Development	Development of a web-based system that manages and provides information about potentially polluted properties	Software engineering; database systems	Prototypes, presentation	Student survey, self-assessments (pre/post)

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Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Purewal Jr., T. S., Bennett, C., & Maier, F. (2007). Embracing the social relevance: Computing, ethics and the community. ACM SIGCSE Bulletin, 39(1), 556–560.	(Socio)technical support	Community computer recycling program	Ethical and social aspects of computing	Not mentioned	Reflection essays, active participation
Quesenberry, J., Weinberg, R., & Heimann, L. (2013, May). Information systems in the community: A summer immersion program for students from historically black colleges and universities (HBCUs). In Proceedings of the 2013 Annual Conference on Computers and People Research (pp. 93–98).	Development	Developed information-based management and operation tools (databases, websites)	Information systems	Prototypes, presentation, creation of fully functional project; project plan	Presentation, student survey, pre/post survey; qualitative interviews
Rader, C., Hakkarinen, D., Moskal, B. M., & Hellman, K. (2011, March). Exploring the appeal of socially relevant computing: Are students interested in socially relevant problems? In Proceedings of the 42nd ACM Technical Symposium on Computer Science Education (pp. 423–428).	Development	Development of search and rescue software	CS	Not mentioned	Student survey
Reid, J., & Slazinski, E. (2003, Oct.). Successful knowledge transfer and project deployment in a service learning program. In Proceedings of the 4th Conference on Information Technology Curriculum (pp. 222–225).	Development	Created a custom database application to track clients for a local judicial government agency	CS, software development, engineering	Presentation, team transition checklist; design notebook	Presentation, project deliverable, design review; communication practices

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Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Reiser, S. L., & Bruce, R. F. (2009, March). Fabrication: A tangible link between computer science and creativity. In Proceedings of the 40th ACM Technical Symposium on Computer Science Education (pp. 382–386).	Outreach	Create mazes with CNC Mill with middle school students	3D modeling and fabrication	Outreach program	Student survey
Reiser, S., & Bruce, R. (2008, March). Service learning meets mobile computing. In Proceedings of the 46th Annual Southeast Regional Conference on XX (pp. 108–113).	Development	Developed mobile tour for an arboretum	HCI; Database management systems; systems integration	Prototypes	Not mentioned
Robinson, S., & Hall, M. (2018, Feb.). Combining agile software development and service-learning: A case study in experiential IS education. In Proceedings of the 49th ACM Technical Symposium on Computer Science Education (pp. 491–496).	Development	Develop deployable software based on agile methods	Agile development methods	Prototypes	Reflection essays, peer evaluation, time management; student feedback; participation grade
Rosmaita, B. J. (2007, March). Making service learning accessible to computer scientists. In Proceedings of the 38th SIGCSE Technical Symposium on Computer Science Education (pp. 541–545).	Development	Produce an accessibility and general usability audit of the websites of local nonprofit groups; redesign webpage	Web design for accessibility	Presentation, demo	Reflection essays, presentation, audit documents

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Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Rusu, A., Rusu, A., Docimo, R., Santiago, C., & Paglione, M. (2009, March). Academia-academia-industry collaborations on software engineering projects using local-remote teams. In Proceedings of the 40th ACM Technical Symposium on Computer Science Education (pp. 301–305).	Development	To specify, design, implement, and test a commercial-grade working product with professional quality documentation within the span of a semester	Software design methods	Prototypes, presentation	Not mentioned
Sabie, S., & Parikh, T. (2019, May). Cultivating care through ambiguity: Lessons from a service learning course. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (pp. 1–14).	Combination	Created a Google map of green spaces; designing a new website; web literacy cards for seniors	Graduate-level technology	Prototypes, presentation, speculative design component (think about a project that would impact the community in 3–5 years)	Reflection essays, presentation, project deliverable, semi-weekly project share outs; interview
Sanderson, P., & Vollmar, K. (2000, March). A primer for applying service learning to computer science. In Proceedings of the 31st SIGCSE Technical Symposium on Computer Science Education (pp. 222–226).	Development	Database management applications (tracking clients, client databases)	Service learning in CS	Prototypes, presentation	Reflection essays, presentation, community organization feedback, 40 hours of service work; performance evaluation with service learning office

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Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Scorce, R. A. (2010). Perspectives concerning the utilization of service learning projects for a computer science course. Journal of Computing Science in Colleges, 25(3), 75–81.	Development	Development of a database	CS database management	Prototypes	Not mentioned
Stanley, T. D., & Colton, D. (2009, Oct.). Six years of sustainable IT service learning. In Proceedings of the 10th ACM Conference on SIG-Information Technology Education (pp. 87–90).	(Socio)technical support	Service troubleshooting help and repair advice	Intro to computer hardware and operating systems	Fixed computers	Participate as part of lab grade; comments
Stewart, K. (2009). 3D game programming as service-learning for CS students. Journal of Computing Sciences in Colleges, 24(4), 246–251.	Development	Created a 3D game to support high school curriculum	Game programming	Prototypes	Project deliverable, peer evaluation, research report on game-related topic
Stone, J. A., & Madigan, E. (2011). Experiences with community-based projects for computing majors. Journal of Computing Sciences in Colleges, 26(6), 64–70.	Development	Web design, systems design, digital storytelling	Information and organizations	Prototypes	Not mentioned

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Table 7. Continued

Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Tan, J., & Phillips, J. (2005). Incorporating service learning into computer science courses. Journal of Computing Sciences in Colleges, 20(4), 57–62.	Development	Employee tracking system; inventory control system	Database-driven systems	Interviews with users, prep of surveys for users, documentation; client updates	Exam, project deliverable, individual and group component; professional technical documents; team meeting attendance; biweekly individual reports
Tashakkori, R., & Andrews, Z. W. (2018, March). A team software process approach to database course. In Proceedings of the ACMSE 2018 Conference (pp. 1–7).	Development	Database for scholarship program to manage activities and student records, and a parks and records database to maintain registration and manage sport activities	Database	Prototypes	Exam, project deliverable, peer evaluation
Thoms, B., & Eryilmaz, E. (2018, Feb.). Social software design to facilitate service-learning in interdisciplinary computer science courses. In Proceedings of the 49th ACM Technical Symposium on Computer Science Education (pp. 497–502).	Development	Design of specialized social networking software	Internet-based social networking	Prototypes, expo, consisted of guidelines, best practices, and tutorials	Project deliverable
Traynor, C., & McKenna, M. (2003). Service learning models connecting computer science to the community. ACM SIGCSE Bulletin, 35(4), 43–46.	Outreach	Partnership with senior citizens and third graders; undergrads teach senior citizens basic computing, and senior citizens interact with the third graders	Computer applications; HCI	Prototypes	Reflection essays, project deliverable, informal feedback, 20 hours of service

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Citation	Project Type	Project Description	Course Subject	Deliverable to Community Partner	Assessment Method
Venkatagiri, S. (2006, May). Engineering the software requirements of nonprofits: A service-learning approach. In Proceedings of the 28th International Conference on Software Engineering (pp. 643–648).	Development	Develop software requirement specification and prototype of a proposed solution for a nonprofit	Software engineering	Prototypes	Project deliverable, less than 50% created satisfactory deliverables
Watson, R. B. (2018, Aug.). Enriching technical communication education: Collaborating across disciplines and cultures to develop the piClinic Console. In Proceedings of the 36th ACM International Conference on the Design of Communication (pp. 1–6).	Development	Low-cost patient information system	Technical communication	Prototypes	Not mentioned
Webster, L. D., & Mirielli, E. J. (2007, Oct.). Student reflections on an academic service learning experience in a computer science classroom. In Proceedings of the 8th ACM SIGITE Conference on Information Technology Education (pp. 207–212).	Development	Development of a comprehensive information system for a nonprofit	Topics in programming; technical software engineering	Prototypes	Reflection essays, reflection built into course activities and part of final writing assignment
Werner, M., & MacLean, L. M. (2006). Building community service projects effectively. Journal of Computing Sciences in Colleges, 21(6), 76–87.	Development	Develop database system using a web-based interface	Software design	Prototypes	Not mentioned
Yilmaz, M., Ozcelik, S., Yilmazer, N., & Nekovei, R. (2012). Design-oriented enhanced robotics curriculum. IEEE Transactions on Education, 56(1), 137–144.	Outreach	Mentoring; basic robotics programming	Robotics	Outreach program	Documentation, participation

ACKNOWLEDGMENTS

We are deeply thankful to our informants who took the time to share their experiences and reviewers whose excellent suggestions helped us to improve the article.

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Received 20 June 2022; revised 20 April 2023; accepted 14 July 2023