

# A scalable model of community-based experiential learning through courses and international projects

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**Abstract**— Partnering students with community clients can have positive learning and community service outcomes. There are challenges, however, defining and assessing curricula learning goals, evaluating community impact, and achieving significant scale, while not overwhelming faculty schedules. We present a model of engaging students with community clients that we have developed over 20 years and have used in multiple modes. Our model defines the students' roles in consulting terms, which allows us to broaden their perspective. Their goal is to help an organization solve a problem, expanding their responsibilities beyond just implementing a system. Ongoing instruction scaffolds the students' experience. The faculty's role is intentionally somewhat detached, serving as an advisor, but not involved as a team member. We use this model in three modes: a consulting course in which individual students work one-on-one with clients; a summer internship program in which students consult with partners in developing communities; and a large required course in which small student teams develop custom software solutions for community clients. Learning goals for all modes include: work with a client to broadly understand their context and to structure an authentic problem; recommend, design, and develop sustainable solutions; communicate and collaborate effectively; and demonstrate good project management.

**Keywords**—Service Learning; ICTD; Consulting; Sustainable Development; Project Course; Capstone; Experiential Learning

## I. INTRODUCTION

Research shows that real-world / project-based courses better prepare students for jobs in industry [e.g., 2, 8, 12, 16]. As such, the Curriculum Guidelines for Undergraduate Degree Programs in Information Systems and Computer Science emphasize in their model curricula the importance of real-world engagements [9, 15]. Furthermore, an IEEE meta-analysis of higher education research found that “more concrete, nontechnical skills like project management, business knowledge, and understanding methodologies are agreed to be areas for improvement in preparing ICT graduates for the job market” [1, pg. 4].

In a globally interdependent world, these technical and nontechnical skills are valuable not only in industrial and corporate settings, but in all sectors of society including nonprofits, schools, hospitals, and government agencies. The public sector has traditionally underinvested in technology [see e.g. 6], and while this is a problem for those organizations, it is

also an opportunity for students. While individuals or teams of students cannot have a big impact in a company with a full IT department, these same students can bring substantial benefit to a nonprofit organization without such a department.

This is true not only domestically, but globally. It is difficult for students to learn to work across cultures without doing so. They need opportunities to develop cultural intelligence --- to be able to go into a new culture and be effective quickly. They need to be adept at the practical logistics of foreign travel. They need strategies to prepare for work in a new culture and to communicate across age, gender, language, and technical ability. And they need to work in ways that brings sustained value to their clients. These are all skills that are not effectively taught in a classroom. Rather, they require students to face challenges and build their own skills. These experiences lead to knowledge that students can take into their personal and professional lives. The students develop confidence that will allow them to take risks, find opportunities, and work effectively in the global community.

Experience in real-world / project-based courses in the computing field is often based on developing solutions for clients' technical problems. In such classes, faculty typically spend significant time helping clients define and scope the project before students get involved. Software development is often the end goal, and clients are left to integrate the solution, which may or may not be complete and workable, into their operations. The richer context of organizational, teamwork and communication problems in professional practice is often underplayed [e.g., 7, 13]. Student designs often fail or are incomplete due to a neglect of essential usability, maintainability, organizational and sustainability constraints. Because a software system is only one component of a business solution, other factors such as user training, application deployment, integration with legacy systems, and maintenance plans must be considered in the client engagement.

Service learning community partners expect a tangible benefit for their time investment. Providing lasting value to community partners should, in practice, be a key objective of any serious engagement. However, as Connolly [3] argues, the needs, concerns and ultimate outcomes for community partners are often overlooked or forgotten. Solutions that are incomplete, poorly implemented, poorly documented, inappropriate to the problem at hand or simply unsustainable may provide little or no value to community partners. In fact,

as Connolly suggests, these solutions may actually be detrimental to partner organizations.

When students look beyond the technology, they learn that technical systems live within, support, and are supported by, social systems. For the students' solution to be sustainable, their vision must include all the factors needed to help their client be more effective in using systems to improve operations, products, or services. This means demonstrating competence in leadership, communications skills, problem solving and project management.

We have developed a consulting model of student engagement with community clients. The goal of this paper is to describe the model and how it has been used in three different modes of experiential learning: an elective consulting course, a summer experience working abroad, and a core required team-based project course.

This model has been reported elsewhere [10, 11] in regards to the first two of these modes. The intention of this paper is to review the first two and then describe the third and newest mode. This newest mode is the most easily replicable at other universities because it serves the most students with the fewest faculty resources.

## II. A CONSULTING MODEL OF STUDENT ENGAGEMENT

### A. Background

The consulting model is informed by Schein's process consulting model [14] and participatory research.

Process consulting is a way of working with, not for or independent of, the client. It involves working in partnership with the client to better understand and bring structure to a complex problem, then co-design and implement a solution that the client can not only use, but can manage and sustain.

Participatory research practices came out of community-based health research. [4]. The practices are not a set of steps, but rather an attitude and approach to working in a collegial partnership with communities, with some humility and respect for their knowledge and ways of knowing.

Building on these insights, the consulting model teaches students how to work with clients to bring about sustainable organizational change using technology. This is not difficult for students to do once we have clearly defined for them their role, goal, and responsibilities.

### B. Role, Goal, and Responsibilities

**Role:** The student's role is defined as a consultant working in partnership with, not for, a client. The student consultant is expected to lead the partnership through a process exploring and bringing structure to a problem, identifying alternative technical solutions, analyzing alternatives and recommending a solution, then designing and implementing the solution while keeping the client involved in all decisions that will impact their ability to not only use but maintain and sustain the solution. Capacity building in terms of both individual learning and organizational change in the client organization are critical parts of the consulting activity.

**Goal:** The student consultant's goal is to help a client to better meet their mission using technology. In that role they may spend time doing system design and implementation, but those roles are subordinate to their more comprehensive goal of solving a problem. Beyond developing a technical solution, students must focus on the social systems that will support, as well as be supported by, the technical solution.

**Responsibility:** Students are responsible for all aspects of relationship management, project management, and communication. Faculty play an important, but deliberately limited role acting only as advisors. Students must step into the leadership role. Faculty advisors focus on how the team is managing relationships, process, and communication, and less on the project itself.

### C. Instruction

Instruction is provided for all stages of the engagement process. The topics include

- Relationship management
- Structuring unstructured problems
- Researching alternatives and best practices
- Crafting a proposal and scope of work
- Project and team management
- Communicating technical ideas
- Capacity building and sustainability
- Documenting and analyzing outcomes

### D. Faculty role

The faculty role in this model is different than in many project-based courses in what preparation they do with the client ahead of time, and how they engage with the student consultants during the engagement.

**Client recruiting:** When recruiting clients, an emphasis is put more on assessing whether the client will be willing to work with the student consultants than on pre-defining what the project solution will be, and on making sure they have reasonable expectations regarding the potential solution. With many project-based courses, faculty spend a lot of time working with a client to determine what the scope of work will be. This misses an opportunity to have students learn from doing that inquiry and analysis themselves. Faculty vet the situation enough to anticipate whether the client's need is generally feasible and the few ways the engagement will likely play out, but leave the full inquiry, analysis, and scoping to the students.

**Teaching:** Before and during the consulting engagement, faculty teach classes covering the topics listed earlier and addressing issues that the students will soon need to deal with.

**Advising:** Throughout the consulting engagement, faculty advisors stay informed about how things are going via the students' proposal, weekly status reports, interim deliverables, and short meetings. They advise on all aspects of the students' activities and products. The faculty member is not, however, a

member of the team, does not meet with the client directly, and does not contribute to the project. As will be discussed in more detail later, this allows the model to scale to large numbers of students because faculty do not spend too much time on any given project. Students also appreciate the autonomy and authority they have in managing their own client and project.

### III. THREE MODES

This consulting model of community-based experiential learning has been used in three modes, two of which are courses and the third a summer working abroad experience.

#### A. An elective individual consulting course

The model was first developed in 1998 as an elective full-semester course in computer science. It has since been replicated as undergraduate and graduate versions of an information systems course<sup>1</sup>. This course has been described fully in [10].

**Student / Client relationship:** In this course, individual students work one-on-one with a community organization. In this way every student gets the opportunity to develop the technical leadership skills such as relationship management, meeting management, and crafting the proposal.

Typically their client partner is a leader in a nonprofit organization, school, municipal agency, or minority-owned startup. Because the student consultant is working alone, rarely would developing custom software be achievable or sustainable. Therefore the best client matches are those organizations with problems for which existing commercial, open source, or cloud-based solutions exist.

**Scalability:** This course has been taught for 21 years, and sometimes twice a year. Class size of 15-20 is typical, but classes have been as large as 30. The faculty role is to teach the class twice a week, provide extensive feedback on the proposal and final report drafts, manage teaching assistants (TAs), meet with students when special situations arise, and occasionally check in with clients. Students who have previously done well in the class are hired as TAs. They grade weekly homework assignments and carefully read weekly student status reports in order to update a course dashboard. The dashboard is then reviewed in a weekly meeting with the TAs to identify students and/or clients that the faculty member needs to follow up with. Recruiting 15-20 clients each semester is perhaps the most difficult challenge, but after years of success clients help recruit other clients.

#### Example solutions:

- Developed a database for a local parks conservancy to store and retrieve its collection of over 30,000 park photographs.
- Helped an organization to adopt cloud-based customer relationship management (CRM) system for donor and customer relationship management.

- Developed and implemented an analytics strategy to monitor and improve constituent and donor engagement.
- Designed and built a movable Skype cart to facilitate communication between hospital residents, staff, and their families.
- Repurposed support-ticket tracking software to allow a nonprofit organization collaborating with a government agency to co-manage finding housing for low-income clients.

#### B. A summer experience working abroad

In 2004 the model was adapted for use in a summer program. Technology Consulting in the Global Community (TCinGC) places student consultants in low-resourced, developing communities globally<sup>2</sup>. Each summer, TCinGC matches students with government ministries, nonprofit organizations, schools, or small businesses in international locations. It is a ten-week program using the same consulting model, but on a full-time basis while students live abroad. It is similar to an internship in that students are using and reinforcing their knowledge and skill, but different in that it is an actual consulting engagement. The student consultant does not have a supervisor who can mentor and advise them on a project. Rather, like in the prior course, the student leads a process from understanding the problem through sustainably integrating a solution into the organization. This program has been more described fully in [11].

Students are selected as part of a competitive application process and receive 20 hours of orientation training ahead of traveling abroad. Training covers instruction similar to the semester course as well as topics such as foreign travel logistics, intercultural intelligence, and safety and security while abroad.

The students' first task is to broadly understand the problem and its context, and the orientation training provides guidelines for how to do so. Defining a feasible scope of work for a sustainable solution, however, is beyond the students' ability without good advising. Therefore during the students' second week, a faculty advisor visits the location to help advise them in crafting the scope of work. This visit also allows the faculty member to advise the client in how to best work with the student consultants, develop additional partnerships for future years, and ensure that the accommodations are safe and stipends are being paid.

The TCinGC program covers student and advisor travel costs to and from the foreign location, with funds raised from university sources and donors. Faculty advisors volunteer their time in return for the foreign travel experience.

**Student / Client relationship:** International clients are selected on similar criteria to local ones. Most important is their interest in not only getting a solution, but in working with the student consultants to understand the solution and build the new organizational capacity to use, manage, and sustain the solution. In addition, the client is responsible for providing

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<sup>1</sup> See <https://cmu.edu/tcinc/>

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<sup>2</sup> See <https://cmu.edu/tcingc/>

accommodations and a basic stipend to cover means and incidentals. The stipend is determined for each location so that students have enough money to support themselves while they are there and are not using their own money.

Typically, client partners are leaders in nonprofit organizations, schools, government ministries, or small businesses that contribute to the social good. Depending on the client resources, students may work alone or in pairs. In any case, we ensure that there are at least two students working in each foreign location for social support. Depending on the situation, the students may use commercial, open source, or cloud-based solutions. Because they are working full-time for ten weeks, students can also develop custom software if it is appropriate and sustainable.

**Scalability:** This program has been in place for 15 years and has placed over 100 students in 44 organizations in 14 countries. In a typical summer, 10 students work in 2-3 countries.

The number of students we can place is bounded by the funds available. We often have excellently-qualified students we cannot place and interesting international partnerships we cannot fill. Because our international partners provide accommodations and a stipend, our cost-per-student is similar to the cost of studying abroad for a semester. It is important to the program, however, that students not be asked to pay for the experience. Focus group feedback has been very clear that while students highly value the experience, and would afterwards be willing to pay to support it, the fact that they were being paid changed the expectations they felt to provide value to their client. If this had been a volunteer tourism arrangement in which they were paying for the experience, then they would not have felt the same responsibility. And furthermore, student participants already forego making money for the summer, fewer would be willing to also lose money.

**Example solutions:**

- Five student consultants over 4 years have worked with the Palau Financial Intelligence Unit to develop their ability to automatically import and manage data from banks and use it to build intelligence to counter money laundering.
- Designed and built a hybrid tablet app to help teachers create lesson plans that align with Palau Ministry of Education curricular goals.
- Developed a robotics curriculum, held workshops for teachers, and created a roadmap to build a robotics program in a Philippines high school.
- Developed a Farm Information System to better manage fields and crops used to support operations of an orphanage in Rwanda.
- Helped Palau Community College develop a sustainable web presence, [pcc.palau.edu](http://pcc.palau.edu), using WordPress.

*C. A required team-based course*

In 2014, colleagues reengineered a required senior-year capstone course using this model. The prior course had been a requirement for well over two decades. Large student teams (typically comprised of 5 students) worked closely with a faculty advisor to build a software system for a community client. In a master/apprentice approach, an advisor took a very hands-on role with each team, meeting with them for at least two hours each week. The team's primary goal was to deliver a software system, and toward that end they would meet occasionally with their client and then present and turn over the system at an end-of-semester meeting. Student satisfaction with the course was not high, the free-rider problem was common, and faculty estimated that only a quarter of solutions were sustainable. And finally, given the amount of time the projects took for each faculty member, the approach would not scale with increased enrollments.

In moving to the consulting model, student teams were reduced to 3 or sometimes 4 members. The whole class meets twice weekly on campus for 80 minutes. The first two weeks prepare students to understand their role, goal, and responsibilities. Teams initially meet their clients in week 3 after the partners have received a separate orientation on the consulting process and instruction on working with students. For the remainder of the semester, one weekly class is used for continued instruction on the topics listed earlier. During the other class time, each team meets with its assigned faculty advisor for a 20-minute, student-driven, status meeting. If necessary, an additional advisor meeting is arranged on an ad-hoc basis.

Moving to the consulting model was beneficial in several ways:

- In reflections, students mention that they worked hard to ensure their deliverables were aligned with *their client's mission and goals*. Students also feel that they would *be less hesitant to push the clients towards a certain choice* if it were not in the organization's best interest.
- Clients, in turn, generally report the engagement was helpful and often return for multiple engagements.
- Faculty find the class time easier to manage. Two faculty share leadership of the course, and make sure all materials and logistics are in place. They also teach a larger share of the whole-class meetings. Other faculty will teach 1-2 whole-class meetings a semester, and advise three teams on a weekly basis during a single 80-minute period. All faculty meet once a week for an hour to coordinate activities and share advising advice.

**Student / Client relationship:** As in the individual consulting course, clients are leaders in a nonprofit organization, school, municipal agency, or minority-owned startup. In a given semester, typically a few are on-campus departments, most are local organizations, and a few are remote. We have had very good success with organizations as far away as Virginia, Massachusetts, and Alaska as long as they are willing to still put in the time necessary each week to

work with the student teams. While local teams most often meet in person, remote teams meet via videoconference and make heavy use of asynchronous communication.

The small teams are also quite capable of delivering custom software applications. When recruiting clients, faculty look for situations in which there is not readily available solutions so that it is more likely that they will have to develop custom software. Once the students complete their inquiry and analysis, however, commercial, open source, and cloud-based software might still play into the solution.

**Scalability:** For the past 5 years we have had 50-60 students in each class. This required around 16 clients, and 5-6 faculty. As previously mentioned, two of the faculty share responsibility to manage the class each advise three teams. The remaining faculty advise three teams in one 80 minute class meeting per week, teach one class meeting, grade their teams 2 major reports, meet as a team with all faculty advisors, and meet with teams as needed for special situations. All told the time commitment is much less than the former master/apprentice model of advising teams.

#### Example solutions:

- Developed a responsive web app that allows the Holocaust Center of Pittsburgh to create and showcase stories and artifacts from their collection.
- For the university contracts office, developed a web application to scrape and analyze the terms and conditions of software contracts.
- For the NOAA Kodiak Lab, developed tool to filter and analyze crab oocyte images to facilitate research into the effect of climate change on crab fisheries.
- Built a web application to help the Beaver County Humane Society more effectively manage placing animals into foster care.
- Created a responsive web application for administrators, volunteers, and coaches of the Best of the Batch Foundation to more effectively manage their signature after-school and summer programs.

#### IV. DISCUSSION

The consulting model has been flexibly adapted to provide multiple options of community-based experiential learning for students. At the same time, it has provided a valuable service to local and global community organizations and government agencies.

One very well developed model of service learning in engineering and computing is Engineering Projects in Community Service (EPICS). EPICS shares many similar goals with our work for their intention was help students develop skills in working in teams, communicating effectively, managing projects, and ethically work across cultures. And their vision was that the partnership would provide two benefits: “academic credit for engineering students via long-term, large-scale, real-world design projects that benefit the community; and access for the community partners to the low-

cost technical expertise they needed to improve their capability to serve the community.” [5]

The consulting model is meant to fill a different niche. In all three modes, the consulting engagements are discrete and fixed term. Because they are full-semester classes or summer experiences, they involve higher student time commitment per week --- the classes about twice the EPICS norm. Students only take the course or participate in the program once. While we may engage with the same client several times, the results of each engagement should be complete and not dependent on future work. (Of course future engagements can build on the past.) This allows us to have minimal administrative infrastructure to keep things running.

Over the years we have developed full syllabi, assignments, grading rubrics, example reports, and client management practices. However, these artifacts are not as important as the partnership and problem-solving mindset we communicate to students. That includes first clarifying that their role is to help by working-with, instead of doing-for the client. Second, setting as their goal to help solve the client’s problem, not merely demonstrate their system development prowess. And third, giving them responsibility to manage all aspects of this helping relationship. Once the student or student team understands these three simple concepts, then all their disciplinary knowledge and skills can come into play in an appropriate way. And in doing so, they will provide sustainable benefit to their community client, and reap the personal benefits that come from community-based experiential learning.

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