

Engagement in Practice: Computer Science Combating Crime in Houston (Collaboration between Houston Christian University and Crime Stoppers of Houston)

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Abstract

Recent statistics have shown that nonprofit organizations are considered the third largest workforce in the United States after retail and manufacturing. Unfortunately, unlike retail and manufacturing, the lack of financial support and in-house expertise has resulted in many nonprofits falling short of technological advancement including proper custom software solutions. This paper describes the approaches taken by the Computer Science program at Houston Christian University to engage the students with Project Based Service Learning through partnerships with Crime Stoppers of Houston. The paper will present the details of how this collaboration started, the challenges encountered, the outcomes, and the lessons learned. The paper will also reflect on the general incentives and challenges that are associated with Project Based Service Learning.

Introduction

Over the years universities have been looking for creative ways to create more engaging STEM programs to increase admissions into these programs, increase diversity, retention, and graduation rates, and produce graduates who are competent enough for the job market. The pedagogical approaches that universities adopted evolved over the years to demonstrate an interesting evolution to the education system, some of these approaches include:

- *Active Learning*: This approach emphasizes student engagement and participation in the learning process through activities such as group discussions, debates, and analyzing different case studies. This approach is based on the idea that students learn best through hands-on activities and interactive experiences [1, 2].
- *Project-Based Learning*: This approach focuses on a real-world or simulated set of problems and challenges as the starting point for learning to promote critical thinking, problem-solving, and collaboration skills among students. The students learn the theories while simultaneously applying them using hands-on projects. This approach has been very effective across the borders of different STEM and engineering disciplines [3, 4].
- *Flipped Classrooms Learning*: This approach reverses the traditional teaching and learning processes by having students watch videos and complete readings before class using class time to complete hands-on activities, problem-solving, and discussions [5].

- *Project-Based Service Learning*: This approach has also been referred to as *Community Engaged Learning*. Through this learning approach, the students work alongside organizations from within the community to help design and build solutions for their various needs [6–8]. While there haven't been yet significant published statistical results to measure the added value of service-based learning, especially when coupled with project-based learning, we decided to adopt this approach at a small scale and analyze its feasibility and effectiveness.

The engineering program at Houston Christian University is a new startup program that started in 2018 and includes BS degrees in Cyber Engineering, Electrical Engineering, and Computer Science. The degrees were established upon the foundations of a series of carefully designed project-based labs referred to as SAFE (Securing America's Future through Engineering) labs. All courses include hands-on activities of either pre-defined projects or open-ended students' chosen projects. To further align the SAFE mission with the degree plans, we decided to integrate our project-based learning with service and community-engaged learning. The goal is that students would find true value in their technical and academic studies by putting them into practice through community service.

We started by approaching nonprofit organizations from within our community. The lack of financial support for many nonprofit organizations induced several technologies and performance gaps which in turn can result in ineffective management and communication, an uninspired donor base, and a lack of data-driven decision-making [9, 10]. For these reasons, we chose to partner with and support nonprofit organizations to help them bridge their technology gaps by providing custom-built software tools for their operational requirements.

The remainder of this paper will elaborate on how the partnership started, the challenges we faced through the process, and how some of these challenges led to adjustments in our approaches. Some of the challenges are still to be looked into and would require some strategic and creative solutions to solve in our future expansions of community-engaged learning.

The Starting Point: Capstone Projects

Our Computer Science degree program requires students to complete a series of two courses: Senior Project I and Senior Project II. During these courses, the students work in teams on an open-ended design project that draws on the student's entire academic experience with emphasis on idea generation, design and implementation of a system, and the application of engineering ethical decision-making and social responsibilities. Students are encouraged to choose projects that tackle real-world problems through industry or community-sponsored projects.

To help the students find community projects to work on, we reached out to both the CEO and the director of the Safe Community Institute of Crime Stoppers of Houston to discuss ways of collaboration. We were welcomed by their team, and they showed great interest in our mission statement – SAFE. After several mutual visits, brainstorming meetings with our senior students, faculty, and college leadership we decided to start our partnership by building a full-stack web support system for Crime Stoppers data analytics research center.

Crime Stoppers of Houston staff regularly perform manual data retrieval from public records for thousands of datasets collected from the Harris County District Clerk office, Houston Police

Department reports, District Attorney offices, Harris County Coroner reports, and others. The data size and scope of work are too big for manual processing making it extremely tedious to extract any meaningful information on the crime patterns in Harris County (the second largest county in the US). The objective of the research center is to track crime trends in the Greater Houston Area and make it available to the public through a website so that community members can have a transparent view of the criminal justice system in Harris County.

The project started with two Computer Science students building this system as part of their capstone senior projects. Throughout the academic year of 2021-2022, they designed and developed the back-end database, automated the data entry process, and designed the front-end website with a visualized data analytics dashboard. The students interacted with Crime Stoppers staff members throughout the year and they presented their work at the end as part of their Senior Project II course requirements.

The project presented a proof of concept, but the end product was incomplete. Unfortunately, at the time the students were working on the project, Crime Stoppers did not have access to all data sources needed to perform comprehensive analytics of crime trends. Without having all the data attributes, the back-end database design and the analysis of the data would be incomplete.

Lessons Learned: Just like with any software development process, the system design, implementation, and testing phases need to go into multiple refinement stages in an agile pattern. This means that system developers need to accommodate constant changes in the inputs, functional requirements, and output specifications. If students start working on a long-term, large-scope community project during their senior year, they will not get the opportunity to continue working on the project beyond graduation.

We concluded that it would be more effective if students start working on large multi-phase community projects earlier than senior year, preferably starting in their second year. This approach will ensure they have the opportunity and the motivation to continue working on the project up until their senior year.

A Modified Plan: Internships

Once Crime Stoppers acquired more datasets, we reevaluated the project design. Since the progress of the project was time sensitive for Crime Stoppers, we had to resume the work over the summer instead of waiting till the Fall semester starts (given that we do not offer Computer Science courses in the summer). To allow our students to work on the project over the summer we requested grant funding from Crime Stoppers to compensate the students. This approach did not work out since they did not have the accounting means by which they can give grants to other non-profit institutes. Instead, they decided to hire two summer intern students. This worked well since all students are required to complete a technical summer internship as part of their degree requirements. We advertised the opportunity for the junior Computer Science students and selected two of them for the internship. The senior students who started the work met with the new students and handed over the project to them.

The intern students were supervised by both Crime Stoppers staff and Computer Science faculty to ensure that the system specifications are well defined, the design and implementation aspects are correct, efficient, and scalable for future expansions. By the end of the summer the students'

work resulted in the launch of the Glenda Gordy research center website of Crime Stoppers of Houston [11]. The students continued working on the project during their senior year.

As of January 2023, the website has processed 998,765 datasets consisting of data from 747,186 individual cases from the years 2014 - 2022. Most of the data was previously manually gathered, but all data following June 2022 has been gathered automatically by pulling the publicly posted monthly datasets on the Harris County District Clerk website. The data is entered into a MySQL DBMS running over Azure cloud services. The back-end code was written mainly using Python scripts and the front-end dashboards were generated using Tableau Data Analytics tools. Additionally, the system has processed 839,626 rows of data from manually compiled HPD reports and 2,800 rows of data from requested Harris County Coroner reports.

The project is expanding, and we are currently looking to add more students to work on other parts of the project, but we are refining the community collaboration model to experiment with a different approach.

Lessons Learned: Allowing students to work on community projects over the summer as interns provides an opportunity for them to practice their interpersonal and technical skills by working on real-world problems. These experiences prepare students for their senior year and allow them to work on these projects as part of their senior design project increasing their chances of completing the development and deployment of the project by the time they graduate.

A Better Plan: Courses Integration

From the previously mentioned lessons learned, we decided to integrate the community projects with some of our core Computer Science courses to start the initiative of Project-Based Service Learning. We selected the following courses: COSC 2355 (Database Management Systems), COSC 3354 (Web Application Programming), COSC 4352 (Software Design and Engineering), COSC 4381 (Data Analytics), and ENSC 4311/ENSC 4312 (Senior Project I and II).

These courses require an open-ended course project as part of the coursework and collectively they define a streamlined pathway for many real-world projects. Therefore, weaving community projects within these courses provides the means to sustain the projects over multiple semesters allowing enough time for development, testing, scaling, and improvements to be made.

Outcomes and Next Steps

Our initiatives with Project-Based Service and Community learning are in their early development phases with significant opportunities for improvements. Fortunately, we can experiment with different approaches with flexibility due to our small class sizes and the willingness of our faculty to support collaborative projects within their courses. While we have not yet utilized formal assessment models for service-learning projects to evaluate the impact on student learning and partners benefits, we have received great feedback from both Crime Stoppers and our students.

One of the students who worked on the project reported her experience by saying:

“Working on this project has given me the opportunity to develop my technical and non-technical skills. I was able to practice some of the skills I learned in my courses at HCU and improve upon my soft skills - such as communication, problem-solving,

and self-motivation - through working together with my co-workers, having meetings with my supervisor and working on the projects assigned to me. Overall, I can see how the things I learned in academia can be applied to the industry.”

CEO of Crime stoppers of Houston reported in a podcast recording saying:

“The value of working with your program and students goes beyond words. It elevates the entire research center to say that we are doing this in partnership with academia.”

Our successful collaboration with Crime Stoppers of Houston allowed us to take on another project with another nonprofit organization called Demand Disruption. One of the organization’s activities is tracking suspected illicit massage businesses that are involved in human sex trafficking activities. The technological needs of this organization are similar to those of Crime Stoppers. Two students started working on this project as part of COSC 2355 and COSC 3354 courses. Later, two of our veteran Cyber Engineering students joined forces on this project.

Crime Stoppers are looking into hiring more of our students as summer interns to continue working on some other urgent projects examples include: automating their Tipline services, creating interactive maps of Houston’s food and Internet deserts, and other projects. Interestingly, Demand Disruption data is valuable for Crime Stoppers, therefore soon we will be able to integrate the two systems to build a more comprehensive data analytic model for both organizations. The projects will carry over from summer projects into Senior Projects.

Incentives and Challenges

While integrating project-based learning with community services is not a straightforward process and requires substantial planning efforts, we were able to see the positive outcomes that would motivate us, and hopefully others, to adopt community partnerships with students’ projects. Some of the positive outcomes are:

- Students have early exposure to solving real-world complex problems which improves their critical thinking, creativity, teamwork, and leadership skills.
- Students can build stronger portfolios and resumes to aid them with job placements.
- Increased opportunities for summer internships if students are hired by non-profit organizations to work as interns.
- Students can see the true value of the academic skills they are acquiring through their coursework.
- Advertising engineering and STEM academic programs that focus on academic and community partnerships would appeal to a wider range of high school students, hence increasing interest in these degrees with higher retention and graduation rates.

Integrating project-based service learning with courses can introduce challenges that would not typically exist in regular traditional academic courses, some of these challenges are:

- The community project purpose and timeline need to align with the course(s) learning outcomes and deliverables. Some organizations would have urgency to complete projects

within a certain time frame that will not fit with the progress of courses. For this reason, during the partnership initiation phase, timeline expectations must be discussed and agreed upon by all involved parties (faculty, community partners, and students).

- Several implementation and deployment challenges must be considered in delivering the projects to the community. These could include regulations, liability, ownership and copyrights, IT infrastructure constraints, and sustainability.
- Regular site visits with the organizations are particularly important; this can be difficult to manage with large class sizes and scheduling conflicts.
- Faculty might find these types of projects more time-consuming than regular project-based courses that have a pre-defined set of projects with well-defined set of outcomes. Coordinating multiple independent projects means extra faculty load due to the inevitable need to micromanage all projects.
- The planning phase for community projects should start several weeks or months before the beginning of the courses. This is critical to the success of students and the projects while ensuring that the community goals are well served.
- Students failing to complete the tasks efficiently and on time would potentially hurt the ability to continue the projects across multiple courses and would negatively affect the timeline and outcomes. This might lead to restarting the project again with different sets of more competent students.
- Students working in teams on long-term community projects would preferably be on the same degree pathway to ensure consistency and ease of hand-off of the projects from one course to the other. Emphasis on technical and consumer documentation is critical to successful hand-offs for the projects between courses, groups of students, and organizations.

Summary

Academia plays an important role in the community, not only by providing highly qualified graduates who can fill in jobs but by also helping with community services and projects specifically for non-profit organizations. One way by which Universities and Colleges can collaborate with the community is by engaging the students in Project Based Service Learning models. This paper presented a successful collaboration initiative between the Computer Science department at Houston Christian University and Crime Stoppers of Houston. The collaboration was the very first attempt for the program to integrate Project Based Learning with Service and Community projects. The collaboration helped identify the different ways by which students can be engaged with the community to help bridge their technology gaps while exposing students to the process of solving real-world problems. The paper presented the lessons learned, outcomes and benefits of community engagement as well as the potential challenges that are associated with similar learning models. While there are several challenges and the process is not mature or as clear as traditional learning models, the prospective positive outcomes justify the need to continue adopting academic and community partnerships as an effective student learning model.

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