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Teaching Case:

Computers and the Homeless: Moving from Code to Compassion through an International Computer Science Capstone

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Hook

Should the capstone for computer science majors only prepare students for further academia and jobs, or should it prepare them to change lives? What if we could do both?

Abstract

Universities have struggled with placing courses in ethics in a humanities context or a major subject context. While this paper does not intend to address this debate directly, it highlights the value of incorporating ethics topics into computer science courses through volunteer tourism. This paper presents the technical and ethical implementation of a study abroad computer science capstone course with service at its core, supporting the secure distribution of sleeping bags to the homeless in Manchester, England. The course is viewed through the lens of Clawson and Knetch's multi-phased structure of trips. The project required an integration of hardware and software, including solenoid-controlled lockers, Raspberry Pi controllers, RFID authentication, and an AWS-hosted cloud management system. The course is not one that simply incorporates a moral component into the syllabus. Instead, it is a course that places service at its heart, incorporating methods for engaging computer science students in understanding the homeless situation in England, meeting and helping them face-to-face, while using those experiences to create a solution to a real-world problem. The students were significantly prepared for the course through an intercultural assessment that helped organize teams and measure growth through a post-test. Our goal with this course was to demonstrate to students that their required capstone, showcasing their college career, could also be directly applied to help others, specifically through hands-on work with an agency working with the homeless. In other words, instead of focusing on the how of technology, this course prompts students to consider a broader context of why.

Keywords:

Computer Science Capstone, Ethics, Service-Oriented Design, Study Abroad, Life Changing Academics, Homelessness

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Computers and the Homeless: Moving from Code to Compassion through an International Computer Science Capstone

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1. INTRODUCTION

Schools have struggled with incorporating ethics into computer science courses. The challenge has become one of integrating ethics into technical classes in a way that shapes the course design. While the question of where ethical content should be placed was being discussed, Miami University restructured its academic calendar, transitioning from two traditional semesters to include a three-week winter term in January. This change enabled students to take a single study abroad course during this term. This brief and intense term offers time- and cost-effective short-term study abroad opportunities.

This change has promoted positive opportunities, as evidenced by the fact that Miami University now ranks as one of the largest study abroad programs in the United States, fluctuating rank between four and 27 in the Open Doors reports over the past four years (IIE Open Doors / Leading Institutions by Institutional Type, n.d.).

The authors, working on the Miami University regional campus, created an initial study abroad course, "Creating Tech Solutions for Multicultural Populations," in 2018 for the 2019 winter term. This was a traditional computer science course which, over time, was merged with the main campus Computer Science department to become the "Computers and the Homeless" capstone course. This course, now a senior-level capstone, encompasses all the technology and skills students have learned throughout their university career.

Ethics and Service Framework
Ethics was incorporated into the course's framework from the beginning, arising from research into vulnerable populations. Not all questions were explored in depth for the course.

- Voluntourism vs. volunteerism: exploring the risk of self-serving projects.
- Intercultural Humility: Respect for another culture/government system.
- Developing resilience so we can create long-term impact and not shy away from uncomfortable learning experiences.
- Dignity and Autonomy: respecting privacy, autonomy, and the choice to live life how you want (maybe some prefer rough living).
- Service: volunteering at Lifeshare, acting as servers in a sit-down breakfast situation, including personal interaction with "clients."
- Digital divide (do we make projects too technical to use, but still must be technical enough to count for a capstone)
- Above all, maintaining the dignity of human beings despite the choices they make.

One of the course's goals was to distinguish between volunteerism, spending time to help others, and voluntourism, "volunteering for development." (Widjaja, 2010, p. 4)(S. L. Wearing, 2003, p. 121). Volunteer tourism, or voluntourism, has left a bad taste in the mouths of academics and universities. The concept is that students or tourists seek experiences that benefit others, in addition to exploring and enjoying different cultures and locations.

The initial reactions to voluntourism were typically positive, with motivations identified as personal growth, sharing with others, engaging with a new community, and working to understand cultural differences(S. Wearing & McGehee, 2013).(S. L. Wearing, 2003, pp. 121–122) Some research, based on medical volunteer tourism, highlighted the medical assistance and educational support that groups can provide. (Stanley, 2021)

However, many researchers have seen the possibilities of colonialism in travel. (S. L. Wearing, 2003) This can create a layer of dependency on the target population through the work of the volunteers. Bandyopadhay believes strongly that much of the reason for volunteer tourism is guilt, that of both white men and women, who are looking to be the "white savior" of those less fortunate. (Bandyopadhyay & Patil, 2017)

Butcher, Smith, and Wearing argue that volunteer tourism is not only beneficial but can also lead to sustainable development where both visitors and locals benefit. (Butcher & Smith, 2010) Additionally, Wearing and McGehee's

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research highlighted several positive motivations for volunteer tourism, including altruism, personal growth, contributing to the host community, engaging in community development, and fostering cultural understanding. (S. Wearing & McGehee, 2013)

Our course incorporated all these viewpoints to create a situation where students' work could benefit both themselves and the onsite partner, while reducing any potential negative impacts. This was achieved through collaboration with local partner NGOs (Non-Governmental Organizations) on-site in Manchester, England, which were already working with the homeless using various methods. We also collaborated with Nazarene Theological College, part of the University of Manchester system, in Didsbury. They graciously provided classroom space and allowed the students to mingle with their students and faculty during daily coffee time.

Our choice of local NGO partners, LifeShare and JustLife, ensured that from the outset, the course would focus on social justice and ethics components. LifeShare (Lifeshare | Homeless Charity Manchester, n.d.) is an agency specializing in feeding the homeless in Manchester and its surrounding areas. JustLife is an organization dedicated to providing housing for the homeless and under-housed populations. (*Homeless Charity Supporting Local People With Health and Housing Needs*, n.d.)

The underhoused are those who can find temporary accommodations, but do not have access to permanent ones. UK government figures state that only 3,000 people are officially homeless in England, yet almost 100,000 households are in temporary accommodations (Maciver, 2018). Temporary accommodations are those where people have a roof over their head for the moment, but it can go away in an instant. They do not have a guaranteed place to stay, and for many people, it can be worse than being officially homeless. (What Is Hidden Homelessness and What Causes It?, n.d.)

2. IMPLEMENTATION

The course was implemented in six major sections: preparation, coursework, design and planning, ethics considerations, completion, and delivery. Appendix A provides a checklist of logistical items to consider. Appendix B provides a detailed outline of the course preparation and implementation details for this particular experience, and could be used as a template for those wishing to create their own similar one based on their needs, topics, and location.

Preparation

Our preparation was completed over the preceding Fall semester with 3 evening meetings. As this is a study abroad course, time is allocated to prepare students for intercultural issues and concepts, enabling them to work effectively with local stakeholders and organizations. Students must complete several assignments for reading, viewing, and completing the IES (Intercultural Effectiveness Survey) psychometric assessment. Groups are created based on the results of the IES and assigned, including leaders, who are also assigned based on the IES results.

Students reviewed a movie demonstrating the ethical conundrum of UK unemployment policies: "I, Daniel Blake" to understand the problematic situation of the clients on the streets facing a digital divide that prevents access to social goods. Students then completed a reflection that included a comparison and contrast of their experiences in their home country versus those in the host country. (*I, Daniel Blake (2016) - IMDb*, n.d.)

The course was designed for 27 students and two professors. This optimum size allowed students to be pre-selected into three teams based on objective results from the Kozai IES assessment. (Kozai Group, n.d.) This assessment has three significant benefits for the course.

1. The information enables students to understand their strengths and weaknesses before they begin the course. It provides detailed information on their level of intercultural competence and resilience, as well as insights into areas where they can improve.
2. The results were then used to form the complete and balanced project teams. We have utilized these teams for four years and have found that having a balanced team far exceeds the benefits of letting students form their own teams.
3. After completing the course, students are asked to complete the post-course IES survey, which allows them to view their intercultural growth. Students complete a reflection on the changes noted in the results of their survey. Students considered: Did the results reflect progress, culture shock, or something else?

During the trip, students completed several activities that facilitated personal and professional ethical growth.

1. Students submitted daily journals, not of what they did but of their impressions. This was submitted by midnight so the professors could quickly review it before the next day to ensure that students were progressing and note if any interventions were needed to optimize student learning or address issues.

2. Each day, one student would present to the class a topic of their own choice related to the location where we were working. This was often a favorite time for the class to demonstrate their interest in anything from UK traffic signs to calculating temperatures in UK ovens.

All students and professors travel separately to Manchester, UK, and arrive at their individual hotel rooms. This decision to put students in separate rooms is a deliberate choice to ensure students have quiet time and can communicate with their families, especially during the COVID-19 pandemic. University policies stipulate that if a medical issue arises, students must be able to relocate to a single room immediately. Staying in their own rooms ahead of time helps prevent potential problems. The single rooms also give students a place to relax after long days of unfamiliar surroundings, challenging social issues, and working on technology-related problems.

The location, purposely chosen in the center of Manchester, England, downtown, is convenient for students needing shopping, food, and commute options. However, it was also selected for its location near the homeless population and its proximity to the partner agency providing weekend food services.

Coursework

The first 2-3 days on site include coursework in Agile technologies, project management, software review, and preparation for potential intercultural experiences. Most students arrive after completing the required and suggested courses, having acquired the necessary skills to start immediately. However, some students have not taken the suggested courses in the correct order and need some additional work to catch up on the technologies and concepts covered in the course. Actual coursework covered Agile concepts, customer meetings, and extra time as needed for system design, operating systems deployment, cloud infrastructure, web programming, and networking.

Design and Planning

The course is designed to work like a real-world assignment. The professors did not create the project assignment in advance; instead, students met with the customer, in this case, their NGO working with the homeless. This meeting marked the beginning of the project, in which students must listen to the customer's needs, interpret what was said, document the information, and then brainstorm to create a possible solution. The proposed solution was then presented back to the customer for approval. As this is a very short winter term course, these activities occurred within hours or possibly a day or two, as opposed to weeks or months in a typical semester or year-long capstone.

The customer explained a need to help get sleeping bags to "rough sleepers." Rough sleepers are homeless individuals who do not sleep in shelters but instead try to find temporary locations in bus terminals, airports, doorways, or other public places. A survey found that 26% of all young people in the UK aged 16-25 had slept rough at some point in their lives. (Clarke, 2016) The homeless agencies are attempting to help them, but one problem is distributing sleeping bags to those who have signed up, sometimes at all hours of the day. They requested a distribution method that would be secure, allow them to text the information to the client, and provide feedback upon delivery.

The proposed plan was to create an "Amazon Locker" type of system, whereby the agency could put a sleeping bag in a locker, close it, assign a code, and then text a "client." The client will be able to access the locker outside the facility, which is available 24/7. They would enter the code, retrieve the contents, and, in doing so, the system would notify the agency of delivery and an empty locker. (Deutsch & Golany, 2018)

Ethics Consideration

The students were not only required to consider the ethics and service-oriented aspects of their projects, but they were also given personal opportunities to put these principles into practice. The first opportunity was helping serve breakfast to the homeless every weekend. The second was in creating the project system designed to help the homeless.

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The hosting NGO, LifeShare, serves breakfast to the homeless on Fridays, Saturdays, and Sundays. The group was provided with five opportunities for five students and a faculty sponsor to participate in serving. This meant that almost all students had the chance to join as volunteers. In practice, several students participated two or three times.

The food service was unique in that it was not a typical, at least in the USA, shelter buffet line, with students helping serve. Instead, it was much more like a sit-down restaurant. The "clients" arrived, were signed in, and handed a ticket while heading to a table. The computer science students then interacted, took their order for food and drinks, picked up their tickets, and then worked with the back-end servers. Drinks were typically tea, and in some cases, coffee, both sweet and milky.

Typical food orders were the "Full English" Breakfast, or some slight variation thereof. Many clients stayed for two or more hours, taking the time to refresh, get a shower, nurse many cups of tea and coffee, and get warmed up. This meant that the students, far away from their comfort zone, had the chance to come back, get more orders, and talk. Once the service was complete, the students washed the kitchen and the floors and organized the setup for the next day. The overwhelming response from the students was that the act of helping became the highlight of the course.

Completion

A course in computer science specializing in a full capstone cannot be considered complete if it doesn't meet the criteria of solving a suitably complex problem. This year's course welcomed a mechanical engineering student, with the requirement from their department being a suitably complex engineering project. This requirement influenced the reasoning behind creating the "Amazon Locker" system, which necessitated both computer software and a comprehensive hardware implementation.

Hardware team

The assigned project team was divided into two parts: one to design the mechanical locker, computer system, relays, and electronics, while the other would create the cloud-based management system along with local control systems to facilitate access.

The engineering team specified a 4-unit locker, which was purchased locally and then modified mechanically, electrically, and electronically.

Figure 1 4-door Personnel Locker

Mechanical changes involved the removal of the existing locks and the installation of solenoid locks, which enabled automatic locking and unlocking at the user's command.

A control box was created on the side of the locker, which contained a Raspberry Pi 4 B to run the entire project. An LCD was attached to the top using the Pi Hat attachment, along with relays to manage the solenoids. Finally, a membrane touch keypad was attached to the input pins, and an RFID card reader was included to allow for management access.

Figure 2 Raspberry Pi 4B

Figure 3 FREENOVE I2C IIC LCD 2004 Module

The 20x4 character digital LCD was an LCD unit, connected via just two ports and requiring specialized library code in Python, included in the kit, to display ASCII strings on the screen.

Software team

The software team was tasked with creating an application that would enable authorized customer team members to access the locker from any location. They implemented a Wi-Fi interface from the Raspberry Pi to the local Wi-Fi service, which then allowed them to access an Amazon Elastic Compute Cloud (EC2) instance inside the Amazon Web Services (AWS) cloud services. (Choudhary, 2021)

The EC2 t3.micro instance was implemented with a standalone Linux Ubuntu system, featuring an Apache web server, Python code, and an embedded SQLite server. The server provides a mechanism for the team member to set up a location, check locker status, and assign lockers. Once a locker is assigned on the website, the team member manually texts the client to inform them of the location and code for their sleeping bag. Future plans include a fully automated text messaging system within the application.

The on-location Raspberry Pi system has the following main functions:

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Server integration

This routine checks in with the server on a scheduled, short delay basis to perform updates in both directions.

It sends updated status information from local pickups back to the server while receiving unlock codes for lockers.

RFID integration

Upon accessing the system using a registered RFID key, the team found that local bus passes worked, just as the Raspberry Pi's RFID keys, as they also utilized RFID technology. This made the system easier, as users could access it using their own device, provided it had been set up for access in advance. This access allows the onsite manager to immediately open any single locker or all lockers in an emergency.

Keypad integration

The standard display on the screen provided unlock instructions. Clients needed to enter their unlock code twice, at which time the specified locker would unlock. The system assumes that the enclosed item has been removed at this time, as no internal sensors are available in this system.

The management menu is activated and displays prompts when an authorized RFID key is scanned. Its primary function was to unlock any or all lockers.

Display Integration

The display system is a single-threaded display that accesses the live device when requested. This required in-depth time for the software team as it is very different from the types of access they had created in prior, higher-level applications. Typically, a display request, whether in ASCII, web-based, or print-based format, is submitted, and the operating system handles the delivery details. In this case, the students had to write that code, keeping an eye on both timing constraints and duplicate requests.

Delivery

The prototype system was created and prepared for delivery in 2 ½ weeks. This included working 7-10 hours a day, whether in the lab, shopping in Manchester for all of the parts, the programming section, or meeting with the customer.

The initial customer meetings were held the first three days of the course, with follow-ups continuously over the next 2 weeks.

The final prototype was completed and delivered in a one-hour presentation to the customer, which included a significant amount of hands-on effort and back-and-forth questioning.

3. DISCUSSION AND CONCLUSIONS

Ethical Work Limits

For the most part, the ethical aspect of the course, which aimed to raise awareness about the homeless situation in other parts of the world, went exceedingly well. All students working on the projects received a glimpse into how they could apply their skills to make a positive impact. From this standpoint, the project was excellent.

From the standpoint of actually helping others, it was still good, but a little more mixed. We had 25 slots available for the students to serve breakfast out of a group of 27. However, only 18 students availed themselves of the opportunity, with many of those attending two or even three breakfast sessions.

Those who did go had a chance to see who they were trying to help in an up-close and personal manner. Every person who came in for Breakfast was a potential client of the system they were creating. It provided them with the opportunity to see them as individuals, talk with them, offer food and drink, and make them feel comfortable. Even though it was a very different world that the clients lived in compared to the students, it allowed them a glimpse into that world.

The other special interaction was with the other volunteers. Some of them are long-term volunteers who are there every weekend. They are the backbone of the food service. However, many others are similar to our students and come in once or twice a year because their company provides a vacation day in exchange for doing so. Either way, this was an opportunity to speak with late 20s young people who could share why they were working, which for many students was as important as meeting the clients.

Project Limits

This project, one of three completed by the students during their 2025 study abroad, was a prototype. By that, we mean that it met many of the objectives, looked reasonable, and provided

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the customer with a visual concept to understand the plan.

Even though the students presented the project to the clients in drawings and written explanations, it was the final presentation that allowed the customer to truly understand the implications and what it could be.

The physical locker being a prototype meant that wiring was out of the way, but the final project could not be considered fully finished. The large plastic box on the side of the locker had extra cut holes from the initial plans, which were then covered with tape. The connectors to the Raspberry Pi for the keypad tended to come loose over time, necessitating periodic maintenance to ensure it continued to function correctly.

Just as the client needed the initial project to be complete to understand what it entailed, so did the project team. This was the first time most of the software team had ever worked with hardware, and it was a great eye-opener. They also needed it to be physically complete to fully understand the communication, application, and integration needs.

4. CONCLUSION

As Barbara Grosz stated, adding ethics to a computer science course must be more than a simple statement, reading, or assignment. She, and her team, suggest moving further by embedding "philosophers teaching ethical reasoning directly into computer science courses." (Grosz et al., 2018)

The course's intention was set from the beginning. Calling the course "Computers and the Homeless," instead of a traditional "Computer Science Capstone," gave the information to the students and their parents much earlier than the start of the course. Most students signed up eight months before the course started, which gave them a significant amount of time to prepare for both the social and technical components.

Pre-meetings were essential to prepare students by talking, taking the IES assessment, and having them view the movie, "I, Daniel Blake," to start understanding the living conditions of the homeless in the UK.

Using the IES to create teams provided for fully balanced teams, where leaders and workers were represented, rather than a group consisting of only one or the other.

Making this a real-world example, where the students were not told of the projects ahead of time, provided them with an understanding of how many projects come together. Some students were not happy and wanted the information at the 8-month mark so that they could prepare their work. Finally, once we arrived, they understood that the customers didn't know what they wanted and needed information so they could articulate their vision.

The students needed more than just a social justice project; they required hands-on time to gain a deeper understanding of their target user, as well as the customer. Adding the breakfast serving component, or a similar initiative, was a significant part of the students' experiences, not just being in a foreign country, but also in helping others.

The formal presentation required numerous practice sessions. This was to help the students realize that they had only one chance to showcase their work, and a 30-minute preparation with a short PowerPoint presentation wouldn't suffice.

The final IES assessment was crucial in determining how the students responded to and developed from the experience. We needed an objective measure of growth to justify the course to both the local department and the global initiatives group at the University.

The result of this course was not just teaching the students. The work of creating and teaching the course with Miami University, Nazarene Theological College, LifeShare, JustLife, and the professors has established a partnership that can be continued long after this one course. This course has become a template for study abroad, computer science, ethics, and social justice.

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6. Appendix A

CSE448/449 Manchester UK: Computers and the Homeless

		Students	Activity	Depart Hotel	Arrive Hotel
1/1/25	Wednesday	Travel			
1/2/25	Thursday	Travel			
1/3/25	Friday	Travel			
1/4/25	Saturday	Acclimate		5:30pm	
1/5/25	Sunday		**Chester**		
1/6/25	Monday		NTC Agile Workshop / Customer Meetings	8:30am	5:15pm
1/7/25	Tuesday		NTC Agile Workshop / Customer Meetings	8:30am	5:15pm
1/8/25	Wednesday		NTC Agile Workshop / Customer Meetings	8:30am	
1/9/25	Thursday		NTC Project Work Time	8:30am	5:15pm
1/10/25	Friday		Lifeshare 6:30-9:30		
			NTC Project Work Time	8:30am	4:00pm
1/11/25	Saturday		Lifeshare 6:30-9:30		
1/12/25	Sunday		Lifeshare 6:30-9:30		
1/13/25	Monday		NTC Project Work Time	8:30am	5:15pm
1/14/25	Tuesday		NTC Project Work Time	8:30am	5:15pm
1/15/25	Wednesday		NTC Project Work Time	8:30am	5:15pm
1/16/25	Thursday		NTC Project Work Time	8:30am	5:15pm
1/17/25	Friday		Lifeshare 6:30-9:30		
			NTC Prepare Presentations	8:30am	5:15pm
1/18/25	Saturday		**Bletchley Park**	8:00AM-7:00PM	
1/19/25	Sunday		Lifeshare 6:30-9:30		
1/20/25	Monday		NTC	8:30am	5:15pm
			Final Customer Presentation		
1/21/25	Tuesday		Complete Documentation/handoff	8:30am	3:00-5:00pm
			Banquet	evening	
1/22/25	Wednesday	Travel Home			
1/23/25	Thursday				
1/24/25	Friday				

Appendix B.

Logistics

Housing

- Hotel, Single rooms
- Budget of about $50-$60 per day, including breakfast
- Send bid requests to major chains' corporate booking (Holiday Inn, for example)
    - You will receive multiple bids and can compare. Don't hesitate to let them know they are high and ask what they could do to drop the price. Some will include meeting rooms.

Travel

- Decide on travel from the airport to/from the hotel. Hired bus, train, tram, etc…
- Hired bus transport for excursions, versus public transport
- Bus contract: Find local companies to get bids
- Local transport using buses, trams, and trains

Classroom

- Select a location, preferably a school, where you can have a dedicated classroom space
- Preferably within 15-20 minutes away
- Best – within walking distance

Location

- Center of town
- Close to restaurants, shopping
- No need for user or other transport for evening food

Meals

- Breakfast at the hotel
- Lunch is typically Grubhub or similar, delivered to school
    - Some schools will offer cafeteria options
- Dinner is on their own, students are told not to go anywhere alone

Activities - examples

- Football (soccer) match
- Football stadium tour
- Theater
- Tour
- Visit a big city (London)
- Closing banquet with NGO partners

NGO Partners

- Let them propose activities
    - Deliver food to families
    - Serve food on weekends
- Contact every NGO in town
    - Many are understaffed, keep trying
- Look for ones that do interesting things you can integrate into your course

Appendix C.

Course Structure

Course Purpose

- Integrate a complete computer science capstone study abroad with a built-in ethical component and intercultural learning.
- Create a working prototype for partner Ngo supporting the homeless in Manchester, England.
- Shift focus from how to include why as a significant component.

Learning Outcomes

- Apply Agile, OS, networking, web, cloud, and embedded programming to a real project.
- Build ethical concepts into every part of the course.
- Collaborate with NGO partners as well as balanced teams, based on the IES assessment.
- Demonstrate growth in intercultural effectiveness (pre- and post-IES).

Pre-Departure

- Orientation
    - Course mission: the difference between volunteerism and voluntourism
    - Overview of partner NGOs (LifeShare and JustLife)
    - Logistical planning, including air, hotel, food, and on-ground transportation
- Intercultural preparation
    - Complete IES assessment; debrief results; form balanced teams and assign leaders
    - View and reflect on *I, Daniel Blake*, regarding the UK benefits system
- Technical readiness
    - Verify prerequisites
    - Verify computer system plans, including AWS, local Linux servers, networking, and classroom plans.

On-Site

Days 1-2: Foundation

- Mini Bootcamp
    - Agile practices, roles, and sprint setup
    - Customer interview details
    - Quick refreshers/technical help on OS, Raspberry Pi, AWS, SQLite, Python
- Intercultural introduction
    - Introduction to locations
    - Learn to navigate local transportation using bus, train, streetcar, and Uber

Days 3-4: Discovery and Scoping

- Initial Partner Meetings
    - Tour facilities
    - Understand the process, the "clients", the needs and methods of working
    - Draft a problem statement with user stories and acceptance critieria
- Concept Design with Customer Presentation
    - Present initial solution concept of Physical lockers with Raspberry Pi, RFID, keypads, and cloud console
    - Get NGO feedback
    - Finalize scope for deliverable prototype plans

Days 5-7: Architecture and Sprint 1

- System Design
    - Split into two sub teams
        - Software:
            - Builds local Linux-based control system on Raspberry Pi
            - Create routines that communicate with all of the hardware

        - RFID, touch keypad, LCD display, lock solenoids
    - Incorporate ethics into design with consideration of access methods, usage, overrides, and failures.
- Hardware
    - Purchase lockers and design locker mechanics
    - Wiring Plans and enclosure layout
    - Build a working prototype of Raspberry Pi with relay board, LCD display, RFID reader, touch keypad, and hard-wired relays activating solenoids for locker opening.

Days 8-11: Implementation and Service

- Sprint 2 Execution
    - Hardware
        - Install solenoids with relays
        - Test GPIO, LCD Driver, and keypad input
    - Software
        - Python locker management program, designed to be used on the keypad and LCD
        - Locker assignment and pickup
        - Management override and open-all-lock command
- Service Learning
    - Rotate volunteer teams to serve at LifeShare breakfast with table service and client interaction.
    - Daily reflective journals, with impressions as opposed to itineraries

Days 12-14: Integration and Field Testing

- End-to-End tests
    - Good path testing:
        - Assign locker → lock → text to client (manual) → client code entry → unlock locker → status notify of locker available
    - Edge case testing
        - Wrong codes
        - Manual override
        - Emergency unlock of all lockers
- UI/UX and operability testing
    - Clear device prompts
    - Maintenance list
    - Set up and instructions for NGO staff

Days 15-17: Test and Presentation Preparation

- Test
    - Continuous testing of applications
    - Invite outside personnel to use the system with minimal instructions and resolve issues or improve process flows.
- Write presentation scripts and Test Present
    - Create resources for slide deck, including videos, audio, and more
    - Create a presentation video to go with the slide deck
    - Test presented to instructors for feedback
- Create deliverables
    - Technical documents
    - Slide deck
    - Demo scripts
    - Planned source code handover

Day 18: Client presentation and Handover

- Final Presentation
    - Hands-on trial, feedback and handover
- Retrospective

- Team and entire class retrospective on technical, ethical and intercultural learning

Days 19-20: Assessment and Reflection

- Post-course IES
  - Analyze intercultural growth and reflect based on IES results
- Final reflections
  - Individual journals, reflections on personal growth, and what changed their concepts of "why" we did this?

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Appendix C.

General Ethical Computer Science Course Structure