The Human-Centered Design With Iterative Service-Learning Framework: Applied to Small Rural Organizations

Sherri Weitl-Harms
Creighton University

The innovative framework described in this work integrates human-centered design principles with iterative service-learning to incrementally develop and improve computing artifacts. An application is demonstrated through work with small rural organizations, who rarely have the expertise or resources to develop computing artifacts to market and deliver their products and services. Historically, service-learning team projects once delivered are not updated. Additionally, there are few structured guides for assisting the implementation of service-learning. Human-centered design has been shown to improve the quality of computing artifacts. Yet, even when using human-centered design principles, computing artifacts rarely function well long-term without updates. The proposed framework addresses issues plaguing service-learning's success while developing high-quality artifacts. A step-by-step execution guide is provided, along with a sample longitudinal application. The framework was qualitatively and quantitatively evaluated at multiple points in the implementation. This research also analyzed impact and found both students and clients reporting high satisfaction levels.

Keywords: human centered design, service learning, community involvement, curriculum development, computer science education

INTRODUCTION AND BACKGROUND

Service-Learning in Computing

Teaching students to develop computing artifacts using human-centered principles is challenging, especially as it requires access to users and stakeholders (C. Zoltowski and Oakes, 2010). Service-learning is *an approach to teaching and learning in which students use academic and civic knowledge and skills to collaborate directly with stakeholders to address genuine community needs* (NYLC.org, 2022). Through service-learning, students develop their technical skills as they collaborate with community partners to apply their classroom knowledge to real-world situations (Homkes, 2012;; Vanoye-García et al., 2024; Weitl-Harms, 2024a, 2024b). Service-learning provides students with an opportunity to participate in community development, recognize and respect differences, and understand their responsibility concerning others and to the common good from a technical and professional perspective (Khan and Milun, 2021; Kilkenny et al., 2022; Patterson, 2020; Robledo Yamamoto et al., 2024; Sandoval and Cantero, 2021). Numerous studies demonstrate benefits to students from participating in well-designed service-learning courses for computing students (Adler and Goggin, 2005; Harrell et al., 2024; Riaji et al., 2021; Robledo Yamamoto et al., 2023; C. Zoltowski and Oakes, 2010). Benefits to programs include attracting and retaining students; preparing students for the workforce by developing professional skills; meeting

curricular guidelines; and providing a technical service for resource-constrained organizations (Kilkenny et al., 2022; Robledo Yamamoto et al., 2024; Shafaat et al., 2016).

A study of eighty-four published works on CIS service-learning (Robledo Yamamoto et al., 2023) found forty-nine examples of software development service-learning publications, include designing a guided tour using a mobile app, designing websites, or developing educational games. Baltierra et al., (2023) reviewed fifteen studies focused on service-learning for computer engineering majors. Other computing examples include allowing students to work with a regional Native American organization to create a database solution for a maple syrup operation (Khan and Milun, 2021) and having students each self-select a small database project for a real client (Weitl-Harms, 2022). The practice of service-learning in an online environment during the pandemic, was explored in Xu et al., (2024).

A sustainable framework for quality computing-related service-learning is needed. A systematic review study on service-learning by Narong and Wattanaphak (2024) concluded that future research should seek to recognize the implications of service-learning in sustainability education, where social, cultural, economic, and political values can influence teaching and learning practices. A study in Malaysia found that service-learning should be continually improved and refined to ensure the smooth implementation (Arsat et al., 2024). Vanoye et al., (2024) evaluated three service-learning experiences among engineering students in Mexico, describing future work needed to enhance the structure of service-learning experiences to ensure that students developed sustainability competencies.

Human-Centered Design (HCD)

Many examples point to the lack of understanding of the user, or an understanding of the way in which the product would be used, that contributed to its failure (C. Zoltowski and Oakes, 2010). The ISO 9241-210 *Ergonomics of Human-centered System interaction* (2019) standard describes HCD as an *approach to systems design and development that aims to make interactive systems more usable by focusing on the use of the system and applying human factors/ergonomics and usability knowledge and techniques*. ISO 9241-210 recommends six characteristics: The adoption of multidisciplinary skills and perspectives; Explicit understanding of users, tasks, and environments; User-centered evaluation driven design; Consideration of the whole user experience; Involvement of users throughout design and development; and Iterative process (Traynor, 2022). HCD has its roots in ergonomics, and computer science (Liedtka et al., 2021). HCD takes humans as its central focus, lends itself to social problem solving (Digital Adoption, 2025), and has been applied in many ways, such as in healthcare applications (Levander, et al., 2024; Burgdorf and Prabhakar, 2021; Bynum et al., 2023; Chui et al., 2023; Coutinho et al., 2024; Haspel et al., 2024; Moilanen et al., 2024; Neumann et al., 2023; Overney et al., 2024).

The Human Centered Design (HCD) framework created by Liedtka et al., (2017) shown in Figure 1 helps structure innovative work and provides a road map for design using a repeatable approach. HCD aims to help developers build things that solve people's problems, using a deep understanding of the problem, and considers human needs, desires, and realities. The HCD framework focuses on the following questions: "What is?"; "What if?"; "What wows?"; and "What works?".

HCD in Service-Learning

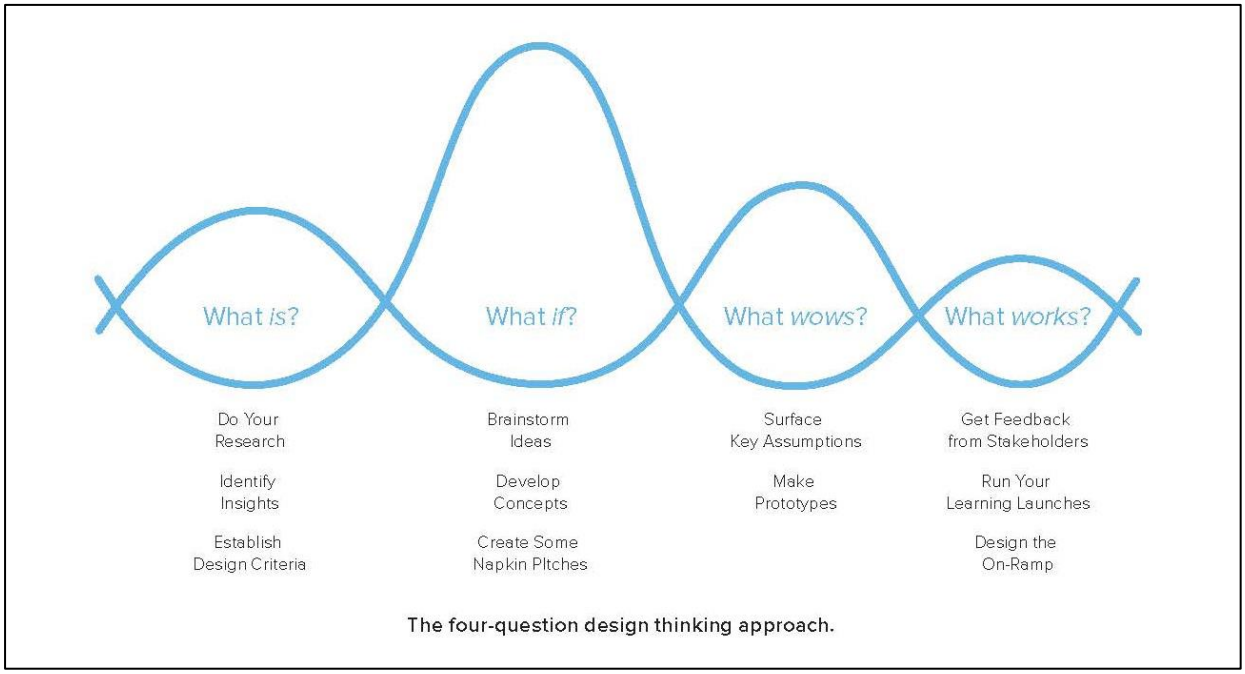
Service-learning offers many synergistic opportunities to create a HCD experience (C. Zoltowski and Oakes, 2010). However, students face several challenges in employing HCD approaches (Schimpf and Swenson, 2022). For example, students may only consider information from users for early-stage design decisions (Rao et al., 2020), withdraw from or reduce user engagement as problem complexity increases (Scott, 2008), or rely on users and stakeholders without critically assessing the information shared (Mohedas et al., 2020). Scaffolding student HCD learning through reflection activities were described in Sanders et al., (2021). A pedagogical framework that synthesized citizen engineering and human-centered design for designing a capstone experience was described in Schimpf and Swenson (2022), but no implementation was provided.

A study of HCD applied to service-learning found that i) students' understanding of the user and ii) their ability to integrate that into their designs are related to developing more comprehensive ways of

experiencing HCD (C. B. Zoltowski et al., 2012). The study found that immersive experiences involving real clients and users were important in allowing the students to experience HCD more comprehensively. A follow-up study analyzed reflections from project teams and found that students were learning through the design process, and they valued their community partners' impact (Abu-Mulaweh and Oakes, 2018).

Human-computer interaction is reshaping the future of the technology industry through the pedagogical precedents set in the classroom today (Brewer, 2024). For example, one team conducted human-centered research and design activities to develop a chatbot prototype that could recognize common patient experience challenges to aid in data collection and the development of interventions aimed at improving patient experience in real-time (Wang et al., 2024) using an early-stage iterative design following the HCD cycle from Harte et al., (2017).

FIGURE 1
HUMAN CENTERED DESIGN FRAMEWORK



Implementation of Service-Learning in Computing

Capstone courses are a common place to implement service-learning (Clua and Feldgen, 2020; Murphy et al., 2017). Many computing service-learning projects involve the creation of software or web sites, which are commonly assessed by evaluating the artifact produced, through presentations, reflection essays, written reports, and/or peer evaluations (Abu-Mulaweh and Oakes, 2018; Robledo Yamamoto et al., 2023).

Incorporating service-learning projects requires extra time and organization from the instructor (e.g., soliciting non-profit organizations to serve as community partners, ensuring the partners are satisfied with their collaboration with the students), as well finding some method of providing maintenance and technical support once the course is over (Chao and Brown, 2009).

Setting up successful collaborations between campuses and community partners can be hard (Medero, 2018). One approach is to use repeat community partners willing to repeatedly work with students on projects (Medero, 2018), such as through sponsoring proprietary client-oriented software projects (MacKellar, 2015). However, these projects are often standalone, one-off projects since companies may be reluctant to have students work on their internal codebase, or to develop mission critical software; which often means that it is often difficult to get time and attention from personnel at the company during the project (MacKellar, 2015). Additionally, these types of projects often do not truly fit the definition of

"service-learning" of doing "computing for social good". Another approach is to engage students via a small project that fits in a one semester course, with a local nonprofit organization as the client. Local nonprofits are often happy to collaborate on these projects since they may have needs for mission-critical software systems that are not well met by the commercial software industry, yet they have limited technology budgets (MacKellar, 2015).

A "service-learning project feasibility assessment model" can help guide instructors through a set of structured questions designed to facilitate meaningful discussions with project partners (Kurkovsky, Williams, et al., 2024) and to evaluating the potential success of a project (Williams et al., 2024). A structure is needed that relies on (1) sustainability for creating a flexible and meaningful thematic context with potential for an existing community engagement infrastructure and (2) the lean UX framework for serving as a foundation of the course structure (Batova, 2021).

One well-developed model of computing-based service-learning that demonstrates legitimately useful software products for non-profit clients is Engineering Projects in Community Service (EPICS) (Johnson and Linos, 2023). The same client is often engaged with several times, but the results of each engagement are complete and not dependent on future work; while future engagements are often built on the past (Mertz and Quesenberry, 2018). Client and student expectations are communicated early, and teams are expected to meet regularly (Johnson and Linos, 2023). This model works well at large universities that have resources for holistic project management and client engagement.

Handing off the project to the community partner is a key component in service-learning. Scaffolded Projects for the Social Good (SPSG) is an adaptable service-learning framework (Kurkovsky, Goldweber, et al., 2024), in which the development phase is structured using the agile methodology. The transition phase occurs during the last week of the semester, typically including the final project demonstration to the project partner and the entire class. Larger development projects are sometimes distributed over multiple terms, with handoffs to different student teams working on various aspects of the project (Kurkovsky, Goldweber, et al., 2024; Robledo Yamamoto et al., 2023).

Impact of Service-Learning on Community Partners

Service-learning researchers have argued that successful service-learning projects embrace service-learning as social justice reoriented towards the community recipients (Connolly, 2012). Relationships are key to bolstering the development of the service-learning product, facilitating knowledge transfer among stakeholders, and fostering transformative growth for each stakeholder (Choudhary and Oakes, 2018; Robledo Yamamoto et al., 2024; Soto and Dzwonczyk, 2015). Jordaan and Mennega (2022) found that community partners are not just passive receivers of the benefits of service-learning but view their role as being integral in helping prepare students for the real world. Community partners who worked directly with students reported valuing the opportunity to teach students about their organization and how it serves the community and found that the experience helped them grow, specifically by being able to obtain a "fresh perspective" on their work (Robledo Yamamoto et al., 2024). The attitude of the partner and the effectiveness of the communication has a significant impact on the quality of the service (Carter, 2009).

Harrell et al. (2024) surveyed computing faculty. They found that student goals are often seen as more important than partner goals with about 25% of respondents seeing benefits to partners as only a bonus. They also found that some programs have difficulty finding or keeping partners, as community partners potentially feel taken advantage of; while students tacitly learn that community organizations' needs are secondary. The literature review of Yamamoto et al. (2023), found only five projects reported using feedback from community partners to evaluate the students' performance and very few projects assessed the community partner's experience, using only informal feedback if any.

It is well known that the full cost of any software development project is not in its initial development but in its ongoing maintenance and support (Connolly, 2012). Many community partners who participate in service-learning lack resources for maintenance or updates (Kilkenny et al., 2022; Robledo Yamamoto et al., 2023). Thus, service-learning projects can drain the organization's resources (Connolly, 2012). Nonprofits must have some means to maintain the system (Bloomfield et al., 2014). Research recommend 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 (Burns et al., 2012; MacKellar et al., 2013; Robledo Yamamoto et al., 2023). Various suggestions include finding a skilled volunteer (person or company) in the community willing to take over this task; or asking the students to allow themselves to be contacted again to help maintain the system (Bloomfield et al., 2014). These time-consuming tasks often fall on the instructor's shoulders, especially at small schools.

Application: Rural Organizations Computing Needs

Rural organizations can benefit from collaborating with university partners in service-learning and HCD projects for the development of computing artifacts, such as social networking plans. Maintaining a strong social media presence is a key computing need for rural organizations. Social media plans are vital for organizations to fully engage with their audiences (Chung et al., 2015), but most small rural organizations do not have the expertise or resources to implement one (Jang, 2015; Xie, 2020). Yet by not doing so, they limit their organizational reach. The design of social media tools must be conducted with sensitivity to the specific needs of small organizations needs to achieve their public engagement goals in the complex and constrained organizational context (Hou and Lampe, 2015). Wallace and Rutherford (2021) found that small organizations are significantly less likely to have social media presence. By not implementing a social networking plan, rural organizations limit their organizational reach to the rural community in which they reside.

Purpose

This research presents the development of a novel framework, named the Human Centered Design with Iterative Service Learning (HCDISL) framework. The HCDISL framework integrates HCD principles with iterative service-learning to incrementally develop, review, and improve computing artifacts for organizations. The initial application of the framework was demonstrated through the longitudinal iterative process of using capstone projects where student teams assist small rural organizations in developing and utilizing social networking plans, aiming to expand the organization's reach within and beyond their local community. The application demonstrates that this methodology can be implemented by individual faculty members at small schools with limited resources, while addressing many of the issues listed above. Like Ilijoski and Ackovska (2022), students learn innovative technologies, and develop a complete product, while getting acquainted with a critical problem. In this way, in addition to the technical knowledge, they also get satisfaction from helping society. As end users, the rural organizations receive a wide range of tools they can use in everyday functioning.

The goals of the HCDISL framework are to improve and enhancing student learning in the development of computing artifacts using HCD principles; further institutional and departmental goals toward institutionalization of civic engagement and service-learning; address community needs and enhancing partnerships; advance the field of civic engagement and service-learning as the pedagogy of engagement. The goal of this framework's initial application is to improve the effectiveness of implementing social media plans for small, rural organizations while demonstrating the framework's effectiveness.

The goals of this paper are as follows:

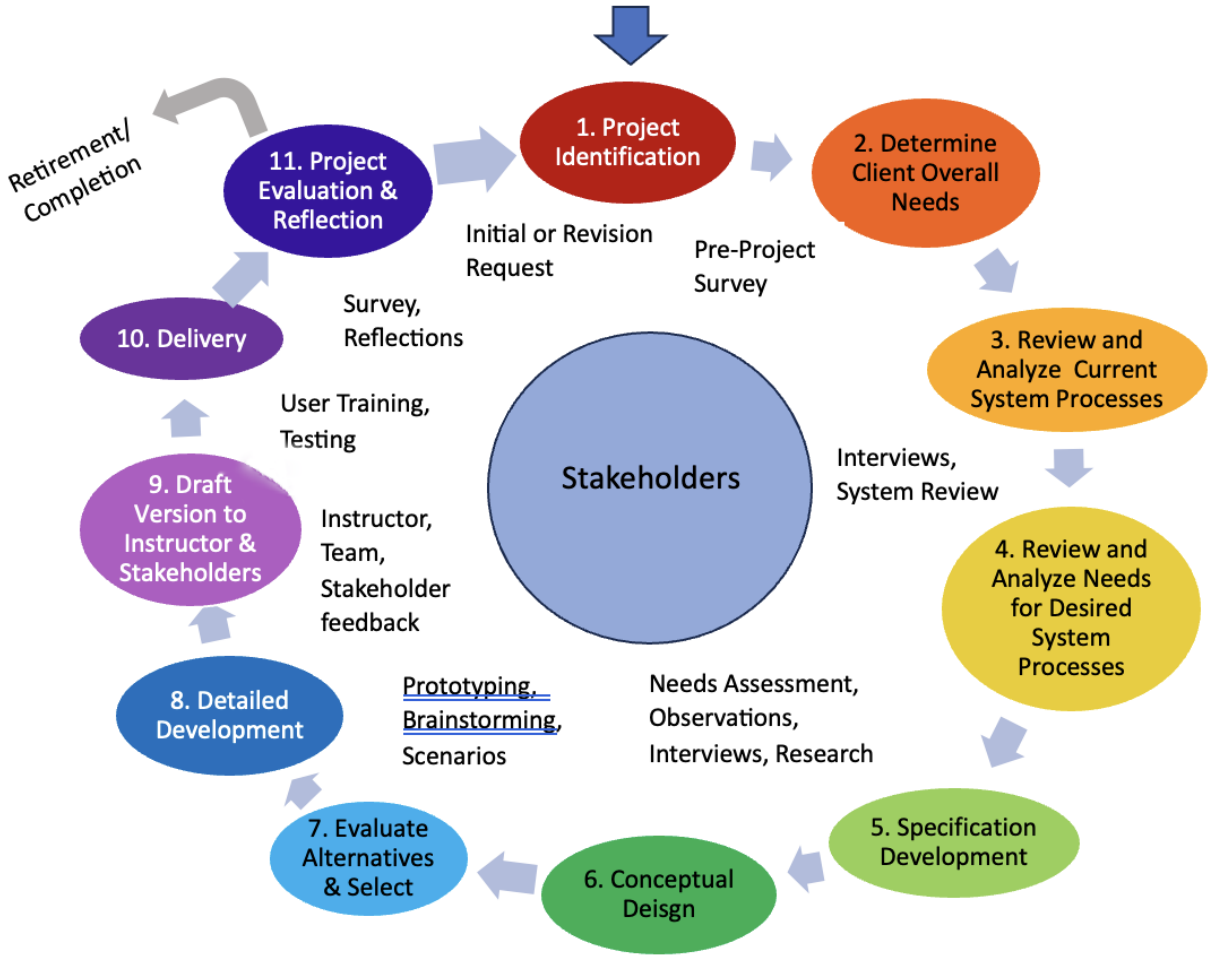
- Goal 1: Describe the Human Centered Design with Iterative Service Learning (HCDISL) framework
- Goal 2: Detail an example application of the HCDISL framework
- Goal 3: Analyze the HCDISL framework processes and resulting artifacts through qualitative and quantitative methods

HUMAN-CENTERED DESIGN WITH ITERATIVE SERVICE-LEARNING FRAMEWORK

The novel HCDISL framework is shown in Figure 2. The framework's goal is to provide a repeatable process for implementing HCD over time, within a curriculum that uses service-learning. While the EPICS design process (C. Zoltowski and Oakes, 2010) is similar to HCDISL, the EPICS process was developed to specifically support students in a single course as they developed one-off service-learning design

projects. Like the EPICS process, continuous stakeholder involvement throughout the design process is important. However, the HCDISL framework includes several unique steps to account for the iterative approach to service-learning. The HCD Framework (Liedtka et al., 2017) questions of "What is?"; "What if?"; "What wows?"; and "What works?" are integrated into the HCDISL framework.

FIGURE 2
HUMAN CENTERED DESIGN WITH ITERATIVE SERVICE-LEARNING FRAMEWORK



Identification

The initial phase of the HCDISL framework is stakeholder and project identification. There are several ways that projects can be identified. For example, students could be required to find their own project (especially if there are no stakeholders requesting project revision), organizations served in previous semesters could be contacted to see if a new version of a computing artifact is needed, or local groups such as the chamber of commerce, could be contacted for assistance in finding organizations with needs. The goal is to identify a specific need for an organization to be addressed, that can be solved within the construct and period of the course, and with the given skill set of the students taking the course. As shown in Figure 2, if a revision request is received from a previous iteration, it is fed into the project identification step of the process. Often this phase could be started prior to the start of the semester, so projects can be in place by the time students are ready to work on them.

While it is critical at every stage to help manage stakeholder expectations for perceived success, it especially at this first phase. This includes letting the clients and students know what to expect from all the

stakeholders, during this complete iteration of the project. They need informed of the safeguards that are in place to provide a quality product for the client, as well as what the students will be learning that semester. Providing samples from previous projects may be useful, if available.

Clients need to know who will be contacting them, how often, and who their primary contact is for this project iteration. Clients should be aware that not all projects are "A" projects, but the artifacts should still be useful. The clients also need to know what will be expected from them. The clients should be committed to meeting with the students, providing information to the students as requested (within reason), and to check in with the student team, instructor, or service-learning coordinator if they have questions or concerns. Having handouts and/or conducting meetings with all clients that will be served in each iteration of the course is useful. The clients need to be aware that working with the students will take time, and they will get out of it what they put into it. It is possible that clients may bow out at this phase. However, having that happen is better than having students trying to collaborate with a non-responsive client in the middle of the semester.

Students also need to be aware of their expectations. They need to know how to contact the client, and often they are expected to contact the client. They need to be advised of the timeline for completion, and what to do if their project gets off-track, or if the client is non-responsive or difficult.

Determine Overall Needs

The next step is to determine the client's overall needs related to the project. This phase is the first step of answering the "What is?" HCD question. A pre-project survey is useful to understand the client's background and needs. If a client has been through the process in a previous iteration, they have a clear idea of the workable scope and level of work expected from the team of students on the service-learning project. If it is a new client, the instructor or service-learning coordinator often will need to sit down with the client to discuss the project scope and level of work that can be expected. At a prominent level, the stakeholders should be made aware of the project's overall needs, with a broad understanding that the service-learning teams will develop an artifact that addresses that need in some way.

Depending on the implementation, this step may be conducted by the instructor or service-learning coordinator prior to student teams assigned to the project. It is important to have committed clients with workable projects defined by the end of this phase.

Review of Current System

By this phase, student teams are assigned to a client for the full iteration of the project (often the entire semester). Through interviews, and by studying the current system, the student teams should analyze the client's perceptions and uses related to their current system. This is the second step of answering the "What is?" HCD question. Students should be provided with the client's current system, and be made aware of HCD techniques and tools, such as empathy mapping (Liedtka et al., 2017), for conducting these reviews. Especially for projects that are not in a first iteration, teams should study the previous artifact's documentation, design, and structure, as they will be building upon the previous version. Students should have deadlines for completing this step as well as assessed deliverables. Clients should expect to be contacted at minimum one time during this phase to provide this information.

Review Needs of Desired System

Using HCD tools such as needs assessments, observations, interviews, personas and research, students will review the client's perceptions and needs of the desired system. This is the last step in answering the HCD "What is?" question. Here, students should remain curious, and empathetic. Students should think about their unanswered questions they have about this problem/opportunity, particularly as it relates to the client's experiences and feelings. It is useful to provide students with assignments that require them to review other systems (even from unrelated industries) to help them explore innovative solutions. Clients should expect to be contacted at least twice during this phase to provide information. Students should have deadlines for completing this step as well as assessed deliverables.

Specification Development

The HCD "What if?" question is in focus as the project moves into this phase. Using HCD processes such as brainstorming, team collaboration, concept ideation is important. Using course and program materials along with the skills they are learning, student teams develop specifications for planned inclusion in the delivered computing artifact. Students will need a clear understanding of their own skill sets, and course expectations as they define the specifications that will be included in the artifact. It is useful to provide students with assignments that require them to evaluate innovations in other systems (even from unrelated industries) to help them explore innovative solutions. Students should have a deadline and assessed deliverables at this step. The instructor may request revision to the specification, based on experience, if the scope does not match the requirements of the course. Depending on the project, clients may or may not be contact during this phase of development.

Conceptual Design

Conceptual designs are created and reviewed using prototyping, brainstorming, white-boarding, scenario development, and other HCD tools. While the HCD "What if?" question is still in focus, teams should start to narrow solution ideas to 2-3 solution ideas. Using HCD relevant design principles, student teams should be able to briefly describe each solution idea and provide a simple sketch of the idea. However, it is important not to focus on a single solution too earlier in the process, and to be open minded as alternatives are considered.

Evaluating Alternatives and Selection

This phase focuses on the "What wows" HCD phase. When evaluating alternatives, teams should focus on the alternatives' desirability, feasibility, and viability. At the conclusion of this phase, teams develop a prototype description for their solution idea from the solution ideas identified. This idea can be the same as an idea identified above or can be a combination of ideas. Depending on the course, this phase may have assessed deliverables or be embedded in the output from the next phase. Teams should evaluate their prototype in several ways, including:

1. the value of it in meeting the client's needs,
2. the client's ability to execute the alternative,
3. the scale of the alternative,
4. the team's ability to implement it within the remainder of this iteration of the project, and
5. the client's ability to sustain the solution.

Teams will also need to evaluate their prototype description against the design criteria and course requirements and make updates to the prototype description. It is useful for the team to verify their idea with the client at this phase and adjust the prototype description by incorporating their feedback. It is also helpful to have a team check-in with the instructor at this point to ensure the solution ideas are converging in a way that meet the instructor's concept of feasible and viable as related to the course learning objectives and timeline.

Detailed Development

In this phase, teams roll up their sleeves to create the artifact solution for this iteration. This is part of the "What works" phase of HCD. Teams collaborate with their instructor and clients as needed. They will need to test internally. They also need to design any on-ramp and training for deploying the solution.

Draft Version to Instructor & Stakeholders

In this phase, the team provides an initial draft version to instructor and client for testing. They will need to get feedback from stakeholders and provide any training and on-ramp. The instructor often plays a larger role in this phase than others, to ensure expectations are managed.

Delivery

Based on client and instructor feedback, the final version for this iteration is delivered to the client. Note, because this is framework is for service-learning project, students are not expected to provide on-going support or training after this iteration is complete.

Project Evaluation & Reflection

The final phase of the HCDISL framework is the project evaluation and reflection. Clients and students should be provided opportunities, via surveys and re reflection exercises to provide feedback on the experience. Because of the iterative nature of this framework, when the client needs an updated version of the system, the entire iterative process is started again.

Example Application

An example of longitudinal implementation was conducted through repeated offerings of asynchronously offered online Social Networking capstone courses in the Department of Cyber Systems at the University of Nebraska at Kearney (UNK), a regional rural university, from 2016-2023. A University of Nebraska Rural Futures Initiative (RFI) grant (Brehm, 2012) provided initial funding to assist in coordinating with local government and economic development groups to start the HCDISL project (Giboney, 2016). The goal of the grant was to help increase the implementation and sustained use rates of social media plans by small rural organizations. The grant provided for a two-year partnership with the Economic Development Council of Buffalo County, the development of online training materials for the most used social networking platforms with a focus on workable solutions for local Central Nebraska organizations, and initial training and tutoring for the new organizations.

The Social Networking course was designed to examine a cross-section of social networking information technologies encompassing textual, aural, and visual methods and further examine the effect of personal and professional interactions. The business marketing aspects of social networking were heavily considered and analyzed within the course (Weitl-Harms, 2024b). The capstone project incorporated into course implemented aspects of HCD (although they were not named explicitly as HCD), team-based learning, and service-learning. The goal of the capstone project was to implement a service-learning component through which students could assist rural organizations develop and utilize a social networking plan to expand their reach within and beyond their local community (Weitl-Harms, 2024a).

Stakeholders

Of the sixty participating organizations, all but one had less than 10 employees; Seventy-seven percent were small businesses, 22% were non-profits. Only 5% of the organizations did all their business online, and 62% had no online business at the start of the project, while 10% did 20% of their business online, 12% did somewhere between 40 and 80% of their business online, and 12% answered “N/A”, as they did not see themselves as “doing business” (Weitl-Harms, 2024b).

At the start of the project, it was found that the most used platform was Facebook, with 88% of the organizations having some Facebook presence, 16% having some Instagram presence, and 14% having a Twitter/X presence. Fifty-five percent of the organizations reported that they had more than two hundred followers on Facebook. However, 96% reported that they had no followers on snapchat. Eighty-eight percent reported no followers on YouTube and Pinterest, and 76% reported no followers on Twitter/X. Only 12% reported no followers on Facebook. Ninety-four percent of the organizations found that social media marketing adds value to engaging customers; while 86% found it necessary for reaching customers; Eighty-four percent stated that managing social media is time well spent;, and 82% understood that social media is necessary to raises awareness about products. However, only 51% used social media to conduct business, and 47% used social media for customer feedback.

The organizations who participated in a second iteration of the project all used Facebook, with over half of them having more than two hundred followers; half used Instagram, and a few used Twitter/X, and YouTube. All but one reported posting 1-5 times per week on a social media platform, with several reporting posting 6-10 times per week. A few organizations reported posting on two different platforms

each week, one reported posting on three platforms each week, and one posted on five different platforms each week (Weitl-Harms, 2024a).

Around three hundred students were allowed to work in teams to create social media plans as part of this HCDISL program. Throughout this project, four instructors taught a total of twelve sections of the course. The instructors assigned Each organizational project to a team of 1-5 students. Students are required to collaboratively develop and present the social networking plan they have created to a representative of the organization, highlighting innovative ideas and tactics the organization could utilize to improve its social media presence.

Computing Artifact

The computing artifacts developed were social media plans, including a written document outlining the plan and a multimedia presentation. The plans were based on content students learn about social media best practices throughout the course. Student teams were required to meet with their client to analyze the client's needs and present a new (or revised) strategic social media plan. The teams were responsible for evaluating the current social media presence (if the organization had any) and presenting ideas for changing and improving the organization's presence. The social media plan was required meet the client's specific needs, identify audiences, set measurable goals, and describe a minimum of three recommended social media strategies and tactics to reach the identified goals.

Part 1: The written plan was required to include:

1. An analysis of the organization and its audiences
2. The goals of the organization and who it serves
3. The organizational need of social media presence
4. Which channels the team is selecting and why (minimum of 3)
5. An action plan that contains the following items:
   - Why use social media: why the client wants to use a social media strategy; how it fits with the overall organizational goal; and why, specifically to use social media. Does the client want to raise awareness, foster relationships, sell something, raise money, inform/educate, and/or entertain? This will read as a statement of purpose to guide the plan.
   - Channel: Name a specific channel, (like Facebook) and why it was selected. Then the team would repeat every part listed below for each of the channels selected.
     (a) Objective: State in each channel objective specifically, and in a measurable (numerical) way, what the client will be attaining with this channel. Examples: "To obtain 5,000 Facebook followers to…" or "To bring 500 new followers in the first month…" or "To obtain 25 YouTube videos naming our brand by Sept. 1…" The step of documenting a measurable objective is important because it is the measuring stick for effectiveness, and it gives the client something to shoot for. It also helps the client remember why they are doing what they are doing.
     (b) Audience: Specific and using demographic and psychographic terms. The audience may depend on the channel/vice versa. It is likely the audiences may be slightly different for each channel. Or, if the client is specifically targeting a niche audience, be sure the social media communication is communicating with this niche audience. Example: "New and loyal customers aged 15-35 who are interested in healthy lifestyles".
     (c) How to obtain audience/drive traffic to channel: How will the client's audience(s) know they are on these channels? How will the client get them to notice them there?) Example: "All advertising promotions will prominently feature social media chicklets; email newsletter…" The team may want to consider suggesting the creation of incentives to drive audience(s) to the channel – a contest, coupon, publicity, etc.
     (d) Frequency: state how often the client should post to the channel. Example: "Facebook updates at 8 a.m., 10 a.m., 11 a.m., 2 p.m., 5 p.m., 8 p.m." Keep in mind the parts of the day, the audience and when and how often they are interested in engaging with the

client via social media. It is expected that frequency will be different on each channel/outpost.

(e) Topics/themes: What, specifically, should the client be posting/sharing, and why? Give ideas of typical posts. Is it the news headlines of the day? Events? Promotions like daily specials or discounts? Customer photos, funny comments from the staff? Does the client want to educate about their product or service? Remember WIIFM – what is in it for me – and what your audience would find engaging, useful, or whatever meets the client's objective. Students should provide examples for the clients.

(f) Author: Who, specifically, is going to do this posting or content development? Is it the client? Interns? The CEO? An advertising agency? Volunteers? The who is important – many plans get developed without considering who is going to do this work and if they have the time. Look at the frequency. Is this practical? Will people need training? consider personalities, especially in small organizations. Teams should address this briefly in the plan if they think it is an issue.

(g) Monitoring: While using the specific channels, the client will need to take the time for responding to posts/questions and other feedback. Who is going to do the response-back? This will require consistent monitoring at specified times. Does the client have an outside evaluation/monitoring tool? Will the client need to do occasional searches to see what is being said about their brand? Competitors? Should clients set up an alert so they can hear about what is said right away?

(h) Evaluation: Clients also will need to occasionally evaluate where they are with their metrics. Are they getting the number of followers/fans/likes/posts that they want, based on the objectives. How should they track return on specials, track retweets, monitor mentions, follows, visitors? How often will they analyze their Facebook or other statistics? Include these in this segment of the plan.

- Provide sample content for each platform (also will be shown in more detail in the presentation)
- Provide sample design ideas for the look of the sites created with social networking (shown in more detail in the presentation). Use an appropriate design (look and feel) for the client. The client may be asked to provide images, color schemes, etc.
- Provide a realistic implementation timeline including dates that makes sense strategically for the organization (with explanation).
- Budget estimate for implementation of social media plan (if applicable).
- A plan to monitor and evaluate the plan's effectiveness.

6. An analysis and conclusion of how effective the social networking plan will be for their organization.
7. At least three source examples and/or citations of research, data, or demographic data

The plan was required to be thorough in listing ALL tactics the student team believes are worthy and carry forward the strategy in the plan. Note that this was a class exercise, and students were not authorized to post content on their client's behalf. The student teams create the draft plan and materials/content. But the client's responsible for taking the resulting paper and presentation and executing the ideas for themselves.

Part 2: The delivered artifacts included a 15–20-minute presentation on the social networking plan presented collaboratively by the student team. The presentation was required to include:

1. Multimedia presentation that presents the ideas from the paper.
2. Each student in the group must be responsible for at least four minutes of the presentation.
3. Visual examples of the social media sites (the sample designs or posts that were created for the plan).
4. All the relevant information from the paper with data, timeline, plan, etc.

The presentation was not simply be a reading of the paper; and was required to be visually oriented, cohesive, and dynamic. Student members were required to be prepared to answer questions.

Example Iteration

Project Identification

The Buffalo County Economic Development Council assisted with informing local small business and non-profit organizations about the opportunity, and they encouraged applications over the life of this project. A website was created for clients to apply to be part of the program. Each client gave informed consent to be part of the project. Stakeholder contact information was shared (between the client and instructor at this time.)

Considerable time was spent at the beginning of this project to meet with potential new clients and conduct meetings to manage expectations. For the initial iterations of new client projects, handouts and kickoff meetings were conducted to provide the clients with information on how to apply, complete consent form, register, and complete initial survey. An explanation of the expectations of all stakeholders over the semester was provided. For clients requesting project revisions in repeated iterations, these meetings and handouts were not required.

Organizations were notified that these are student projects, and that the quality of work was not guaranteed. the safeguards that were in place to provide quality plans were explained. However, if the quality of work was unacceptable, a new student team was assigned to the project for the following semester. Clients overwhelmingly stated their satisfaction with their artifacts (Weitl-Harms, 2024a), with only two of the sixty requesting restarts.

By requiring new clients to attend initial meetings, submit initial surveys, and by explaining expectations of all stakeholders, all clients who completed this step continued through the life of the project. A few clients were sometimes unresponsive due to personal or business demands, but students were overwhelming satisfied with their client interactions (Weitl-Harms, 2024a).

Determine Overall Needs

All clients were expected to provide an explanation of their existing implementation of social media to the assigned student team. A pre-project survey was conducted to understand the client's background and needs. These surveys provided an understanding of client knowledge and expectations (Weitl-Harms, 2024b).

Review of Current System

Student teams conducted client interviews to understand their current system and how well it was functioning for them, using HCD methods and tools. Clients not in the initial iteration were required to provide the student with their existing artifact and explain how well it was implemented. Student teams were required to study the previous artifact's documentation, design, and structure, as they would be building upon the previous version of the artifact. Student teams were also required to submit a proposal during the fifth week of the semester, outlining which organization they are working with and the plan's overall goals.

Review Needs of Desired System

In this phase, students were told to think about the unanswered questions about this problem/opportunity, particularly as it relates to the client's experiences and feelings. To assist students in reviewing their client needs and possible "What is" ways to meet those needs, students were given three assignments that required each student to independently review social media channels. Each channel review was used to help the student discover its uses and describe what it does best. In reviewing a channel, students were expected to learn to use it, practice it, and experiment with it. The goals were for students to understand why people would use it, and what a client organization could did with it. The assignments required the students to record:

1. the social networking site or channel being reviewed,
2. a brief history of the social media channel,
3. a description of its current users (general demographic information),
4. a description of their experience using this channel,

5. if they had not used this social networking tool before, a specific description of why not,
6. a description of the experience as a new user (if they are a new user),
7. a description of the type of content (just words, or photos, videos, graphics, links) is shared within this social network (describe and be specific),
8. a description of at least five ideas on how to use this channel to market a product or service, tell stories, or to enhance a businesses or organization's reputation/relationships with its audiences,
9. a description with specific examples of how much time and resources (staff, content development time, money, equipment, to spend on developing content) would be required from a business or organization considering using this channel, and
10. a description of numeric metrics that a business or organization would be able to use to evaluate the effectiveness of this social media channel to show what they are doing is working.

Student teams were required to meet with their clients and use HCD methods to better understand their needs.

Specification Development

Using course materials and the skills they were learning, student teams developed a listing of specifications planned for inclusion in the delivered social media plan. The course expectations of the project specifications were provided to the student, to ensure a quality final product.

To assist students in exploring innovative "What if" solutions, students were given three assignments that required each student to independently study the social media strategy for an organization (even from unrelated industries). For these exercises, the student was to review an organization's social media strategy, by monitoring a brand, organization or individual for 24 hours to discover how this entity is using social media. A template was provided, which students used to complete the assignments. Students were required to answer all the questions shown in the template. One-sentence answers for each question were not sufficient. The instructions on the template included:

1. List all the related social media channels and site names/handles found for the organization.
2. Study for 24 hours (at least three separate times) ONE site/channel used by the target organization. Describe frequency of posts, types of posts, content of posts.
3. What is the organization site trying to accomplish with the postings/media on this ONE site? (Why is the organization doing what it is doing here? This answer describes its strategy.)
4. What types of media/content are posted on the site? Describe what types of media (photos, video, memes etc.) and what content the media displays.
5. Who is the audience for these posts on this ONE social media channel for the target organization? Why or what tells this?
6. How effective is the channel? – (By "effectiveness" students were required to numerically measure something.
7. What does this specific channel do well?
8. What needs improvement on this organization's social media channel? If the student were responsible for planning and conducting this organization's social strategy on this one channel, what would be done differently?

The instructors suggested to the teams that each team member review different organizations, to get a broader overview of possibilities, as this is the diverging part of the "What if" HCD phase.

Conceptual Design

In this phase, teams were suggested to narrow solution ideas to 5-8 channels to suggest and develop in the plan for the client. When team members meet, they should describe each solution idea and perhaps provide a simple sketch of the idea so their team members can understand their pitch for suggesting that channel for the client. for solution ideas.

Evaluating Alternatives and Selection

When evaluating alternatives, teams should focus on the desirability, feasibility, and viability of the alternatives for the client to be able to implement, maintain, and evaluate. Teams need to understand the client and their resource limits. At the conclusion of this phase, teams develop a prototype description for their 3-5 selected channels solution idea from the solution ideas identified, to be included in the plan. The instructor meets with the team to verbally discuss their plan at this point, prior to detailed development.

Detailed Development

This is part of the "What works" phase of HCD. Teams collaborate with their instructor and clients as needed but start building their elements that are required in the plan, as detailed above. They also need to design any on-ramp and training for deploying the solution.

Draft Version to Instructor & Client

In week 13, teams submit their written social media plan to both the instructor and the client for testing. The instructor provides feedback on the paper, as part of the graded system, which the students should incorporate into their final plan submitted to the organization. The client's feedback must be incorporated as well.

Delivery

During the final week of the semester, students submit their final written plan and multimedia presentation to both the instructor and the organization, and provide any training and on-ramp instructions.

Project Evaluation & Reflection

Clients and students are provided opportunities to provide feedback on the experience via surveys and reflection exercises. Students were required to individually reflect on the project. The reflection included the student's belief that the organization will implement what was recommended; why/why not; what benefits the student's service provided to their client; how the project related to the learning goals of the course; what the student learned through the completion of this project as it applies to his/her future; and what the student learned about him/herself as they completed the project.

Students also provide a team member evaluation, as each student in the group is responsible for writing his/her fair share of the paper and presentation. The final grade will be a group grade (all members of the group will receive the same grade) unless the instructor determines that members of the group were not doing their fair share. In this case some members of a student team may receive lower grades.

Iterative Process

Over time, organizations expressed desire for assistance in revising their artifacts, as expected (Connolly, 2012; Kilkenny et al., 2022; MacKellar, 2015). For example, one organization stated, *it would be fantastic to get new insight on our social media platforms as we are continually growing. We use social media for 95% of our marketing because 1) it is free, and we have a small budget as a non-profit and 2) we seem to reach a lot of people that way* (Weitl-Harms, 2024a).

In the iterative follow-up process, new student teams conduct client interviews, review the initial plans, and analyze metrics from the social media strategies and tactics already in place to provide updated, improved artifacts, using the same HCDISL phases. Current students reviewed and revised The previously developed plans to provide organizations with updated social networking plans to correspond to their current needs. Changes in businesses' attitudes toward social media were analyzed following the initial implementation of a social networking plan in addition to the following years of use. ABET computing learning objectives were used as a basis for assessment, for clients to review the student teams and the artifacts created (Weitl-Harms, 2024a).

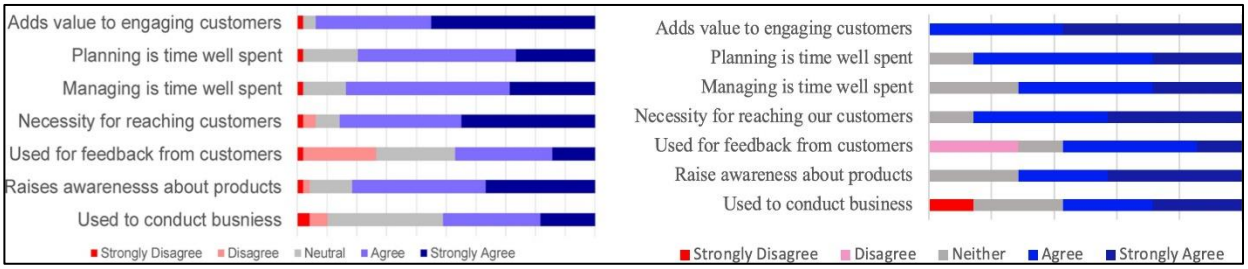
RESULTS: PROJECT EVALUATION

To evaluate the project, data was collected from the organizations pre-first iteration, post-first iteration, pre-second iteration, and post-second iteration. Data was collected from the students post-first iteration, during the second iteration (regarding the value of the existing artifact), and post-second iteration.

A large language model (LLM), Claude.ai (Anthropic, 2025) was applied to each qualitative data set for quantitative analysis. Claude.ai and other LLMs have recently been shown to provide high quality quantitative sentiment evaluation of user reviews (Weitl-Harms et al., 2024). Claude.ai was prompted, "*For the complete text in the new attached input file, please provide a sentiment analysis score to two decimal places between 0.00-1.00 inclusive, along with your qualitative and quantitative confidence in that score."*

FIGURE 3
ORGANIZATIONAL LIKERT SCALE OF SOCIAL MEDIA USE

A. PRE-FIRST ITERATION **B. PRE-SECOND ITERATION**



Client Evaluation

Pre-First Iteration

Before the first iteration, rural organizations could see the potential in social media. Figure 3a shows the results of the Likert survey responses related to the use of social media by the sixty small rural organizations who participated (Weitl-Harms, 2024b). Organizations can see the potential but sometimes lack the time or knowledge to use social media effectively in a professional setting. They can overwhelmingly see that the advantage. Ninety-four percent of the organizations found that social media marketing adds value to engaging customers; while 86% found it necessity for reaching customers; 84% stated that managing social media is time well spent; and 82% understood that social media is necessary to raises awareness about products. However, businesses also found it difficult to use and sometimes lack the time or knowledge to use social media effectively in a business setting, as only 51% used social media channels to conduct business and 47% used social media to gain customer feedback.

During the first step of each iteration, the organization's perception on the use of social media was evaluated by selecting five terms based on the Microsoft Product Desirability Toolkit (PDT) (Benedek and Miner, 2002). Quantitatively evaluating the words selected helps to better understand the organization's attitudes toward social media. Each of the respondents selected five PDT terms (245 selections total). To quantitatively summarize the user's satisfaction with experience, the number of times each term was selected was tallied by category. In Figure 4a we can see that the two most common words chosen were time-consuming and necessary. There are both positive and negative words chosen as expected. The organizations we surveyed can certainly see the potential in social media but also find it difficult to use.

There were several reasons that the organizations self-selected to participate in the project. Some sample reasons include: *"I think it is the most important marketing right now and I don't really understand it.", "While we have a website, a Twitter acct and a Facebook presence, I am not adept at using these formats and could use a plan of action and some support/training.", "It would be fantastic to get new insight on our social media platforms as we are continually growing. We use social media for 95% of our marketing because 1) it's free and we have a small budget as a non-profit and 2) we seem to reach a lot of people that way.", "I'd love guidance on developing a social media plan that aligns with our brand and*

targets our ideal customer.", "We feel as if our social media presence needs attention, and the staff is somewhat unfamiliar with twitter and Instagram, as well as other sites.", "I feel a better social media presence would benefit business and help us to succeed. I do not know enough to drive our social media presence up from where it currently is and a change would be welcome.", "We are a small business that just opened a second location. We currently have one of our employees running our social media but as with many small businesses it is hard to find the time when you wear so many hats. Also, it would be great for our team member to learn from your students and staff to better understand the tools available through social media." (Weitl-Harms, 2024b)

Post-First Iteration

The post-survey from the first iteration found that all organizations agreed that the student(s) effectively analyzed their social media marketing needs and determined the requirements for a social media plan (Weitl-Harms, 2024a). All but one of the organizations reported that the students designed a suitable social media plan for the organization. Organizations found that students provided prompt attendance, had professional interactions and professional attitudes, understood their needs and background, fulfilled expectations, were dependable and responsible, were open and responsive to suggestions, constructive criticism, and were a pleasure to work with. A few organizations did not understand the project parameters and expected the students to help them implement the plan after presenting it.

Pre-Second Iteration

Due to the gap in time between the first iteration (sometimes up to 5 years) and the start of the second iteration, client pre-project surveys were conducted again. At the beginning of a second iteration, all organizations agreed that *social media adds value to engaging our customers*. *Using social media is a necessity for reaching our customers*. All but one organization found *social media planning* and *implementing and managing* is time well spent. Four organizations *use our social media channels to get customer feedback, conduct business, and raise awareness about our products/causes* (Weitl-Harms, 2024a). The results of the Likert survey responses related to the use of social media by the organizations who participated in the second iteration are shown in Figure 3b.

When asked how the organization used social media, sample organization responses include: *we buy ads during the season of the year when customers are looking for our business*; *We used to spend lots of $ on print advertising, and Facebook reaches more people for less money*; and *We focus heavily on Facebook right now but need to get more followers on other channels.*

When asked how the organization would like to improve, sample responses include: *we need more engaging content*; *help to develop a strong presence in this area*; *A plan would be a great place to start...clarity about who uses what platforms and for what purpose* and *align my client base to correct social media*.

To evaluate the overall sentiment expressed by the clients before the start of the second iteration, Claude.ai (Anthropic, 2025) was used. Claude.ai summarized the average sentiment as neutral (0.68 on a scale 0 to 1 scale) and had moderate confidence (0.75) in that evaluation. Organizations expressed frustration with lack of social media knowledge, feeling overwhelmed by technological changes, acknowledgment of current limitations, and a sense of being behind technological trends. They also expressed enthusiasm about potential social media improvements and a desire to learn and grow.

During the first step of the second iteration, the organization's perception on the use of social media was evaluated again, by selecting five terms based on the Microsoft Product Desirability Toolkit, as shown in Figure 4b. The average of all words selected, using the means from (Veral and Macías, 2019) was neutral (3.08 on a 1 to 5 scale), like the first iteration (Weitl-Harms, 2024b). Claude.ai summarized the average sentiment as neutral (0.55 on a scale 0 to 1 scale) with high (0.80) confidence (Weitl-Harms, 2024a). Claude.ai concludes, *the sentiment score captures the document's nuanced emotional landscape, showing social media as a complex tool that simultaneously offers opportunities and challenges for businesses and individuals.* Four of the seven organizations selected **Tedious**, while several words were selected by two of the seven organizations, including **Appealing**, **Influential**, **Frustrating**, **Necessary**, **Challenging**,

Overwhelming, and **Time-consuming**. When listing reasons that tedious was selected, organizations stated, *the method I use to get photos on Facebook is tedious.*; *Takes awhile to figure out how to make the posts and sometimes I get frustrated and just stop.*; *When I try to do things on Facebook it is hard to do.*; and *takes more time than I feel I have to give.*

FIGURE 4
ORGANIZATIONAL EXPRESSION OF SOCIAL MEDIA USE

A. PRE-FIRST ITERATION

B. PRE-SECOND ITERATION

Review of Current System During Second Iteration

Step 3, Review of Current System, is especially critical in the HCDILS framework for projects that had been completed in previous iterations. Student teams reviewing a previously completed project found: *The organization claims to primarily promote their events to older adults, which is why they use Facebook as their primary form of social media. The audience they are trying to reach on their Instagram page is towards families who have young kids. They hope that with a better social media presence, they can reach more people and have a more consistent number of visitors through the years* (Weitl-Harms, 2024a).

Claude.ai found the average sentiment to be 0.47 for the overall sentiment expressed in these qualitative reviews of the existing plans in the iterative process. Students found room for improvement on each project. In the review, students whose client organization currently had low social media presence, provided a review with negative sentiment, finding that the organization had low interactions and few, infrequent posts, while projects with higher sentiment had active, frequent posts and strong engagement. A sentiment analysis evaluation by Claude.ai of each of the nine projects follows.

Project 1: Sentiment 0.78 out of 1.00 with high confidence. Students noted active posting ("very active with frequent posting") ; praised visual aesthetics ("very colorful and pop out at you," "uses bold colors and fun imagery") ; and recognize a useful content strategy (highlighting events, highlighting facilities).

Project 2: Sentiment score of 0.48 with moderate confidence. Students noted super low interactions ("With 3-10 interactions (likes and shares) per post." "It is safe to say that the organization is having issues promoting interactions") ; and business challenges ("during the off-season, the organization does not get that many visitors. Only during the summer season does the organization have enough visitors to cover the bills").

Project 3: Sentiment score of 0.35 with high confidence. Students noted low interactions and few posts, with comments like those shown above.

Project 4: Sentiment score of 0.38, with moderate confidence. Students provided repeated criticism about infrequent posting ("not posted in the last three days," "very little" posting); along with direct criticism ("To be honest I don't think this channel is effective at all" and multiple statements that "they need a lot of help with their strategy", "the whole channel needs improvement, they are

not doing anything correct"); while recognizing that business knowledge ("they do a very good job of showing that they are knowledgeable" and "really care about the industry").

Project 5: Sentiment score of 0.45 out of 1.00, with moderate confidence. Students noted low interactions and few posts but recognized that "they do well with photos of work they have done".

Project 6: Sentiment score of 0.52 with high confidence. Students noted "the organization's posts are very well-made and well-thought-out" and "the posts are meaningful and convey a good message," but observed a low follower count relative to potential audience.

Project 7: Sentiment score of 0.29 with high confidence. Students noted low interactions and few, infrequent posts, and recognized that "There is no following and half of the posts are celebrating holidays."

Project 8: Sentiment score of 0.71, with high confidence. Students noted that the organization "does an amazing job letting the followers know their deals"; described their Instagram as "Well-run"; praised that "they do a good job engaging their followers"; and acknowledged that "the pictures of the products are well organized and have a clear theme", with an "awareness of the audience they are reaching"; and a page setup that is "very clean" and "professional".

Project 9: Sentiment score of 0.39 with high confidence. Students noted effectiveness criticism ("I do not think that this channel is effective whatsoever"; engagement issues: "the posts receive very few likes, if any"; content limitations: "very little content being shared on the page"; posting infrequency: "does not appear to post on her insurance page often at all"; and lack of audience reach: "there needs to be more outreach and more consistent posting").

Post-Second Iteration

The organizations completed a survey, using questions with matching ABET CS student learning outcomes. The results as reported in Weitl-Harms (2024a) follow and show an average of 81.61% overall approval of the quality of the project using this assessment. **The student(s) I worked with on the social media project:**

1. Effectively analyzed the problem and determined the requirements for a solution (ABET CS 1) (85.7%)
2. Designed a suitable solution to the problem (ABET CS 2) (85.7%)
3. Used appropriate software design and development tools to design and develop a solution to the problem (ABET CS 2) (71.4%)
4. Communicated and interacted on a professional level (ABET CS 3) (85.7%)
5. Prepared effective documentation for both non-technical and technical users (ABET CS 3) (71.4%)
6. Interacted ethically with all persons involved with the project (ABET CS 4) (85.7%)
7. Given a suitable job opening, I would employ the student(s) I worked with. (ABET 5) (85.7%)

Comments from the organizations were primarily positive and include *This was a very interesting project to do, especially for an online class and having to coordinate with the other members since we did not have the opportunity to do so in class. The students were professional and did a great job with the assignment.* and *Informative feedback and action plan.* However, one client found "*in reality, this project was thrown together last minute and not as comprehensive as this assignment should have been being a capstone course."* Claude.ai found overall sentiment from organization comments to be neutral (0.45), when the one negative comment was included, and highly positive (0.85) when that comment was not included.

Student Reflections

Students were asked to complete a self-reflection of the project, which are important to student empowerment, a key pillar for experiential learning (Kissel and Stuetzle, 2020; Weitl-Harms, 2022). Student reflections were overwhelmingly positive regarding the experience and expressed strong civic engagement.

Sample student reflections include:

- *I learned a lot about how to make a company's social media effective, what social media is more beneficial for what businesses, and how to tailor a channel to a specific business's needs. As someone who does not use social media at all, I benefited a lot from seeing just how important social media is in today's world to sustaining and building a business. If I were to ever want to create my own business in the future, I now know the benefit of utilizing social media for more than just marketing, but also maintaining engagement and retaining customers.*
- *While doing the project I learned to have good communication skills along with working in a group of people that I was unfamiliar with.*
- *I learned that each person has a different approach to how they would resolve the exact same question, specifically how to manage different social medias as opposed to treating them all the same.*
- *Throughout the completion of this project, I learned the importance of creating a strategy for a social media plan. All the research I did about creating a social media plan pointed to the need to develop measurable and attainable goals. Every social media strategy requires metrics that can be analyzed to measure success. I learned that this is important because not every plan will be successful from the beginning, so measurement and adjustment are necessary to develop a successful strategy.*
- *I learned that I do possess an interest in developing my online communication skills.*
- *The course gives us a real case to analyze and implement what we have learned. We also have to do outside research to learn more about social media marketing.*
- *I enjoyed the real-life application of this project. I feel like many classes have final projects that are simply busy work for the students, but this project had actual needs, deadlines, and impacts on others, which was a little scary and stressful, but essential to learn for the real world after college. I thought our project outcome was exactly what the client was looking for and I believe that we set up an excellent social media schedule for them to follow with plenty of ideas on what to post and how to attract a larger audience. Overall, this was one of the best school projects that I've ever done.*

Student Evaluation of Client and Artifact Delivered

Sample student evaluations of the client and artifacts delivered include:

- *The plan that we created offered guidance and advice to help create effective social media channels including Instagram, Facebook, and YouTube. We were able to use knowledge that we learned in class to suggest how to use the best practices of each channel and create a successful page to the best of our abilities. We were also able to relate course knowledge by suggesting the best ways to monitor the progress of the pages. The project was strongly related to the goal of learning how social networking influences people and businesses.*
- *I think that initially when we met with our client, her problem was that she would be active on social media but getting engagement was hard for her. Facebook brings awareness to different events that could be happening within the organization, and I do feel that our client has posted consistently over time. What she wants is to get more engagement on the post themselves. In order for this to happen the main thing we want to focus on is creating a visually more engaging and consistent platform by utilizing each platform to the best of its ability. Consistent posting is what this non-profit is looking to achieve, and they have achieved the ability to post consistently.*
- *The social media plan that I helped to put together along with my team should help to elevate all their mentioned social media platforms (Facebook, Instagram, and Twitter) if they are posted consistently. I believe that we did a good job expressing what we thought could help the organization reach more people and to also bring in more people to the actual site. We all benefited from learning how to put together a social media plan like this, and the organization benefited by getting a different point of view that could help them.*

- *Through our services, we developed a cohesive theme across the three social media platforms aimed to target the specified target audience of students, alumni, and potential donors. Furthermore, the content we developed focused on educating, promoting events, and fostering connections between the organization and the local community.*
- *I believe my team members and I did an effective job developing a functional, sustainable social networking plan for the organization When meeting with the client, we acquired information about the organization as well as the issues and needs the client wished to address and resolve with the development of a social networking plan. As a result, my group and I had a focus to ground and guide us while designing the three different social media platforms for the organization.*
- *Whether they actually implement the ideas or not, it gives a local business owner a different perspective of social media and how to expand their business with it.*

Quantitative Analysis of Student Reflections on Project Results

A quantitative sentiment analysis of the student reflections for the nine projects follows. Claude.ai noted an average of 0.84 out of 1.00 positive sentiment expressed by students, with high (88%) confidence. Individually, the student teams expressed mostly strong positive sentiment regarding the experience.

Project 1: Sentiment 0.82 out of 1.00 with high confidence (88%). Students noted enthusiasm about the real-world project experience; pride in team accomplishments; learning and personal growth; positive reflection on collaborating with a client; appreciation for the practical nature of the project; and an enjoyment of the learning process.

Project 2: Sentiment 0.87 out of 1.00 with high confidence (88%). Students noted comparable items as the previous project.

Project 3: Sentiment 0.85 out of 1.00 with high confidence (90%). Students noted mostly positive sentiment regarding the course, but noted resource limitations for this organization, and described that "Meeting the needs of this organization was a bit difficult." (Note, this was the organization that believed the student project was rushed and was one of the projects noted above that did not implement much of the previous iteration's plan.)

Project 4: Sentiment 0.84 out of 1.00 with high confidence (88%). Students expressed enthusiasm about helping the business improve its social media presence; optimism about the potential benefits of the social media strategy; pride in understanding client needs and creating effective solutions; excitement about learning digital marketing skills; and appreciation for the practical nature of the project.

Project 5: Sentiment 0.86 out of 1.00 with high confidence (92%). Students recognized the purposeful approach of this process: We came up with goals that could help the client develop more clientele and noted future potential: my team and I provided sample designs and content that she could implement. However, students noted that the client did not seem interested in using social media tools outside of Facebook and Google.

Project 6: Sentiment 0.88 out of 1.00 with high confidence (93%). Students noted pride in meeting client needs; optimism about future career applications; deep appreciation for practical learning experience; and positive reflection on team collaboration.

Project 7: Sentiment 0.70 out of 1.00 with moderate confidence (75%). While students noted much of the same positive sentiment as above, they also noted some frustration with team communication; uncertainty about fully meeting client needs; and doubt about the depth of client understanding. Note, this was also a client who did not implement much of the previous iteration's plan.

Project 8: Sentiment 0.89 out of 1.00 with high confidence (94%). Students expressed enthusiasm about the project's value for local businesses; pride in personal social media knowledge; optimism about future business applications; and appreciation for practical learning experience. Students acknowledged initial communication challenges and subtle project complexities.

Project 9: Sentiment 0.82 out of 1.00. Confidence high (87%). Students had similar positive sentiment as above, but also acknowledged the uncertainty about client implementation. This client did not implement much of the first iteration's plan, as noted above.

DISCUSSION

For the first iteration, providing grant-funded interventions to manage the implementation of social networking plans at the end of the semester was critical for helping organizations effectively utilize their social networking plans. However, this was not sustainable without funding. Prior to the first iteration, this study found that small rural organizations could certainly see the potential in social media, but few used it for business purposes. The study also found that the organizations were overwhelmingly pleased with the computing artifacts delivered at the end of the first iteration.

The addition of the iterative approach addressed the challenge of maintaining of the computing artifact by community partners who do not have the resources to do it in house and without outside grant funding for the university. The effectiveness of implementing social media plans for small, rural organizations was addressed with the iterative approach. The goal of the iterative approach in the HCDISL framework is to provide the client with an opportunity to revise the artifact as the student teams use HCD practices to evaluate the impact of current artifact and develop an updated version to improve business functioning. In the example application, the improvements were in terms of the implementation and sustained use rates of social media plans developed through service learning.

At the start of the second iteration, the analysis of the client expressions and PDT survey data showed that clients were eager to restart. However, they also expressed some frustrations with their current implementations, resulting in overall neutral sentiment. When students reviewed the current version of the artifact, students also noted the need for improvements, but found some quality elements in the artifacts, also resulting in overall neutral sentiment expressed toward the current artifacts.

At the end of the second iteration, the analysis of the client review of the student work was overwhelmingly positive, with only one client expressing a little dissatisfaction; and the ABET-based assessment resulted in an 81.61% approval. The student reflections were also extremely positive, with an average of 0.84 out of 1.00 on a 0-1 sentiment scale. These client and student positive sentiment expressions were observed even for projects with low initial sentiment expressed regarding the client's confidence in using social media and the students' review of the clients' current implementations of their previous plans.

By the example application, this project also aims to aid in understanding the implementation of social networking plans for rural businesses and local non-profit organizations everywhere. In general, the interventions introduced aim to increase implementation rates, social media use, and long-term success for organizations in rural communities.

This study also advancing the field of civic engagement and service learning as the pedagogy of engagement by providing the HCDISL framework to explore, develop, and evaluate new strategies regarding service-learning initiatives. It also is innovative in using qualitative and LLM-based quantitative evaluation of client and student qualitative (pre and post) reflections to evaluate organization and student perceptions.

While this paper describes only two iterations of the HCDISL framework, with only nine selected organizations in the second iteration from the original sixty organizations originally studied, further iterations are feasible and would follow the same pattern as the second iteration.

Overall Issues

As with any project, there were communication issues. As noted above, student and client reflections expressed communication concerns. One student commented, *When we are assigned a client who does not respond to emails after 3 weeks, isn't there to answer questions on multiple occasions, and then when she is there, she directs me to talk to someone else who does not even work for her business, it makes it hard to understand what they want from our group.* One organization commented, *the students gave some good*

ideas, but we are already implementing what they said. Still good ideas though. The instructor is required to serve as a facilitator to clear communication issues as they arose.

As mentioned above, each section of this course was offered asynchronously online. This did not seem to hurt the results, as one student noted, *this was a very interesting project to do, especially for an online class and having to coordinate with the other members since we did not have the opportunity to do so in class.* Instructors in the first iteration addressed some early communication issues due to the asynchronous online nature of the class. One adjustment was the inclusion of Zoom in the class to help the students get to know the instructor and course expectations better, as well adding a required mid-semester team meeting with the instructor.

Transferability

HCDISL framework is feasible for universities of any size to implement, as it was implemented at a small rural regional university. This study also showed that working with small rural organizations over multiple iterations is feasible. It is easily transferrable for use by universities and local organizations around the world, as the framework provides a structure for straightforward application.

The innovative HCDISL framework described in this paper is transferable directly for service-learning projects utilizing social media plans as the computing artifact. Social media plans are vital for organizations to fully engage with their audiences, and the plans and social media activity should be regularly reviewed. Since most small organizations do not have the expertise or resources to implement one, iterative service learning is a highly effective mechanism.

The HCDISL framework applies to various artifacts, even though the application focused on delivering a social networking plan. For computing artifacts such as software or websites, using the HCDISL framework would require that the student teams have access to the working code, which can sometimes be an issue with changing technologies. Additionally, code bases often take much longer to review and understand than social media plans. However, the concept of using HCD and iterative service learning, with teams of students, even five or more years later, to provide necessary maintenance on a service-learning artifact is a viable alternative. Other transferability ideas demonstrated in this project include incorporating client evaluations (based on ABET learning outcomes), student reflections into the grading, and evaluating reflections for quantitative sentiment using modern LLMs.

Finally, in many situations, HCDISL is likely a more viable framework than finding a skilled volunteer (person or company) in the community willing to take over this task; or asking the students themselves to allow themselves to be contacted again to help maintain the system as suggested in (Bloomfield et al., 2014), especially if the updates requested are not immediately after the initial hand-off, but years later.

CONCLUSIONS AND FUTURE WORK

Future work includes conducting and evaluating various applications of the HCDISL framework, including further iterations of the social media project introduced here. Future work also includes a longitudinal impact study of the interventions in increasing implementation and sustained use rates of social media plans for the organizations served over the past ten years through service learning in this course, to compare organizations who were served in the various iterations of the course; as well as to compare with organizations in the local area who did not work with the university students. Future work includes using the HCDISL framework in computing courses, particularly in courses where the artifact is software or websites.

This research introduces the HCDISL framework that integrates iterative approach to service learning with Human Centered Design principles to develop, review, and improve computing-based artifacts. The research shows an application of the HCDISL framework to develop social networking plan artifacts for small rural organizations, over an extended period. This framework addresses the well-known issues that plagues the success of service learning in computing programs: the fact that computing artifacts rarely function well long-term without versioning and updates; and the fact that service-learning projects are often one-time engagements, completed by single teams of students over the course of a semester or yearlong

course. These problems limit the benefit of the service-learning experience for the community partners, such as small rural organizations, which do not have the expertise or resources to review and update a project on their own.

The benefit and application of the HCDISL framework was demonstrated through the development of social media plans for small rural organizations through service learning over several years. In a computing capstone social media development course, teams of undergraduate students created tailored social media plans for numerous small rural organizations, using HCD principles and the steps in the HCDISL framework. The second iteration of the HCDISL framework was demonstrated using selected clients who had previously received a social media plan as part of the service learning five years earlier. The new student teams followed the HCDISL framework to conduct client interviews, review the earlier artifacts, and analyze metrics from the social media strategies and tactics already in place to provide updated, improved artifacts following a systematic HCD process. Using ABET computing learning objectives as a basis for assessment, clients reviewed the student teams and the artifacts created. Clients and students also reflected on their experiences. Overwhelmingly, the sentiment of both the client and student feedback from this approach was positive, as measured qualitatively and as measured quantitatively using an LLM. This research demonstrates an innovative framework for creating and maintaining computing artifacts by applying HCD principles through iterative service learning, while addressing the resource constraints of small rural organizations.

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