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CUR Focus

Design Thinking as Research Pedagogy for Undergraduates: Project-Based Learning with Impact

Abstract

In the Design Thinking to Meet Real World Needs course at Grand Valley State University (GVSU), faculty members recruit an internal university or external community-based organization to pose a vexing question to the class. To address this question and develop an original hypothesis or problem statement, students collect data. The students then derive multiple innovations to address the problem. The innovations are tested and transformed to validated solutions through a repeated process of data collection and critique. As a course final, the students' results are disseminated publicly as a community call-to-action. Thus students engage in learning through a process that parallels undergraduate research. Pursuing an authentic research question through a multidisciplinary lens (Hakim 1998; Henne et al. 2008) allows students to find not only their academic voice (McNary-Zak and Peters 2011) but also their entrepreneurial voice.

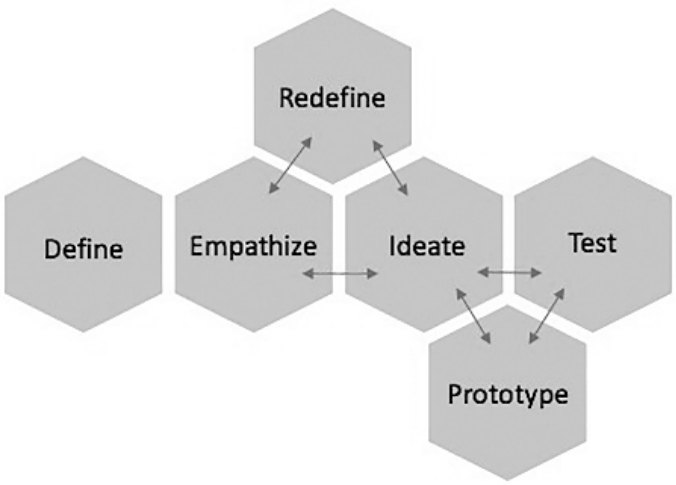
Keywords: *community-based projects, design thinking, high-impact learning, project-based learning, research pedagogy*

The Use of Design Thinking to Frame and Practice Research

The course GVSU Design Thinking to Meet Real World Needs is based on the fundamental principles of human-centric, or design thinking practice, systems thinking, and elements of collaborative best practices. This intersection of methodology and practice facilitates student learning by preparing students with current tools and approaches commonly used in industry for product innovation. These practices are also newly emerging in social innovation sectors. Experience using course tools enables the students to successfully frame the problem and then generate innovative solutions, as well as develop skills in dialogue and interdisciplinary teaming that are essential for constructive progress to be made in the summative class project.

Established practices serve as the class foundation for the intersecting concepts of design thinking, systems thinking, and interdisciplinary teaming. The design thinking methodology is derived from the Stanford d-School model (http://dschool.stanford.edu/use-our-methods/). Design thinking applies a specific and deliberate design process that interconnects creative and analytical approaches while embracing learning across the disciplines. By using techniques of discovery that are rooted in the concepts of viability, feasibility, and human values, students learn to develop innovative designs that are validated, therefore usable and desirable. The design thinking process focuses on five essential elements, as noted in Figure 1: *empathize* (data collection through qualitative research), *define/redefine* the problem statement (authentic research question), *ideate* (pursue original solutions), and construct *prototype* concepts and *test* (data collection for proof or efficacy). For more information about the design thinking process, see T. Kelley and D. Kelley 2013; Brown 2009; Liedtka, King, and Bennett 2013; and Martin 2011.

Figure 1. Visualization of Design Thinking Model Constructed for the Course



In addition to design thinking, the course uses components of systems thinking to facilitate mapping the ecosystem of the design challenge, which is referred to here as *stakeholder mapping*. This helps the students explore the connections and interdependencies among and between project variables, and forces students to develop a broader view of the problem. It also creates a tangible "map" through which students develop a research plan. The systems thinking content was derived from Senge's seminal work, *The Fifth Discipline* (1998).

As many of the real-world projects for the course center on problems that are complex, dynamic, and seemingly unsolvable (also referred to as *wicked problems*), it is critical that students not only understand the value of interdisciplinary

teaming but also put that learning into practice. Readings from *The Fifth Discipline* and *The Opposable Mind* (Martin 2009)—as well as *Swans, Swines, and Swindlers* (Alpaslan and Mitroff 2011)—provide the foundation for understanding a complex system of problems and working through these with collaborative best practices. In addition, faculty use selected videos for emphasis on dialogue and team dynamics.

In addition to readings about design thinking, systems thinking, and interdisciplinary team learning, the course requires students to read materials that contextualize their project question. These project-specific readings are provided by the project "client" championing the initial design challenge posed to the class and serving as the students' key point of contact for the project. The client also is the ultimate recipient of the student work product.

Intentional Course Design

The course is specifically designed with learning objectives that focus initially on the students' ability to comprehend and utilize key concepts and theories in design thinking. Secondary course outcomes focus on the students' ability to apply these concepts to a real-world problem. As the coursework is team-based, corollary learning objectives include understanding collaborative processes as a means to build interdisciplinary team effectiveness. The content of the 15-week course is paced to manage the content learning, practice of method, student team development, and class deliverables. This approach helps students to pursue an original solution, engage in knowledge creation, and develop voice.

Before the class convenes, faculty activities include identification of the design challenge, meeting with the project client, securing the client's commitments for student accessibility and participation in semester project debriefs, scheduling guest lecturers, and working with the university's Human Research Review Committee and Institutional Review Board for issuance of a letter of determination enabling the students' methodology in qualitative research. Faculty also create student teams to maximize diversity in student major, gender, ethnicity, personality "type" (using Myers-Briggs), and grade point average. Teams consist of 5–7 students, with 4–5 teams per class.

Pursuit of an Original Solution

Prior to the start of the semester, a design challenge or a single, community-based issue is identified by faculty and evaluated to assess if, through using the design thinking process, the issue can be adequately addressed during the semester. The selection criteria include the following questions:

- Can the project client commit the time and resources needed to participate fully in the course? Is the client willing and able to provide background materials on the topic, connect students with stakeholders, and engage with students in the classroom? After completion of the course, is the client resourced to implement class innovations?
- Does the challenge present an opportunity to exercise multiple forms of inquiry—primary and secondary research, observation, and immersion?
- Will the students have access to the community stakeholders involved in the issue?
- Does the challenge offer appropriate breadth and depth to challenge students to think creatively and critically but not overwhelm them? Can the challenge be successfully addressed in a 15-week semester?
- Does the challenge align with the university mission for the public good?

In week 1, the design challenge is presented to the class as a broad question that needs to be understood, clarified, and explored. From the posed design challenge (weeks 2–3), the student teams are required to review all information provided by the project client, prepare a stakeholder map, and identify those from the community who should be engaged in their research—particularly those that could be affected by addressing the design issue. During the Empathize phase (weeks 4–8), teams use this map to formulate and apply a research plan that directly engages stakeholders, helping students to better understand the real-world context of the posed problem. This engagement demands the class utilize design thinking disciplinary practices for experimentation and inquiry such as individual interviews, community observation, and extensive review of scholarly literature. Students are trained in interview best practices and human subjects research ethics and rules prior to starting this work. Each week, student teams are required to complete four "stakeholder" experiments and engage in collecting two secondary sources. Each experiment must be clearly documented via provided templates and submitted weekly for faculty review and feedback.

During this process, the collected data is critically evaluated by the student teams for insights. The insights are captured and applied in cluster mapping, so as to identify affinities or common patterns in the response data. In this process, the students write one key insight from their research per sticky note, adding each to a large wall board. Typically students have 5–10 insights per experiment. After new insights are added each week, the student teams engage at their team board to "cluster" sticky notes that are cognitively similar, essentially creating affinities and making sense of what they heard. This step ultimately provides an analytically-derived empathetic lens that originates an essential problem state-

ment unique to each student team.

Faculty have noted that students struggle with application and implementation during this phase of the course. Student teams strongly desire to rush through data collection and affinity mapping, and move toward solving the problem in the innovating and prototyping phase of the process. As most of these students do not have experience in research, they may feel uncomfortable with the process ambiguity and the challenge of the unknown. Additional faculty coaching is provided during this portion of the class to emphasize the importance of the design thinking process. It is crucial that students appreciate the process of thinking critically about their work and the value of the time spent on data collection and review, so as to avoid the potential for cognitive bias and assumptive models that could derail the final product.

Creative Output

In weeks 9–13, the students apply creative thinking skills in developing innovative solutions to the problem statement. Working from their affinity map, the students prepare "needs" statements that translate to a more specific problem statement. This redefined problem statement becomes their innovation platform, from which they will brainstorm hundreds of innovations. Brainstorming best practices are utilized to support their efforts. These innovations are further refined through an iterative research process with stakeholders.

Critique of student innovations is directly gained through three "stakeholder debriefs" that are strategically placed at critical stages in the design thinking process:

1. validation of initial insights,

2. review of initial innovations, and

3. top prototype selection.

The debriefs involve extensive practice in both the giving and receiving of criticism. Between these debriefs, faculty engage with the student teams in a substantial and intentional way. Immediate assignment feedback is expected from the students to allow for revisions before taking next steps in the design process. Strong faculty mentorship supports translation and inspiration for the teams as they create and validate their hypothesis. By week 13, the students clearly understand their problem statement and have defined prototype concepts or actionable solutions.

Academic and Entrepreneurial Voice

The design thinking course culminates in week 14 at an Innovation Symposium where the student teams present to university administration, faculty, and students, as well as invited community stakeholders. Typical attendance ranges from 60–70 persons, including the class. The student presentations are practiced with the university's Speech Consultancy Lab. Oral presentations last 8–10 minutes, with an equal amount of time dedicated to dialogue with the audience on next steps. Faculty strongly encourage students to ask for further engagement from stakeholders. At the conclusion of the Innovation Symposium, attendees are asked to rank the innovations for both effort to implement and potential impact. The attendees provide feedback to the student teams on the substance of their video and presentation through written surveys. Faculty compile these surveys, which are integrated as a component of the assignment grade.

The students' work is also assembled in professionally modeled Innovation Portfolios, which are published in GVSU ScholarWorks for global dissemination, and a printed version for the students and project client. The portfolios include a written project description, results of the student research, summations of the innovations, prototypes and collaborator debriefs, and visuals of their work. Each Innovation Portfolio also includes a link to a 2–3 minute video prepared by each team. These videos quickly summarize the work found in the portfolio, and faculty have found that these videos reflect the learning as well as the personality of the teams. The 13 portfolios from three completed semesters have resulted in approximately 1500 downloads on five continents.

Personal interviews of key stakeholders are conducted by faculty several weeks after the course concludes, and are currently being surveyed for longer-term implementations. There are clear indications that the students have successfully defined and validated hypotheses that are purposeful and applicable in a real-world environment. In other words, implementation of their solutions is having a high impact in their community, as well as in their own learning experience. Faculty are prototyping the same design challenge over two semesters to better understand the effect on prototype implementation by the project client, as well as student learning outcomes.

The course details, including the design process, research process, and supporting activities are noted in Table 1.

Design Challenge Examples

One example of a design challenge is from the fall 2015 class, which addressed the question, "What is the role of a university in addressing student food justice?" The project client was the director of the GVSU Women's Center. The four student teams mapped the stakeholders, which included students, administration, faculty, staff, the student food pantry, regional food providers, and transportation systems. The teams executed their research plans, which generated more than 140 interviews with stakeholders or other community members, as well as sourcing and consideration of more than 50 relevant scholarly works. The information was analyzed with

each data source yielding 5–10 insights or approximately 1500 data points in total, which were synthesized for trends to derive redefined problem statements such as "we will raise awareness about the student food pantry to meet the needs of the food insecure in the campus community," and "we will understand student preferences for service from the food pantry." The problem statements served as the team innovation platforms. More than 30 different innovations were outlined, and final prototypes of best solutions were presented after the debrief critique process. Two solutions were a promotional video for freshman orientation and a food truck for inter-campus service (Student Innovation Portfolios 2015). As a direct result of the students' work, student food pantry services were included in freshman orientation beginning in fall 2016, and a student club focused on food justice issues is fund-raising to implement the food truck solution.

In winter 2016, the class faced the following design challenge: "How can we reintegrate returning citizens into a neighborhood?" The project client was the director of Seeds of Promise, which is a regional, grassroots, neighborhood advocacy group. The four student teams built their research plans from a stakeholder map that included returning citizens, neighborhood residents, city government, local religious organizations, law enforcement and criminal justice advocates, and centers serving homeless populations. Through the research process, more than 120 interviews were conducted with stakeholders, multiple observations and immersions were completed, and more than 50 relevant scholarly works were investigated. Each source yielded 5–10 insights, or more than 1400 data points in total, which were synthesized for trends. The trends yielded problem statements such as "we will address the fragmentation and isolation of returning citizens by catalyzing community integration," and "we will develop a reintegration program with a housing component, which promotes community development and support while also fostering participant's independence." Consequential ideation, followed by structured critique, resulted in the teams presenting final prototype concepts, including a neighborhood "Kindness Wall" for distribution of goods and a door-sign campaign to foster community building through personal connection. The project client is now working with regional service organizations to implement these creative means to connect people in the Seeds of Promise community.

Learning Outcomes

Although the course culminates in the Innovation Symposium, faculty reinforce personal mastery of course objectives throughout the course through application of continuous feedback to all team experimentation and assignments. Creation of the Innovation Portfolios are paced in sections, with each section requiring a draft version before final work

Table 1. Outline of Course Syllabus, Design Thinking to Meet Real-World Needs

Timeline	Design process	Research process	Activities
Weeks 1–2	Building Competency	Team formation, literature review	Instructor lecture, student self-assessment, team formation, creation of team charter and communication portal, introduction to the real-world problem through on-location presentation by the project client
Weeks 3–8[a]	Empathize	Data collection, analysis, and synthesis	Creation of design brief, stakeholder mapping and research plan development (primary and secondary), training in qualitative research methods, student data collection and affinity mapping, generation of independent hypothesis (clear problem statement)
Weeks 9–10[a]	Ideate	Originate an essential problem statement	Brainstorming methods, utilization of constraints, project champion debriefs
Week 11–13[a]	Prototype and Test	Data collection, analysis, and synthesis	Experimentation, data collection and analysis, synthesis and idea refinement, final prototype selection
Week 14	Innovation Symposium	Dissemination (formal presentation of research)	Team call-to-action presentations to project stakeholders (in-person and through student-produced video)
Week 15	Innovation Portfolio Publication	Archiving of research portfolio	Informal celebration of the semester's work, student feedback to instructors on the course, professional compilation of research submitted for publication to university repository (GVSU ScholarWorks)
Week 16+		Project client survey on implementation of student prototype concepts	Faculty, with support from prior students who are engaged in subsequent semesters as teaching assistants, survey project clients for progress in implementation of prototype concepts at 3, 6, 9, and 12 months. Longer term impact of student learning outcomes is ongoing, through survey of fall 2015 cohort.

[a]Design practitioners, qualitative research specialists, research compliance officers, and community stakeholders as guest lecturers and/or engaged in debriefs

is submitted for a course grade. For the course final exam, each student is required to prepare a personal reflective essay demonstrating their proficiency in design thinking language and methodology, as well as application to real-world issues. Students are also required to imagine and project how they will utilize design thinking in their future endeavors. Final grade composition is 35 percent individual (engagement, reflective essay) and 65 percent team (Innovation Symposium, Video, and Innovation Portfolio that consists of the written team design brief, stakeholder map, affinity map, written descriptions of the top five innovations and top two prototype concepts, project client debrief worksheets, link to team video, and final team presentation. The appendices contain complete documentation of all research). Therefore, student learning gains are determined through completion of the Innovation Portfolios, analysis in the reflective papers, and feedback from the project client. A quantitative approach to assessment is in development, and implementation of the method is planned for fall 2017.

This interdisciplinary, design-thinking experience is a powerful and natural extension of the traditional inquiry-based research model for undergraduates offering disruptive pedagogy for scholarly engagement for social innovation. The students are operating under a theorem—the design challenge—in search of their own original hypothesis—the problem statement, which they validate and propose solutions to through inquiry methods. Students benefit from development of advanced skills in critical and creative thinking, collaboration, and communication, affording them a competitive advantage as they transition into their professional careers.

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Susan Mendoza is the founding director of the Office of Undergraduate Research and Scholarship (OURS) at Grand Valley State University. Her area of practice as a scholar practitioner is the intersection of disciplinary epistemology, high-impact interventions, and student agency. Mendoza previously held multiple roles at GVSU, Kalamazoo College, and Michigan State University in integrative learning, career development, academic advising, residence life, and internationalizing student life. She has a BA in integrative social science, anthropology, and political science; an MA in student affairs administration and personnel services; and a PhD in higher education administration.

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