Designing Local Food Systems: Results from a Three-Year Pilot

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Abstract

A redesigned course employing blended delivery, a flipped format, and modified mastery learning with a buffet approach to assign final grades was used to teach engineering design to approximately 25 dual-level (juniors, seniors, and first year graduate) students pursuing baccalaureate degrees in environmental, civil, or architectural engineering or a graduate degree in environmental engineering. The course replaced a traditional pedagogical format that used lecture-discussion augment with extended homework assignments and a semester-long design project, which focused on the content of designing a wastewater treatment plants. The redesigned course uses the engineering design process to improve the local food system, which includes aspects of sustainability and life cycle principles of water, carbon, and nutrients. Spanning the full impact of COVID-19 (spring semester 2020 initial disruption and movement to remote learning; spring 2021 online instruction; and spring 2022 a return to face-to-face instruction), this paper describes: a) details of course pedagogy; b) details of course content; and 3) outcomes from three course offerings over a period of three years to 84 students. Attributes of this course described in this article, include: 1) students completed lecture content mapped closely to the Environmental Engineering Body of Knowledge (EnvEng BoK) and the design criteria described by the Engineering Accreditation Commission (EAC) of ABET Inc.; 2) students prepared podcasts to teach design principles to specific audiences (i.e., high school students, peers, and public officials); and 3) students worked independently and in small groups to perform term-length design exercises. A unique aspect of this course included interdisciplinary involvement of faculty from environmental engineering, University extension, and nursing to provide both breadth in how to engage with communities for design (i.e., from a nursing perspective) as well as depth in how to understand and consider local food systems (i.e., from a University extension perspective).

Introduction

Historically, the use of a traditional lecture-discussion pedagogical format augmented with extended homework assignments and a semester-long design project was employed to teach the design of wastewater treatment plants and other environmental cleanup technologies to approximately 25 seniors in the final year of pursuing a baccalaureate degree in environmental engineering at the Missouri University of Science and Technology, a state-sponsored, technological research university in the Midwest. During senior year exit-interviews, students previously commented that the environmental engineering degree program was "overly focused on the design of wastewater treatment plants", and students suggested that additional design examples be considered to offer breadth of content for students to pursue.

In response to student feedback, the existing course, CArE5619 Environmental Engineering Design – Lecture and Lab, was significantly modified both in content and pedagogical approach by the new course instructor (DBO).

The course content, including the semester-long design project, was modified to focus on the redesign of the local food system including sustainability and life cycle principles of water, carbon, and nutrients [1]. The course content was selected to be consistent with the Grand Challenges in Environmental Engineering [2], which include sustainably supplying food by tackling climate change impacts from the farm gate to the dinner plate [3, 4]. Throughout the semester, students completed required lecture content mapped closely to the Environmental Engineering Body of Knowledge [5] and the design criteria described by the Engineering Accreditation Commission (EAC) of ABET Inc [6].

The new course instructor (DBO) modified the course pedagogy to use blended learning (i.e., between 25% and 75% online), a flipped classroom (i.e., student engaging with content BEFORE lecture), and modified mastery learning to assign grades (i.e., students complete required assignments before firm deadlines to earn a grade of "C", and students complete optional work from a buffet of assessment to earn a grade of "B" or "A") [7]. To practice communication, students prepared podcasts to teach design principles to specific audiences (i.e., high school students, peers, and public officials). To learn design through hands-on application, students worked independently and in small groups to perform term-length design exercises. As part of expanding the engineering design experience to interface with interprofessional education, the course included the involvement of Professional Engineers in Environmental Engineering as well as faculty of nursing (SEO) and faculty from University extension (SHM). This unique approach was selected to provide both breadth in how to engage with communities for design (i.e., a nursing approach) as well as depth in how to understand and consider local food systems (i.e., a University extension approach).

This paper describes: a) changes in the course pedagogy using blended, flipped, and modified mastery learning; b) details of course content including the term-length project focused on the redesign of the local food system; and 3) outcomes from three course offerings over a period of three years to 84 students. Results include student demographics (i.e., Myers-Briggs and Learning Styles Inventory), student assessments (i.e., graded assignments), and evaluations of teaching effectiveness (i.e., anonymous end-of-semester Likert-scale agreement with statements as well as open-ended questions).

In particular, the results from this three-year pilot span the full impacts of the COVID-19 pandemic as results include course offerings during the spring semester of 2020 (i.e., an unplanned, spontaneous transition from face-to-face to synchronous online learning), the spring semester of 2021 (i.e., all work performed using synchronous online learning), and the spring semester of 2022 (i.e., all work performed using face-to-face learning).

The purpose of this paper is to share the format and the experiences gained from three offerings of a pilot course focused on designing local food systems.

Methods

Course Catalog Description. The course, CArE5619 Environmental Engineering Design – Lecture and Lab, includes the functional design of water and wastewater facilities and other environmental cleanup systems. Prerequisite: Civ Eng 3615 or Env Eng 3615 Water and Wastewater Engineering. (Co-listed with Civ Eng 5619). (from on-line course catalog)

The following note also was added to the syllabus as part of the course description for the redesigned course:

> *"At times in the past, students have opined that the, "environmental engineering programs does too much wastewater and water design, and not enough design of other systems." In response to this student observation, the instructor and faculty of the environmental engineering program have decided to offer a slightly "different" approach to EnvEng5619 starting in Spring 2020. Rather than focus "exclusively" on the design of a wastewater/water treatment facility, EnvEng5619 will focus on the, "design of the Phelps County food system." This choice is based, in part, upon the recent EAT Lancet commission's observation that dietary choices influence both human health as well as planetary health (i.e., what we choose to eat impacts the physical health of the eater as well as the health of the planet because the food we choose to eat must be grown somewhere, using some method, and processed and transported using some approach). Therefore, as an approach to "environmental cleanup", the design of the Phelps County food system will include a mass/energy balance approach of food import, food conversion, waste export, and food production/exchange from within Phelps County. In this way, life cycle concepts will be used to consider sustainability (i.e., food loss and waste), risk/safety (i.e., contamination of food supplies), uncertainty/reliability (i.e., access to nutritious, culturally appropriate food), and environmental impacts (i.e., how an individual's diet relates to planetary health). Therefore, water/wastewater treatment will be a part, but not the whole, of the design. The instructor and faculty of the environmental engineering program note that Env Eng 4097 Senior Design includes design of environmental unit operations and systems; thus, students in Env Eng 5619 and Env Eng 4097 will receive exposure to environmental engineering design as well as wastewater treatment plant design in two different courses."*

Course Delivery. The pedagogical approaches used in this course – including blended learning, a flipped classroom, and modified mastery learning – have been described previously [8, 9, 10]. Briefly, course content was shared with students both in a face-to-face lecture as well as through online media, which is a style known as "blended learning". Students reviewed material before lecture in what is known as a "flipped classroom". Assessment of student learning was accomplished using a two-step process, where required exercises were repeated until mastery was demonstrated to earn a grade of "C". Thereafter, students were allowed to select from a variety of optional exercises to earn credit toward a grade of "B" or "A" as part of "modified mastery learning".

Course Content. The course consisted of seven required lecture modules, including: Module 0) introduction to: blended, flipped, mastery learning, and buffet assessment; Module 1) introduction to engineering design; Module 2) what are food systems and how do we apply life-cycle principles to their design?; Module 3) uncertainty via food and nutrition; Module 4) the risk of food borne; Module 5) unsustainable food loss and waste; and Module 6) climate impacts of food. An optional term design exercise was completed in three design modules, including: Module 7) fully understand the problem; Module 8) iterate to validate a solution; and Module 9) communicate.

Course Assessment. Student personality traits via Myers-Briggs testing, a Learning Styles Inventory, and student demographics were collected online as part of Module 0) Introduction to: blended, flipped, mastery learning, and buffet assessment. An anonymous, end-of-semester survey of student satisfaction was performed by the institution. Throughout the semester, mastery learning was constantly measured using online quizzes via the Learning Management System (i.e., Canvas), while design work – both individual and team effort – was submitted for evaluation by peers, interprofessional experts (SHM and SEO), and the instructor (DBO).

Human subjects: IRB exemption was provided by the University for this educational activity.

Results

Details of Course Content: Six Critical Elements. While a full description of the entire course content of CArE 5619 Environmental Engineering Design is beyond the scope of this paper (please contact the author for full course content), six critical elements of the course content are discussed below, in detail.

In brief, Appendix A includes the learning objectives and the key references for required Modules 1 through 6; whereas Appendix B includes the learning objectives for optional design Modules 7, 8, and 9. When reviewing Appendix A, the reader will note that sub-discipline aspects of environmental engineering design (i.e., life-cycle principles, uncertainty, risk, sustainability, and environmental impacts) (i.e., [6]) are coupled with aspects of food and nutrition security and safety (i.e., food systems, nutrition, food borne illness, food loss and waste, and climate change) to create modules that combine design and food. When reviewing Appendix B, the reader will note that broad, general principles of engineering design are included, such as: problem identification, requirements, analysis and synthesis, generating multiple solutions, evaluating solutions against requirements – all while considering the public health, safety, and welfare as well as global, cultural, social, environmental, and economics factors (i.e., [6]). The reader is encouraged to contact the author for additional discussion of the details included in Appendices A and B.

Critical Element 1: Podcast to communicate content being learned during lecture portion of the course. American surgeon William Stewart Halsted (b. 1852 – d. 1922) is attributed with the educational approach to surgery known as, “See one, do one, and teach one.” While there are a number of variants on this general approach, the central concept is that learning occurs through observation, through performance, and through instruction of others. As CArE 5619 is a “design course”, the primary course instructor (DBO) incorporated a variant of the Halsted method in the redesign of the course. Specifically, as students learned content through blended delivery in a flipped classroom format, assessment of learning was provided through an optional exercise wherein students were invited to create and record a “podcast”. A podcast is a digital audio recording that is available for just in time consumption at the convenience of the listener.

A list of course modules, the podcast topic, and the associated target audience for optional exercises in CArE 5619 are provided in Table 1.

An example of the instructions and the rubric used to grade the first podcast are provided in Appendix C.

Table 1. Description of optional podcast exercises associated with various course modules

Course Module	Podcast Topic and Audience
1) Introduction to engineering design	Introduce engineering design to a high school sophomore, which requires piquing interest and sustaining engagement
2) What are food systems and how do we apply life-cycle principles to their design?	Explain what food systems are and how a life cycle assessment may be used to evaluate a food system to another environmental engineer, which requires great depth of knowledge and the use of rich disciplinary-specific language
3) Uncertainty via food and nutrition	Answer the question, “what is food and nutrition security (and uncertainty)?” to a the lay public and politicians, which requires a professional manner that is simultaneously informative yet not condescending
4) The risk of food borne illness	Explain the risk of foodborne illness and how is it controlled to engineers from different disciplines, which requires you to share accurate yet comprehensible descriptions of your work
5) Unsustainable food loss and waste	Creating a convincing argument to use the Emerson Good Samaritan Act to help avoid food loss and waste for any audience you wish, which means you have full creative autonomy.

Critical Element 2: Design Module: Fully understanding the problem. Modern engineering design cannot be performed in a vacuum (i.e., an engineer should not simply “create” a solution to a perceived problem without fully understanding the preferences and constraints of the end-users). While engineering design in the past – and still in some limited cases – may be performed without substantial need for stakeholder engagement, increasingly engineers recognize that “speaking with communities and users” is vital [11, 12]. Similarly, engineering is a “team sport”, and engineers need to be comfortable both working independently as well as collaborating as part of a diverse – often interprofessional – team (i.e., [13]).

To support the approach to stakeholder engagement and collaborating as part of a team, Module 7) Fully understanding the problem included an emphasis both on communication as well as teamwork. Table 2 provides a description of the components of Module 7 as well as a list of possible points that may be earned by a student completing the optional components of the module. Because CArE 5619 uses a "straight scale" without a curve, and because "required" assignments resulted in a minimum grade of "70 points = C", students were made aware that the successful completion of all optional assignments included in Module 7 would raise a student's grade from a "C" to a "B" (i.e., 70+10 pts).

Details of the "story board" / "poster" communication exercise, including a grading rubric, are provided in Appendix D.

Table 2. Details of design work associated with Module 7) Fully understanding the problem

Possible Points	Details of assignment(s)
2	1. Identify and communicate with stakeholders (2 pts total) a. Working alone, create a "one-page" interview guide (1 pt) b. As a group, create a common interview guide c. Working alone, use the common interview guide to interview one stakeholder (1pt)
2	2. Formulate a problem definition (2 pts total) a. Working alone, create a "half-page" definition of the problem starting with the statement, "The problem with the Phelps County food system is…" (1 pt) b. As a group, create a "one-page" definition of the problem, including 10 references to support the statement (1 pt)
2	3. Assemble background and precedents (2 pts total) a. Working alone, create a referenced list of THREE precedents (i.e., "examples", which may include newspaper, magazine, journals, blogs, etc; REMEMBER: A picture is worth a 1,000 words!) (1 pt) b. As a group, select the FIVE most significant precedents (1 pt)
4	4. Determine appropriate design requirements considering public health, safety, and welfare as well as global, cultural, social, environmental, and economic factors (4 pts total) a. Group score (2 pts) – create a "story board" / "poster" of the information collected to demonstrate a "full understanding of the problem" b. Individual contribution to group effort (2 pts) – peers confirm your contribution to the group effort

<u>Critical Element 3: Design Module: Iterating to find a solution.</u> Modern engineering design is characterized as an "iterative, creative, decision-making process", which aims to "convert resources into solutions," [6]. In alignment with this reality, Table 3 provides details of design work associated with Module 8) Iterating to validate a solution.

As described above in Critical Element 2, CArE 5619 uses a "straight scale" without a curve. Therefore, a student who successfully completed all content in Module 8 would raise their grade from a "B" to an "A" (i.e., 70 + 10 pts for Module 7, above + 10 pts for Module 8, here).

As important aspect of engineering judgement includes the ethical dilemma of less experienced engineers being "overruled" by supervisors or regulators – perhaps even by those with lessor or no Professional Engineering license (or professional credential). As part of Module 8, students were specifically confronted with the need to become familiar with, incorporate, and respond to the document, "Final Report of the NSPE Task Force on Overruling Engineering Judgement,"

[14]. The successful training of students of engineering must include an awareness of, an appreciation for, and a thoughtful argument in support of licensure and credentialing as a critical element of protecting the health, safety, and welfare of the public served by the Professional Engineer.

Table 3. Details of design work associated with Module 8) Iterating to validate a solution

Possible Points	Details of assignment(s)
2	1. Construct an evaluation matrix (2 pts total) a. Working alone, create a "ten-point" list of criteria with descriptions (1 pt) b. As a group, select a limited list of relevant criteria c. As a group, develop a "weights" among the criteria and present in tabular form with equations (1 pt)
2	2. Brainstorm solutions (2 pts total) a. Working alone, create three alternative solutions (i.e., a "half-page" description of who, what, where, when, why, and how) (1 pt) b. As a group, construct a final evaluation matrix with all alternatives scored across the limited list of relevant criteria (1 pt)
2	3. Prototype and test solutions (2 pts total) a. As a group, develop and execute a plan to collect information about the feasibility and viability of the top three alternatives (i.e., from interviews, from precedents, from history, etc) (2 pt)
4	4. Select a valid solution using engineering judgement (4 pts total) a. Group score (2 pts) – create a "one-pager" to argue for your team's single best solution and post to the discussion board b. Individual contribution to group effort (2 pts) – offer criticism (pros, cons, neutral observations) that support or refute the best solution proposed by all five teams

<u>Critical Element 4: Design Module: Writing a final report.</u> While the content of engineering design is prescribed as part of ABET accreditation (i.e., [6], the format of written engineering design reports is flexible and students may leverage freely available online resources to guide their writing. Therefore, as part of Module 9, existing resources were shared with students to guide the preparation of an interim as well as a final design report. These resources included:

- How to Write a Design Report, available at: https://dl.icdst.org/pdfs/files/1f5dfbb378e59a04f27b6d47fd74a0e9.pdf
- Design Report Format, available at: http://www.msoe.edu/eecs/ee/seniordesign/EE408ReportFormat.pdf
- An Example Format for Design Report Projects, available at: https://www.academia.edu/27357167/AN_EXAMPLE_FORMAT_FOR_DESIGN_PROJECT_REPORTS_ADAPTED_FROM_ASME_GUIDELINES_FOR_STUDENT_DESIGN_COMPETITION_TITLE_TIMES_NEW_ROMAN_12_BOLD

<u>Critical Element 5: Interprofessional Education: learning how to interview stakeholders.</u> Engineers often collect and regularly use scientific data to support engineering design. Typically these data are quantitative and are collected and analyzed using methods from mathematical, physical, chemical, and/or biological pure and natural sciences. Less commonly, these data are

qualitative in nature and are collected and analyzed using methods from the mathematical and social sciences such as applied statistics as well as economics, psychology, sociology, political science, and anthropology.

As part of this design course, students were equipped with the skills needed to interact with people directly through stakeholder interviews. This approach is particularly useful when considering triple bottom line outcomes – prosperity, planet, and people – that are part of sustainable development. One of the instructors for this course, a professor of nursing (SEO), previously has described the application of nursing science to achieve the United Nations Sustainable Development Goals (UNSDGs) [15, 16]. Nurses and engineers work well together both at the bedside as well as in the community to solve challenging problems – such as sustainable development – through interprofessional partnerships [17]. Prior experience constructing interview guides for studies led by nurses was adapted to support the creation and use of interview guides by students of engineering enrolled in CArE 5619 [18].

Examples of the interview guides prepared by students to speak with producers of food, distributors of food, and public officials are provided in Appendix E.

<u>Critical Element 6: Interprofessional Education: Learning how to communicate to stakeholders.</u> Among the subdisciplines of engineering, "Agricultural and similarly named engineering programs" are perhaps most closely aligned with local food systems [6]. The ABET program criteria for these programs include, "… biological and engineering sciences consistent with the program education objectives and applications in agriculture, aquaculture, forestry, human, or natural resources," [6]. It is interesting to note that "human resources" are listed as a specific area of application for agricultural engineering. The American Society of Agricultural and Biological Engineers (ASABE) serves the lead society for the ABET accreditation of agricultural engineering programs. ASABE also provides accreditation of "agricultural systems management", which specifically requires these programs to include, "management sciences – courses can include economics, management, marketing, sales, accounting, personnel management, finance, legal studies, and insurance," [19].

University extension often works with the agriculture community to support improvements in food systems through better understanding of research applied through practical education. One of the instructors for this course, a professor of extension (SHM), previously has described approaches to understanding local food systems in rural areas, such as the communities examined as part of CArE 5619 [20]. This practical experience was invaluable in "judging" and "coaching" the students of engineering to accurately capture what they were learning from stakeholder interviews with community members and converting this content into useful educational materials to return back to the community for further engagement. The iterative process of fully understanding the problem and iterating to find solutions were supported by regular interactions between the engineering students and the instructor (SHM).

Examples of the "story boards" / "posters" created by teams of students using the information collected from interviews and returning back to the community to share through education are provided in Appendix F. As a commitment to the success of CArE 5619, the University of Missouri System decided to highlight the work by engineering students as part of the annual

Extension and Engagement Week of 2022, which focused on “All Things Food”. As part of educational outreach for in celebration of the week-long activities, the University of Missouri System developed a video montage of the work being performed by the engineering students. A link to the video and representative screen captures are included in Appendix G.

Details of Pilot Results. A redesigned course, CArE5619 Environmental Engineering Design – Lecture and Lab was offered by DBO in the Spring semester of 2020, 2021, and 2022 to a total of 84 students. Table 4 presents a summary of course demographics. As part of the Required, online lecture, students were directed to complete an online Learning Styles Inventory and a Myers-Briggs Personality Test. The results of these assessments were captured in questions included in Module 0) Introduction to blended, flipped, mastery learning, and buffet assessment. Additional student demographics including gender and enrollment status (i.e., distance student or face to face student; Graduate student, Senior, or Junior standing; and degree program) were collected from information provided by each student and cross referenced with the database maintained by the Registrar.

Of the 84 total students who participated in the three course offerings, the classes were approximately the same size each semester (N=26, 30, or 28). Each class was between 47 and 62% female. Visual was the preferred, single strongest Learning Styles, but a consistent minority of students documented a preference for two or more styles. Among the results of the Myers-Briggs Personality Test, the Jung Typology for “source of energy” indicates a near equal balance for Introversion and Extroversion, which is perhaps surprising from engineers who often are stereotyped as “shy” or “introverted”. The results for how students “gather information” indicates a near equal balance for Intuition and Sensing, and similarly the results for how students “make decisions” indicates a near equal balance for Thinking and Feeling. As reported in Table 2, the most significant difference for Jung Personality Type was observed in a strong preference for Judging over Perceiving (i.e., a total of 50 individuals versus 24). A similar trend has been regularly reported in courses in this Department (i.e., [8, 9, 10]). Therefore, based upon the trends in Jung Personality Type, the use of clear “lists of instructions” was an important part of the pedagogical approach to this course.

In the Spring 2020 semester, the entire course switched – unexpectedly – from face-to-face learning to remote-learning during to the COVID-19 pandemic. In Spring 2021, remote learning was used throughout the semester, and in Spring 2022, face-to-face was the approach to learning. These changes (mid-semester switch from face-to-face to remote; full semester remote; full semester face-to-face) may profoundly impact the results of student satisfaction surveys as well as comments on open-ended questions and should be carefully considered in any interpretation of the results of this research.

The overwhelming majority of students in the class were enrolled as undergraduate students pursuing a baccalaureate degree in environmental engineering, and most of these students were enrolled in their final semester (i.e., this course is recommended in the final semester before graduation and often is taken concurrently with “senior design” and “senior seminar”, which provide a team-based, capstone design experience as well as exposure to practicing Professional Engineers). Given the maturity of the student population, it was somewhat surprising and disappointing that the results from course evaluations, discussed below, represented limited participation (i.e., results discussed below in Figure 2).

Table 4. Demographics of a total of 84 students enrolled in three course offerings of "Environmental Engineering Design – Lecture and Lab" in the Spring semester of 2020, 2021, and 2022.

	Spring 2020	**Spring 2021**	**Spring 2022**
	N = 26	N = 30	N = 28
Gender			
Male	10	16	12
Female	16	14	16
Learning Styles Inventory			
Visual	7	9	12
Auditory	6	4	5
Kinesthetic	4	8	3
V, A, K all equal	6	4	2
Two higher than third	3	5	6
Jung Typology			
Extrovert (E)	12	13	13
Introvert (I)	14	17	15
Sensing (S)	15	15	16
Intuition (N)	11	15	12
Thinking (T)	13	16	14
Feeling (F)	13	14	14
Judging (J)	18	19	13
Perceiving (P)	8	11	5
Enrollment status			
Distance	0	* 30	0
Face to face	* 26	0	* 28
Graduate student	2	4	6
Senior standing	23	26	22
Junior standing	1	0	0
Civil Engineering	2	1	1
Environmental Engineering	24	29	27
Other	0	0	0

* Note: Instruction during the Spring 2020 semester began as face to face and transitioned to fully online due to the COVID-19 pandemic and "stay at home" orders. Instruction during the Spring 2021 semester was conducted exclusively online. Instruction during the Spring 2022 semester was conducted exclusively face to face.

A summary of final grades for "Environmental Engineering Design," is presented in Table 5. As might be expected in a course that is typically taken in the final semester of an undergraduate degree, all of the students completed both the required assignments (i.e., to earn a grade of "C") as well as sufficient optional assignments to earn a grade of "A". This fact is important to note when considering the responses to the open-ended, end-of-semester, voluntary surveys as the student population enrolled in this course is highly invested in the program of study, is mature, and is looking forward to employment immediately following this course.

Table 5. Summary of final course grades for "Environmental Engineering Design" for the Spring 2020, 2021, and 2022 semesters.

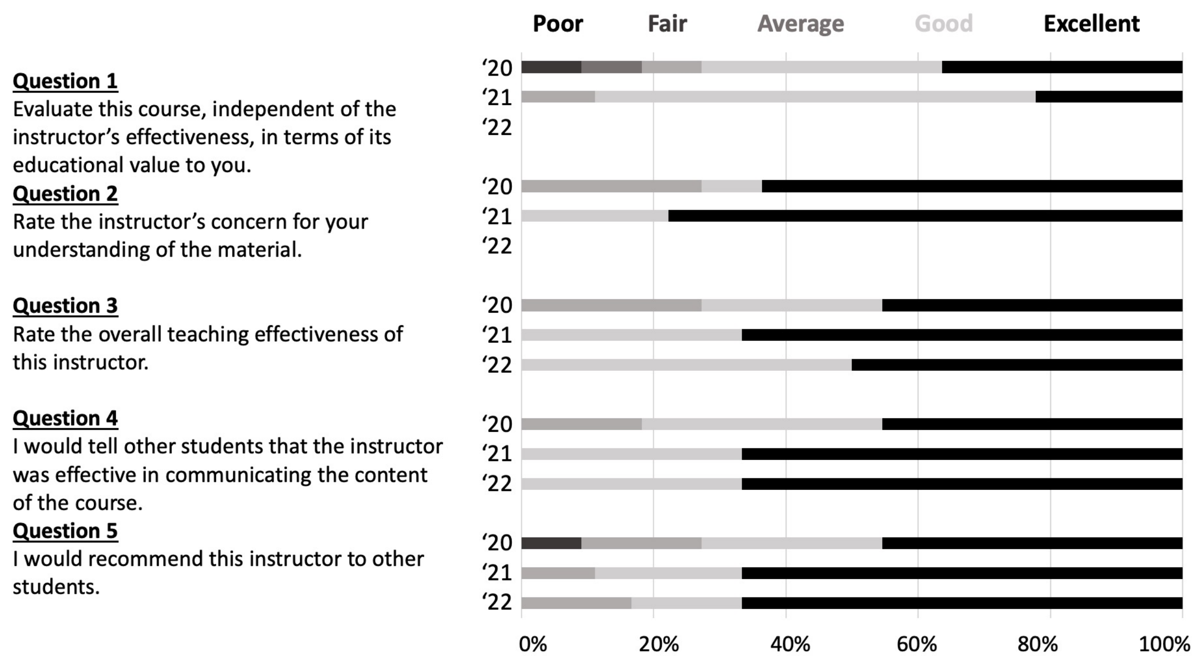
Final grade	Spring 2020 (N=26)	Spring 2021 (N=30)	Spring 2022 (N=28)
A	26	30	28
B	0	0	0
C	0	0	0
F	0	0	0

Figure 2 presents a summary of student satisfaction for Spring 2020, Spring 2021, and Spring 2022 collected using an anonymous, online course evaluation administered by the institution during the fifteenth week of the course. For Spring 2020, the rate of response (N=11) was less than half of the full course enrollment (N=26). This result – a lack of students completing the online, anonymous course evaluation – is consistent with the overall low level of participation in most end-of-semester evaluations conducted at our campus – and calls into question the value of these data for interpreting teaching effectiveness. Five questions were included in the assessments. The first three questions – assessing the quality of the course independent of the instructor; the instructor's (DBO) concern for students; and the overall teaching effectiveness of the instructor (DBO) – are required by the institution. The fourth and fifth questions – tell other students about the instructor's (DBO) communication skills; and recommends the instructor (DBO) to other students – are required by State law.

For the fifteenth week of Spring 2020, the results for all five questions point to the conclusion that the students "represented and liked the instructor (DBO)" but had "concerns for the course content" (i.e., Questions 2, 3, 4, and 5 – that focus on traits of the instructor – were more likely to be scored as "excellent" as compared to Question 1 – focused on the educational value of the course independent of the instructor). This trend, appreciating the instructor and expressing concern for the course, appears to be consistent in Spring 2021 as well. Unfortunately, the university modified the campus-wide course evaluations in Spring 2022, and therefore, data for Question 1 are not available. Although a limited sample size, the aggregate results presented in Figure 2 suggest that the course content – redesign of a local food system – was not a "favorite topic" of some of the students.

A further detailed analysis of Figure 2 shows that for Spring 2021, the same five questions were administered during the fifteenth week of the course. The response rate (N=9) was equal to one-third of the full course enrollment (N=30), and again reflects the poor rate of response typically observed on our campus. As mentioned above, in Spring 2022, only three of the same five questions were administered during the fifteenth week of the course (i.e., question 1 and question 2 are no longer included in the campus-wide instrument). The response rate (N=6) represented a minority of the enrollment (N=28). While the overall response reported in Figure 2 was generally positive, it is important to note that the only "poor" or "fair" responses were related to the "educational value of the course."

Figure 2. Results of student assessments conducted after the fifteenth week of the semester in Spring 2020, Spring 2021, and Spring 2022. Responses are reported normalized to one hundred percent.



To supplement the numeric scores reported in Figure 2, representative "additional comments", edited to increase readability, have been provided in Appendix H for all three semesters. These comments are provided as representative of the "free responses" received from students. To aid in evaluation of the comments, the similar comments have been grouped into three categories, namely: 1) about the instructor (DBO); 2) about the course format; and 3) about the course content.

Comments A, B, and C reflect a strong positive reaction by the students to the style of classroom instruction, which was clear, enthusiastic, and emphasized learning in the cognitive, psychomotor, and affective domains (i.e., in the knowing, doing, and feeling domains). Comments D, E, and F highlight that the students were aware that the instructor was specifically addressing significant issues of social justice and "drilling down" into "uncomfortable issues" of local food systems (i.e., "sometimes the instructor mentions topics that are pretty controversial…"). It is important to note that while students felt these uncomfortable topics were handled in a respectful manner, the focus on issues of social justice may be perceived as "distracting" by some students of engineering. This result highlights the importance of future efforts by more faculty in the program to increase student awareness of and to facilitate free discussion with students to surface personal bias and pursue for self-improvement in the area of social justice.

Comment G represents a useful transition from the examination of comments about the instructor and to begin to focus on comments about the course format. For example, comment G indicating that the instructor should "push students harder" is complimentary to Comments L and M, which surfaced the concern that the course "lacked depth in engineering". In general, students responded positively to the blended, flipped, modified mastery learning with a buffet of summative assessments – as reflected in the positive nature of Comments H, I, and J. Comment K suggests that at least some students enjoyed the optional podcast exercises. Comments N and O specifically relate to the procedures used in the course to assemble groups to work as a team in contrast to the completion of independent work by individual students. In the future, how to manage teams effectively is one area where the instructor (DBO) plans to make improvements.

The comments about course content – Comment P through W – reflect two diametric views, namely: food systems are useful as a subject for engineering design versus food systems – as studied in this course – provided insufficient opportunity for detailed engineering design work. In particular, Comment V expresses significant frustration on the part of a student in response to the course content. Perhaps Comment U – emphasizing a lack of "math" – captures the kernel of the issue raised in Comments V and T?

As defined by ABET EAC, engineering design includes the application of "basic sciences, mathematics, and engineering sciences to convert resources into solutions," [6]. At least some of the students enrolled in CArE 5619 seem to express the view that "math" equates to "engineering design". Certainly, quantitative skills are part of the tools-kit of a fully trained student of engineering. And yet in the 21st century, some may argue that a lack of "empathy" and/or a lack of "art" is the Achilles heel that limits the abilities of engineers. For example, the addition of caring to the science, technology, engineering, and math professions is described to create "STEMpathy" jobs. Similarly, there has been an increased emphasis on STEAM – where art (often referencing more than merely the aesthetic component of design) is proposed as essential to future success.

The primary course instructor (DBO) made an intentional choice to integrate nursing and University extension into this course as part of the shift to focus on the design of local food systems. The concerns expressed by students about the course content – Comments T, U, V, and W – must be weighed in the balance with the positivity represented by Comments P and Q as well as the encouragement represented by Comments R and S.

The diametric views represented in the examples highlighted in these comments about course content reflect the diversity of the students enrolled in CArE 5619. Future effort by the primary course instructor (DBO), will continue to address the apparent disconnect in an engineering design course that emphasizes "professional skills" as compared to an engineering design course that emphasizes "basic science, math, and applied engineering". As described in the introduction of this paper, the primary instructor (DBO) made a conscious choice in the approach to pedagogy and the content of the course in response to prior requests from students as part of senior exit interviews to expand beyond "just teaching the design of sewage treatment plants". Therefore, although some students expressed concern with the need to do a better job "teaching engineering design as math," the encouragement from other students – especially in the broader context of prior results from senior exit interviews – means that at least some of the perceived needs of the student population are being specifically addressed by the approach employed in CArE 5619.

Discussion

The engineering subdiscipline of environmental engineering has identified five critical areas for future research, including: 1) providing a sustainable supply of food, water and energy, 2) reducing climate change and adapting to its impacts, 3) designing a future without pollution and waste, 4) creating efficient, healthy, resilient cities, and 5) fostering informed decisions and actions [21]. The "sixth" grand challenge – namely the education of future environmental engineers – requires improvements in the knowledge, skills, and attitudes cultivated among students through an improved "body of knowledge" [22]. As described throughout this article, the collaboration between engineers, nurses, and University extension professionals offers an opportunity for environmental engineers to engage in solving a grand challenge in a manner that leverages and benefits the profession of nursing moving from a focus on the clinical bedside to emphasize prevention and wellness of populations in the community [23].

The subject matter selected for CArE 5619 – the redesign of local food systems – is clearly within the mandate of the future direction of the subdiscipline of environmental engineering [21, 22]. The use of novel pedagogical approach – including blended, flipped, and modified mastery learning – has been repeatedly demonstrated to be suitable for adult learners in prior courses [1]. The novel aspect of this course includes the integration of faculty from diverse disciplines, including a professor of nursing and a professor of University extension. The intentional addition of interprofessional education stretched students outside of their "engineering" comfort zone. While it is important to listen to and consider the concerns expressed by some students (i.e., "we didn't do enough math as part of engineering design"), it is also important for faculty to exercise academic freedom and scholarly in teaching and learning to explore new subject matter and new ways of sharing that subject matter with students.

Conclusion

In the aggregate, the redesign of CArE 5619 should be considered a "success" with an opportunity for "substantial future improvement". The redesigned course used the engineering design process to improve the local food system, which included aspects of sustainability and life cycle principles of water, carbon, and nutrients. The most unique aspect of this course included the intentional choice of interprofessional education that combined Professional Engineering with nursing and with University extension. This choice allowed students of engineering to gain valuable skills in how to construct and use qualitative interview guides as well as how to synthesize and return to the community to use education as a tool for improving practical conditions in the real world. Future work should look to replicate this approach at additional institutions with diverse student populations.

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Appendix A. Objectives and key references for required modules 1 through 6.

Module	Objectives
1	The objective of this unit is to introduce the overall concept of Design – with a capital D – and then to explain how Engineers – with a capital E – approach design. The overall approach yields an understanding of the concept of “Engineering Design”. By the end of this units, students should: 1) create a personal, working definition of Design – capital D 2) evaluate how engineers use a Design approach 3) describe the importance of an Engineering – capital E – approach to Design 4) describe the steps of Engineering Design 5) recall examples of Engineering Design Key reference(s): 1) Wade-Leeuwen, B., and Vovers, J. (2018). Explainer: what’s the difference between STEM and STEAM? The Conversation.
2	The three-fold objectives of this unit including: 1) introducing the historical and current definition of “food systems”; 2) introducing the method of life cycle assessment; and 3) exploring case studies of life cycle assessment (LCA) applied to food systems. By the end of this units, students should: 1) recognize the components of food systems 2) describe the process of completing a life cycle assessment 3) recall examples of LCA applied to food systems Key reference(s): 1) University of Missouri Extension. Introduction to local food systems. DM271.
3	The three-fold objectives of this unit including: 1) introducing the historical and current definition of “food security”; 2) introducing the double burden of nutrition – undernourished while obese; and 3) how measurements of food and nutrition security can be applied across developing, low- and middle-income, and developed countries. By the end of this units, students should: 1) recognize the four pillars of food security 2) describe the double burden of malnutrition 3) recall examples of food and nutrition insecurity, local to global Key reference(s): 1) University of Missouri Extension. (2019). Missouri Hunger Atlas.
4	The objective of this unit is to understand the relationship between the modern industrial food system designed for maximum production at minimum cost, and the historical food system that relied upon ecological health to protect the consumer. By the end of this units, students should: 1) recognize the importance of modern food safety and inspections of food service operations 2) identify the benefits and drawbacks of the modern industrial food system in terms of human health 3) describe the relationships between the risk of foodborne illness and the industrialization of the modern food system Key reference(s): 1) State of Missouri. (2013). Missouri Food Code.

5	The objective of this unit is to identify causes and solutions to food loss and waste (FLW) in developed countries and in developing countries. By the end of this units, students should: 1) identify the differences among food loss and food waste 2) understand the US approach to FLW 3) understand the European approach to FLW 4) appreciate how developing countries approach FLW Key reference(s): 1) United States Congress. (1996). Bill Emerson Good Samaritan Food Donation Act.
6	The objective of this unit is to understand the relationship between food preferences, food production, food consumption, and impacts on the climate. By the end of this units, students should: 1) recognize how food production – including consumption of energy and fertilizer as well as available land and fresh water – impacts climate change 2) recall how a changing climate impacts food production – including drought and excess rainfall damaging the production of food 3) recognize ways that individuals consumers can select diets that are simultaneously health for individuals as well as beneficial for planetary systems Key reference(s): 1) EAT-Lancet Commission. (2019). Healthy diets from sustainable food systems.

Appendix B. Objectives for design modules 7, 8, and 9.

Module	Objectives
7	The objective of this unit is to identify causes and solutions to re-design local food systems in developed countries and in developing countries. By the end of this units, students should: 1. List types of stakeholders, create an interview guide, select and interview a stakeholder 2. Consolidate stakeholder input into a problem statement 3. Identify relevant materials to elaborate the view of stakeholders, the problem statement, and to begin to identify directions for possible solutions 4. Explicitly consider the wide breadth of requirements that may be necessary to consider when designing a solution to the problem statement
8	The objective of this unit is to identify constraints, brainstorming alternative solutions, and identify a best alternative to re-design local food systems in developed countries and in developing countries. By the end of this units, students should: 1. List types of criteria with adequate descriptions, including an approach to comparison among criteria (i.e., weighting) 2. Use brainstorming techniques to identify alternative solutions to the design problem 3. Construct an evaluation matrix to rank order alternative solutions 4. Develop and deploy a prototype solution and assess feasibility and viability 5. Convince yourself and your audience of the value of your proposed solution
9	The objective of this unit is to communicate written results. By the end of this units, students should: 1. Apply the concept of draft design report and prepare a suitable product 2. Apply the concept of final design report and prepare a suitable product

Appendix C. Instructions for podcast for Module 1) Introduction to engineering design including grading rubric.

Course:	CArE 5619
Unit:	1 Intro to Engineering Design
Document:	Optional Pod Cast presentation

An important skill of a Professional Engineer is the ability to communicate effectively with a wide range of audiences. For example, engineers needs to: 1) explain the essence of engineering with excitement to students in grades K-12; 2) share accurate yet comprehensible descriptions of their work with other engineers from different disciplines (i.e., environmental need to communicate with construction management); lead in-depth discussions among teams of like-trained engineers (i.e., lead a team of environmental engineers working on a single project); and interact with the public – including the lay public and politicians – in a professional manner that is simultaneously informative yet not condescending.

To practice your skills as a communicator, you are being asked to create a Pod Cast to introduce engineering design to a high school sophomore (not unlike the eight videos you've watched about engineering design). Pod Casts are different from Videos because the production depends entirely upon audio. Therefore, it is critical to speak in "sound bites". Pod Casts can be created by a single individual, or they may be created by two people (or a small panel) with one person serving as the "interviewer" (i.e., question asker and commentator) and the other person (or small panel) serving as the "interviewee" (i.e., question answerer). It's essential that a Pod Cast contain accurate information – inaccuracy results in a lower grade. It is also important that a Pod Cast entertain the listener – boring results in a lower grade. Clarity of voice – also known as annunciation – is important, and this may be influenced by the quality of the recording. Finally, appropriate background noise can add to a Pod Cast, while distracting background sounds would be detrimental.

The two-fold purpose of this optional exercise is: 1) to demonstrate your knowledge of engineering design; and 2) to have fun exploring the communication format of Pod Cast. While there may be some recordings that we could all identify as "poor quality", there are certainly many, many different examples of "excellent Pod Casts". My advice is to look around on an internet a bit for advice, to give it your best effort, and to have fun in the process. Don't forget, there are multiple optional assignments and plenty of opportunity to earn points towards a grade above a "C". Relax. Have fun. Enjoy the opportunity to practice a different way of communicating.

Be sure to:
1) include a clear outline of your presentation so that the audience may follow along
2) identify and define key terms
3) provide a clear recording that's worth our time to listen in class
4) make it long enough to explain your points, but no longer than needed
5) make it entertaining enough to capture the attention of your audience, but remain professional

Post your Pod Cast on a cloud server (i.e., Sound Cloud or similar). Be prepared to play your Pod Cast in class. Be prepared to answer questions after we've listened.

The (max 20 points) grading rubric is included below:

Knowledge
4 – all participants showed excellent knowledge of engineering design, needing no cues and showing no hesitation in talking or answering questions
3 – all participants showed excellent knowledge of engineering design, but there were 1-2 clear examples of hesitation, stumbling, or incoherent talking or answering questions
2 – participants showed reasonable knowledge of engineering design, and there were 3 or more examples of hesitation, stumbling, or incoherent talking or answering questions
1 – extensive hesitation, stumbling, or incoherent talking or answering questions

Questions
4 – excellent, in-depth, probing questions drove the content and served as a clear outline for the entire Pod Cast
3 – questions served as a clear outline for the entire Pod Cast
2 – questions served as an outline for most of the Pod Cast
1 – there was little "back-and-forth" and a notable absence of Q and A

Entertainment value
4 – every member of the audience was captivated throughout the entire Pod Cast
3 – the majority of the audience was captivated throughout the entire Pod Coast
2 – the majority of the audience was captivated during a substantial portion of the Pod Cast
1 – the audience was captivated by at least one portion of the Pod Cast

Audio quality
4 – all participants were clear, annunciated properly, had a similar level of volume, and any background noises added to the quality
3 – many of the participants were clear, annunciated properly, and had a similar level of volume, and any background noises added to the quality
1 – at least a portion of the Pod Cast included clear audio with proper annunciation and appropriate volume

Audience
4 – Demonstrates a clear understanding of the potential audience and uses appropriate vocabulary and arguments. Anticipates audience questions and provides thorough answers appropriate for the audience
3 – Demonstrates a general…
2 – Demonstrates some…
1 – It is not clear who is the audience

Appendix D. Grading rubric for the "story board" / "poster" associated with Module 7) Fully understanding the problem.

Course:	CArE 5619
Unit:	7 Fully Understand Problem
Document:	Optional Storyboard

An important skill of a Professional Engineer is the ability to communicate effectively with a wide range of audiences.

To practice your skills as a communicator, you are being asked to create a Story Board to explain how you "fully understand the problem" of the Phelps County Food System.

The two-fold purpose of this optional exercise is: 1) to demonstrate your knowledge of "the problem"; and 2) to have fun exploring the communication format of Story Board.

Be sure to:
1) indicate how to identified stakeholders, and share what you learned from meeting with them
2) share what you formulated as the problem definition
3) document background and precedents
4) cover the waterfront of public health, safety, and welfare while considering global, cultural, social, environmental, and economic factors

Create your Story Board using the materials provided to you in class (or anything else you wish to use). Be prepared to display your Story Board so that others can view it and ask questions.

The (max 20 points) grading rubric is included below:

Creativity
4 – Several of the graphics or objects used in the collage reflect an exceptional degree of student creativity in their creation and/or display
3 – One or two of the graphics or objects used in the collage reflect student creativity in their creation and/or display.
2 – One or two graphics or objects were made or customized by the student, but the ideas were typical rather than creative (.e.g, apply the emboss filter to a drawing in Photoshop).
1 – The student did not make or customize any of the items on the collage.

Incorporating stakeholder input supported the process of problem definition
4 – excellent, in-depth, probing questions and the exceptional answers of stakeholders clearly utilized to support the creation of a problem definition
3 – stakeholder questions and answers were clearly utilized to support the creation of a problem definition
2 – one component was missing: stakeholder questions, answers, problem definition
1 – two components were missing: stakeholder questions, answers, problem definition

Background and precedents supported the process of problem definition
4 – four or more precedents were used well to support the problem definition
3 – two or more precedents were used well to support the problem definition
2 – two or more precedents were identified in the problem definition
1 – precedents were present, but poorly utilized to support the problem definition

Accuracy of problem definition
4 – the problem definition was exceptionally clear and accurate
3 – the problem definition was clear and accurate
2 – the problem definition was accurate
1 – one or more aspects of the problem definition were inaccurate

Incorporation of professional engineering constraints

4 – All three pillars – public health, safety, and welfare – and all five factors – global, cultural, social, environmental, and economic – were clearly explained
3 – At least two pillars and at least four factors were clearly explained
2 – At least one pillar and at least two factors were clearly explained
1 – Explanation of pillars and factors was highly inconsistent and lacking

Appendix E. Three examples of stakeholder interview guides

Example for interviewing a producer of food (i.e., farmer or rancher)

Aims

1) Identify the problem of the Phelps County food system
    Is there a problem? What's the problem? Who or what causes it?
2) What are the limitations/difficulties of being a producer
3) What they, the producer, thinks their impact on the system is
4) How do you distribute your produce?
    local farmers market? Big industry? Self use?
5) What are your concerns of the future
6) What do they, the producer, think would fix the food system?

Inclusion Criteria

- must reside or their facility is in Phelps County

Introduce myself and the project/ point of the interview

- paraphrasing - "hello, my name is . I'm currently studying environmental engineering at . In my design class we are studying and trying to solve problems related to the Phelps County food system. Today I'll be asking you some questions to get insight into the producers' side of things. I will be recording answers, is this ok with you?

IG

1. Can you describe your occupation to me? Production process
2. How long have you been in *this* business?
3. Where or who do you sell your product? How do you make profit
4. What are some difficulties you face in your occupation?
5. What are some advantages of your occupation?
6. How has new technologies affected your business
7. What do you think a food system is?
8. Is there a problem with Phelps county's food system?
    A. If yes,
        a. why? Who or what caused the problem?
        b. How could the problem be fixed
    B. If no, ask "so no one if the county has a hard time getting food?"
        a. Does this lead the convo too much?
        b. Does it sound rude?
9. What do you think your impact on the food system is?
10. Does anything go to waste in your facilities?
11. Do you have any concerns for the future of Phelps County's food system?
12. Do you have any concerns about staying in business?

Example for interviewing a distributor of food (i.e., grocer)

Aims/Goals

1) How does Phelps County's community influence the supply and demand (distribution) of various food stores?
2) What is the impact of waste on the food system?
3) What areas could be improved to make the most positive change to the food system?

Question Topics

Section 1:

- Can you briefly explain what your distribution system looks like day to day?
    - How is it processed in the store?
    - How often is the store stocked?
- Where does your food come from? (relationship with suppliers/producers)
    - Is any of the food local?
- Do you think more food should come from local suppliers?
    - What are challenges with local suppliers?
- What issues with suppliers cause problems with distribution?
- What factors play a role in supply? (seasons, student pop, etc)
    - What causes the store to order different amounts of product?
- What are the benefits and challenges of having multiple distributors in this region?
- Are there any specific marketing strategies that are used in Phelps County? (Farmers, Students, etc…)
- What incentives do you utilize to increase sales for specific items or as a whole?
    - Including: Coupons, Food Stamps, Sales, etc

Section 2:

- What area of distribution do you see waste/efficiency issues?
    - How does your store waste dealt with?
- What parts of the system are attributed to food waste?
- Do you see food waste or waste in general, as an issue in Phelps County

Section 3:

- What improvements would you like to see in how your business distributes?
    - How do you think those issues can be resolved?
- What does success look like for you/distributors?
- Where do you believe the largest contribution to the problem is for the Phelps County food system?

Example of interviewing a government official (i.e., mayor of member of County Commission)

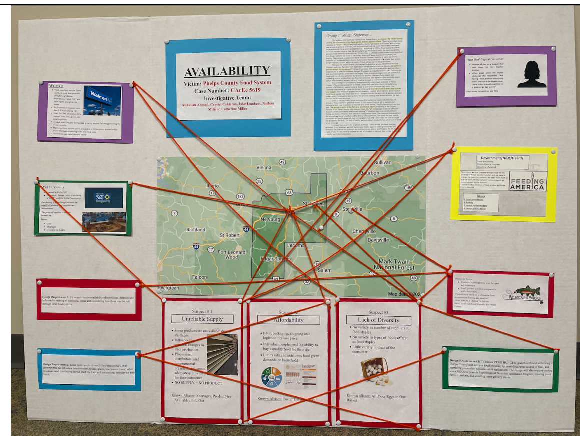
Aims:

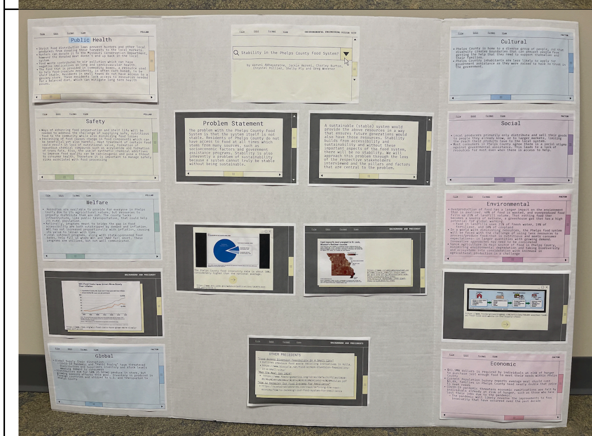
- Understanding what governmental and health entities see as their role in the Phelps county food system.
- Understanding how these entities see the issues and strength of the current food system.
- Understanding how they would like to remedy those weaknesses, and utilize the strengths.

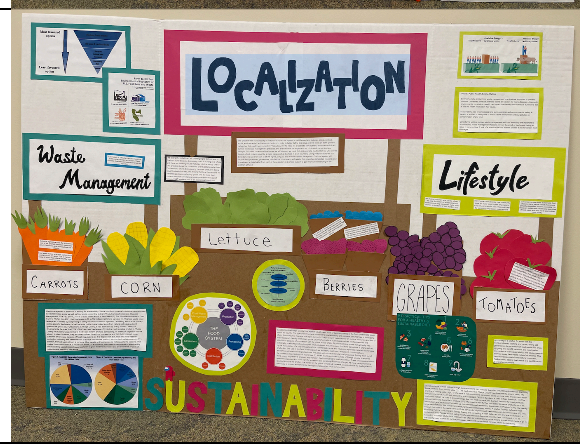
Interview Guide:

1. Tell me about your position.
    - Title?
    - Specific responsibilities and importance?
2. What do you see as the purpose of a food system, broadly speaking?
    - What about Phelps County specifically?
3. Describe what you view as the Phelps County food system currently.
    - What do you see as the major players or parts involved?
    - How do resources move in and out of the system?
    - Who has access to (which) resources?
    - How do these parts interact?
4. Is the purpose, as you see it, being met currently?
    - What aspects does it currently fulfill?
    - Where is it falling short?
5. How does your organization play into the Phelps County food system?
    - What about your role in the organization & food system?
    - What previously mentioned function/interaction do you contribute to?
6. Tell me about what currently works from your perspective in the Phelps food system.
    - How are these strengths being utilized?
    - Who does it benefit?
7. Tell me about what doesn't work in Phelps County.
    - Who is the most affected by these shortcomings?
    - How could these parts be made better?
    - Has there been any effort to fix these problems? How did it turn out?
8. Describe what you would see as a perfectly functioning system.
    - What additional resources are needed?
    - Who should be responsible for providing these resources?
    - Why do you think your idea would work well for Phelps County?
9. What do you see as roadblocks to creating that ideal system?
    - Which of these are the biggest obstacles to your organization?
10. Are there any other thoughts you'd like to share about the current food systems or prospective changes that you'd like to share?

Appendix F. Examples of “story boards” / “posters”

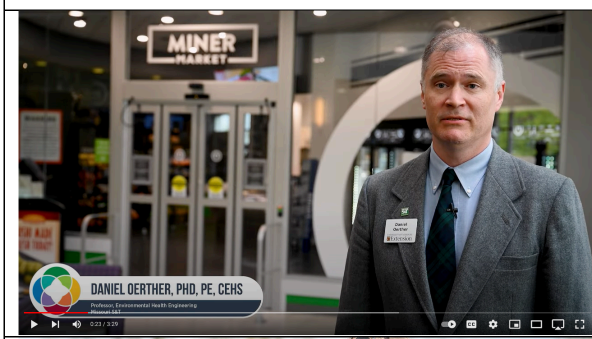


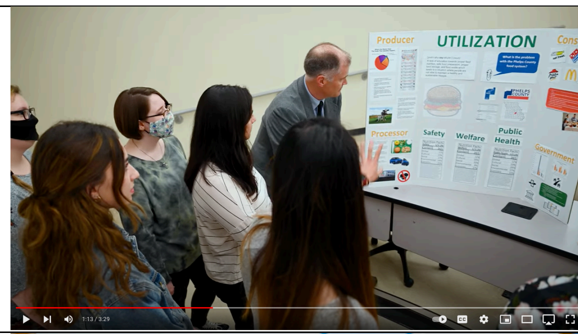


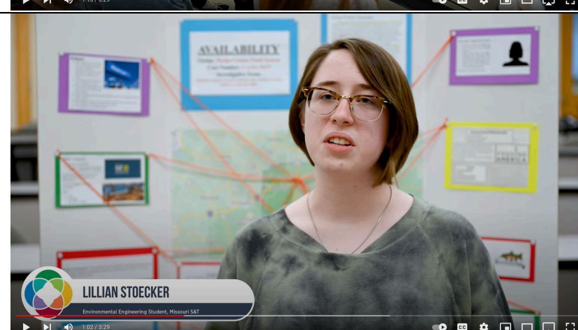


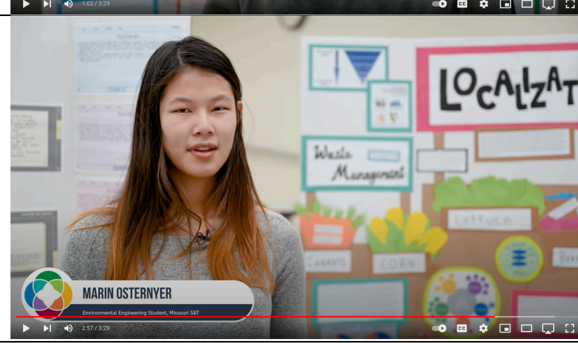
Appendix G. Screen capture from videos from Extension and Engagement Week

The following screen captures were grabbed, with permission, from: University of Missouri Extension. (2022). "A Look at the Phelps County Food System Through the Eyes of an Environmental Engineer." Online at: https://youtu.be/3mtXvmWA7UI









Appendix H. Representative student comments provided during assessment in all three offerings.

About the instructor:

A. enthusiastic and clear communicator who has a passion for education
B. genuinely cares about people and wants his students to learn the material and why it is important
C. causes students to be introspective of why we're in the engineering field, and why we want to be engineers
D. at times, the instruction felt overly rehearsed and un-natural at times; although the information presented was thought provoking and interesting
E. sometimes the instructor mentions topics that are pretty controversial, which can come across badly in a classroom, but he was always respectful
F. very knowledgeable and expert in his field, but at times becomes distracted during discussions raising side-points which deters from quality learning
G. his weak point in this course was not pushing hard enough; our design should have progressed faster and students should work on deadlines to prepare them for professional responsibilities

About the course format

H. I really like how his grading system works and is spelled out, so you are never surprised and it always seems fair
I. mastery learning makes me feel respected as an adult and allowed me to work at my own pace around my own schedule
J. he provided a lot of opportunity for collaboration, even all online, which I think will be very beneficial moving forward in my career
K. I liked the podcasts, that's not something I ever have done before
L. one weakness is the lack of engineering calculations we used in the class; I appreciate that he feels like these are things we know, but in terms of basic environmental design, I do feel somewhat like I missed out
M. I'm not sure we got fully into an actual design process, especially with the setup of the class where not everything is required
N. I understand what the goal was with changing groups for each part but potentially adding an option to keep a group member for the next part would help; my first group was phenomenal and then followed by a group that would not engage in differing opinions and having people that care around you is helpful
O. The interviews were more difficult to complete. It is odd, because if you are in a group, but some things are optional, and only half of the group does the work, it is kind of awkward because the rest of the group didn't help, but it was optional anyway. Can lead to some in proportional points for efforts.

About the course content

P. I liked the new approach to environmental design (food system rather than wastewater treatment plant)
Q. provides valuable information into the engineering process and how we can reach an end product; the course provides a wide range of learning outlets to keep students engaged (ie group work, podcasts, interviews, creating posters and reports)
R. difficult when pioneering a new design concept, but maybe include successful examples of design intervention for food systems as part of the course material
S. field trips to getting to see different parts of the food system would be awesome if Covid-19 wasn't a thing
T. the food system design platform failed to teach engineer design in an adequate manner; I never felt like the class prepared me for real-world engineer design
U. find a way to incorporate more calculations or something in the class; regardless, I really enjoyed the course, and do consider it to be one of my favorite courses to date.
V. In previous years, this course was used to teach students how to do the entire engineering process. This new project of designing a food system was not thought out before the class began. Throughout the process we never did any actual engineering. Someone without an engineering degree could have done as much as we did. 60% of the course was spent identifying the problem. Most of the techniques used to do that we learn in MechE 1720. This class should prepare students for their senior design project. I do not feel prepared for that in the slightest. I'm not saying this course needs to go back to being strictly water and wastewater

design, but more designing needs to occur. I feel this course was a complete waste of my money and I hope in the future things can be changed to make it more beneficial to students.

W. re-develop design platform and force students to develop a legit design paper and presentation