EXAMINING A COURSE-BASED UNDERGRADUATE RESEARCH EXPERIENCE IN A FOOD SYSTEMS COURSE

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Project funding source: none
Acknowledgements: We thank the students who voluntarily participated in our research study.
Conflict of interest statement. The authors declare no conflict of interest with this study.
Author note. This study was reviewed and determined exempt by the Doane University Institutional Review Board (#S23 EX05 DC IRB HS).

Abstract

Recent reforms in undergraduate education have encouraged the use of high-impact and student-centered approaches to teaching and learning over teacherdirected approaches. The use of Undergraduate Research Experiences (UREs) has gained in popularity and research has indicated many positive learning outcomes associated with their use. However, prior research has also suggested unequal student access to these opportunities. One solution to provide broad access to UREs is through the use of Course-based Undergraduate Research Experiences (CUREs) within traditional academic courses. This paper provides an example of a semester-long CURE within a food systems course. Students' perspectives toward the structure of the CURE and impacts from participating in the CURE were explored through a qualitative study. A focus group was implemented with students at the end of the course and data were analyzed using a multi-cycle coding method. Three themes were identified: (1) structured choice with mentorship; (2) research challenges; and (3) learning outcomes. Findings from this case study support the use of CUREs in agricultural systems courses to foster students' interest, motivation, and development of technical and soft skills.

Keywords: course-based undergraduate research experiences, inquiry-based instruction, focus group, food systems, undergraduate research

Combating the most pressing local and global issues in agriculture, food, and natural resources (AFNR) requires the development of students' critical thinking abilities, problem-solving skills, and agricultural and science literacies (National Research Council [NRC], 2009; Worosz et al., 2020). In 2009, the NRC proclaimed that college teaching practices in agriculture must shift from teacher-centered to student-centered instruction to amplify these desired student learning outcomes (NRC, 2009). Despite this proclamation still being relevant today (Alford et al., 2024; Scott et al., 2023), as well as similar calls such as Vision and Change in Undergraduate Biology (Branchaw, et al., 2020; National Science Foundation [NSF], 2012), the use of student-centered teaching practices in undergraduate classrooms is still overshadowed by instructors' dominant use of teacher-centered instruction, such as lecture (Asarta et al., 2020; Ewing & Whittington, 2009; Macdonald et al., 2018).

One high-impact and student-centered approach to teaching is to immerse students into the process of authentic, scientific discovery through Undergraduate Research Experiences (UREs). These experiences allow undergraduate students to assume the role of a scientist to investigate real-world problems. A large body of research has identified many positive impacts of student exposure to UREs, including students' improvement in critical thinking and prob-

lem-solving (Carson, 2015; Haritani et al., 2019; Jones & Lerner, 2019), knowledge gain and retention (Wolkow et al., 2019), self-efficacy in conducting research (Brownell et al., 2012; John & Creighton, 2011), formation of science identity (Camacho et al., 2021; Frederick et al., 2021), undergraduate retention (Chamely-Wiik et al., 2021; Nagda et al., 1998), and persistence in seeking a career or graduate degree in science (Mastronardi et al., 2021; Russell et al., 2007).

There are many different structures of UREs, ranging from summer research programs to credit-bearing opportunities for students to conduct research under the mentorship of assigned faculty (Guidry & Hill, 2022; Maaz et al., 2022). Often, UREs are stand-alone experiences that are supplemental to degree requirements, and students apply to such opportunities, or they involve a competitive selection process. These structures may unequally provide exposure to UREs for students who come from more advantaged backgrounds, further amplifying inequity in STEM (Bangera & Brownell, 2014; Pierszalowski et al., 2022). Additionally, UREs that are part of a required curriculum are likely to consist of a student capstone experience toward the end of degree completion (Callender et al., 2014; Davis, 2011).

Due to the potentially exclusionary nature of URE opportunities, and in efforts aligning to curriculum reform (NRC, 2009; NSF, 2012), incorporating UREs within traditional courses can expand student exposure to and foster more robust inclusion in undergraduate research (Bangera & Brownell, 2014). This type of URE is commonly referred to as a course-based research experience (CURE). It is important to note that CUREs go beyond short, lab-based, "cookbook" practicums, and often extend to structured, semester-long, authentic research projects that integrate course topics and provide students with openended discovery. In our review of CURE research within the context of undergraduate AFNR education, CUREs were predominantly integrated into "agriscience" courses such as animal science (Jones & Lerner, 2019), horticultural science (Fontanier et al., 2019), and natural resources and wildlife sciences (Flaherty et al., 2017; Ortiz et al., 2020; Sorensen et al., 2018). Our investigation focuses on student perception toward the implementation and impact of a CURE within a systems-based AFNR course, Local and Global Food Systems, where permanent teams of undergraduate students conducted authentic, social science research through structured project assignments and faculty mentorship.

The use of CUREs has been reported as effective in prior literature. However, within AFNR, many of these studies have been conducted in traditional "agriscience" courses (e.g., Flaherty et al., 2017; Fontanier et al., 2019; Jones & Lerner, 2019; Ortiz et al., 2020; Sorensen et al., 2018) and few studies (e.g., LeGrand et al., 2017) have reported the impact of CUREs in systems-based AFNR courses that integrate applied social sciences. The course under investigation required students to conduct applied social science research within agricultural systems, and therefore, this case study provides a unique perspective on CURE impacts within post-secondary AFNR education. The research questions that guided this study were: (1) How did students' perceive the organization and structure of the CURE?; and (2) What were the student-perceived impacts of the CURE?

Theoretical Framework

We used Bandura's (1986) social cognitive theory as a guiding framework for our investigation. According to Bandura (2002), human behavior is influenced by the interactional effects between personal, behavioral, and environmental factors. Social cognitive theory has been highly influential in educational pedagogy (Burney, 2008; Colclasure et al., 2022). Students' personal factors, also referred to as cognitive factors, include constructs such as knowledge, expectations, and attitudes. Low knowledge, poor expectations, and/or unfavorable attitudes toward course-based research may undermine student performance and engagement. Prior studies show that many undergraduates are initially apprehensive of research; however, after exposure to CUREs, students' knowledge and attitudes toward conducting research are likely to improve (Harrison et al., 2011).

Environmental factors, including constructs such as social norms, access, and social interaction, are also highly significant in the teaching and learning process. As CUREs mimic the scientific process, students often work together in collaborative research teams to investigate problems. Furthermore, strong faculty mentorship has been identified as a leading component to the success of UREs (Houser et al., 2013; Monarrez et al., 2020). Lastly, behavioral factors, such as skills, practice, and self-efficacy are foundational to teaching and learning. Behavioral factors often guide the teaching process through backwards design, such as the identification of desired student learning outcomes which then guide curriculum development (Wiggins & McTighe, 2005). Prior research illustrates CUREs can be particularly beneficial to the development of students' critical thinking skills (Carson, 2015; Haritani et al., 2019; Jones & Lerner, 2019), research skills (Laungani et al., 2018), and technical and soft skills (Burmeister et al., 2021; McLaughlin et al., 2020).

Concept of Investigation

Case Study Synopsis

Doane University is a predominantly undergraduate institution in Nebraska that enrolls approximately 1,000 residential undergraduate students and offers 24 majors, 26 minors, and several pre-professional programs. Approximately 40 students have a major within the Department of Natural Resources and Environmental Sciences (NRES). The NRES Department offers several agricultural-based courses, including *Local and Global Food Systems*. This course is an upper-level undergraduate course required for students majoring in NRES (Agricultural Systems Emphasis) and Agribusiness. In the fall semester of 2022, there were 11 students enrolled, which is a typical enrollment number at this small liberal arts university. This 16-week, three-credit hour course met on Mon-

days, Wednesdays, and Fridays for 50 minutes. The course design centered on desired student learning outcomes related to building students' critical thinking skills, problem-solving skills, and discovery of information within regional and global agricultural systems. The course consisted of two primary components, the first of which was not a focus of this investigation but entailed reading the book *Battle to Do Good: Inside McDonald's Sustainability Journey* (Langert, 2019), instructor-guided discussions on the chapters and concepts of local and global food systems, and graded reflections. The second component was a semester-long CURE project completed in permanent teams, which was the crux of the course. Our research explored the impact and student experience of this CURE implemented in the fall semester of 2022.

CURE Details

The CURE was designed to be completed via chunking and scaffolding (Wiggins & McTighe, 2005) during the duration of the 16-week course. The CURE consisted of nine components and was completed by three permanent teams of students. Each team consisted of 3 to 4 students, and students selected their own team members at the beginning of the course. For each component, students were given detailed assignment instructions and a rubric at the onset. Each team was also provided a shared Google Drive folder designed to store generated material. The nine components and corresponding time frames are listed in sequence in Table 1 and are described in the following sections.

Table 1

CURE Components

Week(s)		Project Component
Week 1-2	1.	Topic Selection, Purpose Statement, and Research Objectives/Questions
Week 3-5	2.	Annotated Bibliography
Week 6-7	3.	Introduction, Literature Review, and Framework
Week 8-9	4.	Research Methods
Week 10-12	5.	Data Collection & Analysis
Week 13-14	6.	Results
Week 15	7.	Discussion and Conclusions
Week 16	8.	Dissemination
Final Week	9.	Total Project Submission

Project Component 1. Topic Selection, Purpose Statement, and Research Objectives/Questions.

Students worked in their permanent teams under the guidance of the instructor to identify a research topic of interest to them. The research topic was required to adhere to food systems and to be researchable through systematic study and authentic, applied sociological research. Further, the instructor required the topic to be narrow enough to add to the existing body of knowledge and to address a specific problem. Students were able to identify a realistic, narrowed topic after brainstorming sessions, a brief review, and additional instructor guidance. Lastly, students were required to write a draft purpose statement and research questions or objectives.

Project Component 2. Annotated Bibliography.

Each team was required to develop an annotated bibliography related to the topic identified in Component 1. The annotated bibliography served as a summary of, at minimum, 15 peer-reviewed sources. For each source, students were required to cite the source in APA 7th ed. format and create a summary using bulleted points. The instructor provided examples of how to use searchable databases and format APA citations.

Project Component 3. Introduction, Literature Review, and Theoretical/Conceptual Framework.

Students worked with their team to write an introduction, literature review, and framework section. Although there was no minimum page requirement, the instructor recommended that the three sections should combine for at least 4 doublespaced pages. Additionally, the instructor required the paper to have 15 in-text citations, largely based on the completed annotated bibliography.

Project Component 4. Research Methods.

With instructor guidance, each team was to identify the best research method used to answer their research objectives/questions. Teams were to first identify if their research method would be qualitative or quantitative. The instructor showed examples of peer-reviewed papers that used common methodology and discussed specific methods with each group separately. Each group then added a methods section to their team's paper. The instructor recommended that the methods section be at least one page and use several citations to support the methodology. Each team also developed their research instruments (e.g., semi-structured interview guide, survey, etc.). Lastly, each team completed an Institutional Review Board (IRB) application on their research project and submitted the application after instructor review and feedback. Due to the small size of the university, the IRB review and revision process is typically completed in several days, which was the case for all teams in this study.

Project Component 5. Data Collection and Analysis.

After IRB approval, each team used their identified research methods to collect data. Teams were given three weeks to collect their data and analyze it. The instructor recommended that each group start collecting data as

soon as possible and stay organized throughout the process. However, due to the instructor's expectations that complications with data collection were likely to occur, groups were only required to submit evidence that data collection and analysis had occurred, or significant progress had been made.

Project Component 6. Results.

Each team used their data and analysis to add a results section to their paper. The instructor guided each team by providing specific strategies to report results (e.g., creating tables, graphs, and using and reporting statistical analysis for quantitative data and reporting themes and participant quotes for qualitative data). The instructor recommended that the results section be several double-spaced pages.

Project Component 7: Discussion and Conclusions.

Each group was responsible for identifying their primary findings that aligned with their research objectives or questions. Additionally, each group compared their results to prior literature to identify consistent, contradictory, or novel findings. After team discussions and instructor guidance, each group added a discussion and conclusion section to their research paper. The instructor recommended that these sections be combined and incorporate the researchers' suggestions for practice and/or future research based on their findings. The instructor recommended that these written components be two to three double-spaced pages in total.

Project Component 8: Project Dissemination.

The project dissemination component consisted of a formal 10 to 15-minute oral presentation from each team on their research project. The presentations were given to the whole class during the course's final exam period, which was an extended 3-hour class period. Following each group's presentation, a formal five-minute question and answer portion was held, after which the instructor facilitated an untimed and informal class discussion. Each member of the team was required to speak during the presentation. The instructor required the use of PowerPoint for the presentations, and they were to cover project components 1 through 7.

Project Component 9: Total Project Submission.

The total project submission was the last component of the CURE. For this submission, each group combined their written portion of project components 1, and 3 through 7. Each team was expected to use the instructor's feedback from their prior component submissions to create a full research manuscript. The instructor recommended that the manuscript be between 11 and 15 double-spaced pages, not including references. All portions of the written manuscript were required to follow APA 7th edition formatting guidelines. The final project submission for each team was submitted electronically prior to midnight on the last day of the final exam week.

Grading.

The course instructor provided a detailed grading rubric for each of the seven components of the course. Components 1 through 7 were graded by the instructor, who provided detailed feedback. Students were expected to utilize the feedback for component 8, the total project submission. Additionally, in components 1 through 7, each student used the same rubric to self-grade the team's submission, as well as a point-based contribution value (i.e., 1, did not contribute to 5, fully contributed) for each member of the permanent team. For each team, members' scores were averaged to provide a total team self-evaluation value. For individual members, the score was reduced if they were deemed as not contributing to the project by their fellow members. The total point value of the CURE was 650 points, which represented 65% of each student's total course grade. The point values for each component can be found in Table 2.

Student Team Research Projects.

The 11 students in this course self-selected into three permanent teams at the start of the semester. Each team completed project components 1 through 8, with guidance from the instructor, through the duration of the semester. The research topics selected by the student teams were: (1) Factors that influenced adoption of locally grown hops by small-scale brewers in Nebraska; (2) College students' perceptions of genetically engineered animals for human consumption; and (3) An exploration of the motives and barriers of small-scale farmers who transitioned from conventional to organic agricultural practices. One team used quantitative research methodology, and two teams used qualitative research methodology. Each team successfully completed their CURE with high marks.

Methods

We determined that a qualitative approach would provide thick and rich data to best answer our research questions in the context of this case study. At the conclusion of the course, students were given the opportunity to voluntarily participate in a focus group to share their perspectives on the course and, in particular, the CURE under our investigation. A focus group format was chosen as the research method to best explore the shared interactions (e.g., experiences, understandings, tensions) between students (Ryan et al., 2013). This research was reviewed by Doane University IRB and deemed exempt (#S23 EX05 DC IRB HS).

Focus Group

The focus group was held immediately after all groups presented their final research projects during an extended final exam block on the last scheduled day of the course. A semi-structured interview protocol and moderator's guide was developed in an effort to elicit student responses surrounding our research questions (Krueger & Casey, 2009). Prior to the start of the focus group, the instructor of the course left the room, and a faculty member who was not part of the class served as the moderator of the focus group to minimize the instructor's influence on participant responses. Students were told that the focus group would

Table 2

Point Value by Component of the CURE

Project Component	Self-Evaluation Team Point Value	Instructor Point Value	Total Point Value
Topic Selection, Purpose Statement, and Research Objectives / Questions	25	25	50
Annotated Bibliography	25	25	50
Introduction, Literature Review, and Framework	50	50	100
Research Methods	50	50	100
Data Collection and Analysis	25	25	50
Results	50	50	100
Dissemination		100	100
Total Poject Submission		100	100
Total Value	225	425	650

Table 3

Participant Characteristics

Pseudonym	Gender	Year in School	Major
Brandon	Male	Senior	Agribusiness
Riley	Male	Junior	Agribusiness
Chase	Male	Junior	Natural Resources
Gabrielle	Female	Junior	Natural Resources
Neil	Male	Senior	Agribusiness
Baxter	Male	Junior	Agribusiness
Kiara	Female	Sophmore	Agribusiness
Josh	Male	Junior	Agribusiness
Chase	Male	Junior	Agribusiness
Dean	Male	Senior	Natural Resources

be recorded and that the focus group recording would not be provided to the instructor of the course until final course grades have been processed. Furthermore, students were told that participant names would be replaced by pseudonyms in research dissemination. All 11 students enrolled in the course were invited to participate in the focus group, and 10 volunteered to participate. Table 3 illustrates student characteristics in the focus group. The focus group lasted for approximately 30 minutes.

Data Analysis

The primary data source for this case study was a transcript of the audio-recorded focus group. Two researchers who held doctoral degrees in agricultural education and who were familiar with qualitative research analyzed the transcripts using a multi-cycle coding method (Saldaña, 2016) and NVivo software (Jackson & Bazeley, 2019). In this process, the two researchers worked separately using an inductive approach via open coding to create initial codes from the transcript (Glaser, 2016). After initial coding was completed individually by both researchers, the two researchers met to discuss, revise, and condense their initial codes into second-cycle axial codes (Saldaña, 2016). The two researchers then worked collaboratively to complete a thematic analysis of the data and to organize data into recurring themes (Braun & Clarke, 2006).

Additional strategies, beyond using two coders, were implemented to improve the qualitative quality of the study (Lincoln & Guba, 1985). To address the confirmability of our findings, we provided full, detailed descriptions of our methodology (Lincoln & Guba, 1985). To ensure dependability, an audit trail was created by the lead researcher and reviewed by the research team throughout the research project (Lincoln & Guba, 1985; Nowell et al., 2017). Finally, in an effort to improve credibility, the moderator conducted member checking to elicit student feedback during a debriefing summary, and triangulation was achieved by reviewing additional documents, including instructor notes and materials, student course evaluations, and student journal reflections as additional data sources (Carter et al., 2014; Lincoln & Guba, 1985).

Results

Three primary themes emerged from the data that were related to our research questions: (1) structured choice with mentorship; (2) research challenges; and (3) learning outcomes. Findings for each theme are reported below.

Theme 1: Structured Choice with Mentorship

The CURE under our investigation separated a semester-long, authentic research project into multiple, smaller components throughout the duration of the course. Students were supportive of chunking the larger project into smaller components and emphasized the advantage of clear organization and due dates. Chase mentioned, “The way [the instructor] set it up was nice because you had to do certain things to go to the next. The due dates and stuff were set up pretty nice as well.” Kiara added, “Going off of that, we would turn [project components] in and [the instructor] would give us feedback so we could fix it for the final project because for that we put all of the sections together.” Lastly, Gabriella summarized by saying, “I feel like [the instructor] did a really good job at walking us through each step to make sure we were successful.”

Students also described how they appreciated the structure of the document storage and peer review process. “I like how [the instructor] organized everything in Google Drive for us… You could always go back and find stuff quickly,” said Riley. Charles described the importance of the peer review for each component, “[The instructor] let our groups and partners give a peer review about each other and yourself which really helped to make sure everyone was doing their part.”

Students also expressed appreciation for being given choice in selecting a research topic and their permanent team members. For example, Brandon contributed, “I think it was a good thing that [the instructor] let us pick our groups. So we got to know the strengths and weaknesses of our partners and try to build on those too.” Riley added, “I thought selecting a topic was easy for us because we could pick our partners and we all kinda agreed on something that we were passionate about so having a passionate group of buddies to do a project really makes it more efficient.” The authenticity of not only the research process, but also in selecting a research topic that was relevant to students and their community was valued by all students. Neil summarized his perspective by contributing, “I think at the beginning of the project before we actually chose what we were going to really do, I thought the research was going to be more like every other class I’ve done where we just look stuff up instead of actually getting results from people. It turned out being really good.”

Theme 2: Research Challenges

Students were explicit about several challenges they faced during the CURE. Some students, such as Gabriella, described “not having participated in any formal research” previously and being very “weary about that.” Other challenges were mainly focused around conducting the research. Each of the three research teams ran into issues affecting their ability to collect data. When reflecting on the difficulty his team experienced in obtaining research participants around a school break, Chase observed, “[Our data collection] was right around Thanksgiving break so we talked to our participants and tried to set up a time to interview but that was difficult.” Dean, who was in a different group that also conducted a qualitative study, concurred, stating, “Yeah, nobody really responded to [our initial research request] ... we probably should have it done it differently.” Gabriella’s group, which conducted a quantitative survey, experienced similar issues. She stated, “Our main challenge was a low response rate … we sent out over 300 emails.” Despite these data collection challenges, which are like those faced by career scientists, each group was ultimately able to problem-solve and obtain enough data to develop substantiated research findings.

The participants suggested that the stress and research fatigue students experienced in the data collection process could have been reduced by modifying the structural timeline of the CURE. Charles described his group's biggest challenge as "making time to collect all of the data and to get interviews in." Baxter described his recommendation for future CUREs and stated, "One thing that I thought of was to [provide] a little more time to do the actual interviews." "Bump everything up a little bit so you have more time to gather data," Riley added.

Theme 3: Learning Outcomes

Students described learning, applying, and improving several technical and soft skills through the CURE. Even though some students expressed initial hesitation toward conducting authentic research, they were able to learn and hone their research skills throughout the CURE. For example, Riley described how his group became better at facilitating one-on-one interviews with participants. He stated, "Our first [interview] was pretty rough and then by the end of it, it was pretty awesome how smooth we could get through our whole thing." Riley also added, "[Now] we have a better understanding of how [research] works from both perspectives instead of just one side."

Overwhelming, students described improving their soft skills applied to scientific research. Several students highlighted communication skills. Neil emphasized this by stating the avenues in which these skills were employed, "Not only did we communicate with our group members, but we also had to communicate with other professors … and to get the interviews set up." Communication skills were not limited to organizing and obtaining data but expanded to students' written and oral research presentations as well. Neil, Gabriella, and Kiara described learning how to create visually appealing presentation slides that were not just "a bunch of numbers" or "a bunch of words." Charles summed up the emergent discussion on soft skills by stating, "It kinda just applied to all things, like teamwork, communication, and time management."

It was noticeable that students linked the skills employed in the CURE to be applicable to their real lives. Chase described the transferability of these skills by stating, "I feel like it's something that you can take into your job and into the real world. It's kinda a good stepping stone." Riley added, "I think overall, since we're mostly upperclassmen, it's a great way to get yourself out there and kind of introducing you to … steps you're going to have to do once you graduate." Gabriella was appreciative of the connection as well and stated, "yeah, because a lot of classes you just go through the motions of learning stuff, taking a test, learning more stuff, taking another test. This class applied real-world stuff."

Discussion and Conclusions

As faculty may have hesitation to implement CUREs in their classrooms (Govindan et al., 2020), this case study provides a structured example of CURE development, implementation, and perceived student outcomes. As such, this study can serve as an example CURE for faculty who have an interest in incorporating their own CUREs in teaching. The flexibility in CURE design and structure provides ample ways to incorporate them into the classroom; as such, the limitations and successes of these varying approaches should be documented. The CURE in our investigation was implemented throughout the semester by chunking a complete research study into multiple components. Students were also separated into permanent teams, and ample feedback and guidance were provided by the instructor to each team throughout the duration of the project. Our findings revealed that students appreciated the organized structure and clear expectations of the CURE, while also speaking in favor of flexibility in choice (e.g., selecting a research topic, methodology, and team members). Prior research has been explicit in the positive impact of strong faculty-student mentorship in the research process (Houser et al., 2013; Monarrez et al., 2020). Our findings show that students highly valued the structured mentorship and guidance from the instructor throughout each step in the research process, including both informal and evaluative feedback.

Conducting scientific research rarely goes without unplanned challenges. Well-designed CUREs mimic scientific discovery, and students are often exposed to significant disruptions in their planned research. Most students in our research identified challenges during their CURE. While some challenges were expected due to the nature of applied social science research itself, like participant recruitment and retention, other challenges could be minimized by a well-designed CURE. Students in our study expressed frustration with the time constraints of the CURE that occurred toward the end of the project. When designing similar-style CUREs, we recommend moving the research timeline up to allow data collection to start prior to the mid-point of the course. We believe this will provide more opportunities for students to confront challenges in the data collection process while providing additional time for them to engage in in-depth data analysis and create meaningful research conclusions and presentations.

Despite observing challenges, the students in this study overwhelmingly perceived the CURE as a positive and engaging experience that applied course concepts to address real-world issues. Like Esparza et al. (2020), we acknowledge the ability of CUREs to foster student engagement and motivation. Additionally, it was evident that students applied problem-solving and critical thinking skills through this CURE. Although some of the students mentioned improving their understanding of the research process, similar to findings from Laungani et al. (2018), the largest self-perceived learning outcome by students was applying and improving their communication skills. Students' descriptions of these efforts included group communication within their permanent teams, technical communication when conducting research, and science communication when presenting their research findings. These findings support prior research suggesting students' soft skill development through CUREs (Burmeister et al., 2021; McLaughlin et al., 2020).

We acknowledge several limitations to this study. This research served as a case study approach to investigating

the impact of a single CURE in a unique agricultural course. The results of this study are not and should not be generalizable to all CUREs. The teaching and learning process will vary with teaching context, student and teacher characteristics, and the learning environment, among other factors (Biggs, 1989). This study focused on a class with small enrollment that may be more conducive to implementing this structure of a CURE. Courses with larger enrollment may consider alternative approaches.

Implementing a CURE is not a one-size-fits-all approach. They must be developed and implemented according to the desired learning outcomes of the course, the needs of the students and instructor, and in a way that is feasible in the learning environment (Wiggins & McTighe, 2005). However, through case study approaches to researching CUREs, like this one, we can begin to paint a broader picture of their effectiveness within undergraduate AFNR education. While qualitative research can investigate CUREs through in-depth exploration of the student experience, we recommend additional research, such as experimental or quasi-experimental design, to provide statistical data on the effectiveness of various CURE structures on student learning outcomes. A substantial research base on CUREs within AFNR undergraduate courses is needed to inform best practices as they are rapidly and appropriately gaining in popularity to advance inclusion in undergraduate research.

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