Examining Student Perceptions of Engagement and Learning in a Flipped Introductory Agricultural Mechanics Course

Jay K. Solomonson[1] and Trent Wells[2]

[1]Illinois State University
[2]Murray State University

Jay K. Solomonson, Assistant Professor of Agricultural Education, Department of Agriculture, Illinois State University
Trent Wells, Assistant Professor of Agricultural Education, Hutson School of Agriculture, Murray State University
We have no known conflicts of interest to disclose.
Correspondence concerning this article should be addressed to Jay K. Solomonson, Department of Agriculture, Illinois State University, Campus Box 5020, Normal, IL 61790-5020. Email: jksolom@ilstu.edu

Abstract

Active, student-centered approaches to teaching and learning in university classrooms have been given greater focus in recent years. Consequently, the use of flipped classrooms in American universities has proliferated considerably. Evidence suggests that flipped classrooms have been successfully employed in agricultural coursework, such as university-level agricultural mechanics courses. Theoretically underpinned by Murillo-Zamorano et al.'s (2019) Flipped Classroom in Higher Education model, the purpose of our study was to determine students' perceptions of their engagement and learning in a flipped introductory-level agricultural mechanics course taught at Illinois State University. We used a valid and reliable electronic instrument to collect data from 61 undergraduate students over the course of four semesters. Our findings indicate that using a flipped classroom design to deliver an introductory-level agricultural mechanics course is a worthy endeavor that can positively impact students' course experience. We are seeing similar results each semester, which suggest that our students prefer this teaching style over a traditional lecture style. The lead author intends to continue teaching the *AGR 130: Introduction to Agricultural Engineering Technology* course with a flipped classroom design for the foreseeable future. Our recommendations include: (1) instructors of introductory-level agricultural mechanics courses consider using a flipped classroom approach and (2) replicating our study to further examine this topic.

Keywords: agricultural mechanics, flipped classroom, engagement, learning

As student engagement factors change with each successive generation of students, so must instructors' approaches to teaching and learning (Edgar et al., 2016). The increasing emphasis on student-centered, active learning in American classrooms dictates that instructors be open to new approaches to reach and teach their students (McCubbins et al., 2018). One such approach that has proliferated across the American university landscape in recent years is the flipped classroom (O'Flaherty & Phillips, 2015). Student-centered in nature, flipped classrooms provide students with the flexibility to explore course content at their convenience before actively engaging in deeper, meaningful applications during course meetings (McCubbins et al., 2018). Well-executed flipped classrooms can yield positive experiences for both instructors and students. Moreover, the recurring practical applications and activities frequently employed within flipped classrooms can be used to help students mentally adjust into the professional roles that they will soon occupy (Rotellar & Cain, 2016).

The active nature of the flipped classroom often lends itself well to agricultural courses (McCubbins et al., 2018). Instruction in agricultural courses is often centered on preparing students to solve complex, thought-provoking problems (Parr & Edwards, 2004; Phipps et al., 2008). Thus, the applications that can be used within flipped classrooms often align well with instructors' goals for student learning. Ideally, these applications will be complex enough to promote higher-order thinking skills that will help stimulate both deeper involvement in the subject matter being studied and enhanced student engagement in the learning process (McCubbins et al., 2018). Such applications could include determining the appropriate feed rations for beef cattle, successfully identifying diseases that are plaguing plants in a greenhouse, or engaging collaboratively in a team to properly complete an agricultural mechanics project.

The flipped classroom has recently been studied in university-level agricultural settings. Busato et al. (2016) noted that student learning outcomes in agricultural engineering courses can be positively impacted by employing a flipped classroom. Busato et al. (2016) also found that students exhibited a strong, statistically significant preference for the flipped classroom in comparison to traditional lecture-style course delivery. In their work with students enrolled in a production agriculture-focused, capstone-level course, McCubbins et al. (2018) indicated that using a flipped classroom "develops an engaging learning environment in which students assume responsibility for their own learning while working collaboratively to solve real-world problems" (p. 147). Conroy et al. (2019) described how University of New Hampshire agricultural alumni perceived that using the flipped classroom was effective for their learning. Similarly, Keck et al. (2021) reported that cognitive engagement and comprehension of the subject matter increased in their flipped soils nutrient management course. Further, Connor et al. (2014) found that "a flipped classroom approach seems to have promise as a model for delivering a[n] [agricultural teacher education] teaching methods course" (p. 65). Connor et al. (2014) subsequently opined that "other instructors of similar courses [should] attempt a flipped classroom approach to test the model in other contexts" (p. 65).

While the aforementioned literature provided evidence that using the flipped classroom can be successfully accomplished across differing agricultural contexts, the use of the flipped classroom in university-level general agricultural mechanics courses has received limited scholarly attention. Instruction in agricultural mechanics is meant to provide students with opportunities to engage in practical, real-world problem-solving via knowledge- and skill-based activities and experiences (Herren, 2015). Thus, agricultural mechanics courses may likewise be a suitable vehicle for employing the flipped classroom.

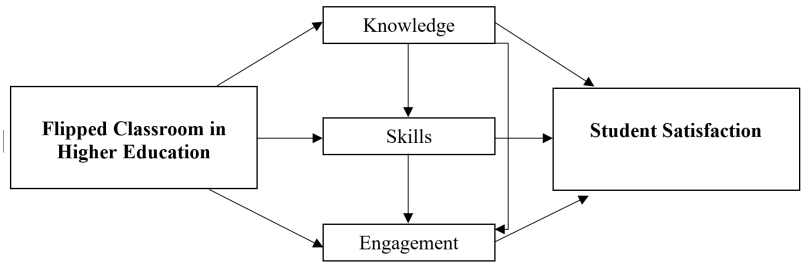
Answering Connor et al.'s (2014) recommendation, Figland et al. (2020) helped to address this gap in the literature. Figland et al. (2020) found that students who experienced a flipped classroom in an introductory-level agricultural mechanics course at Louisiana State University viewed their experience favorably. Considering that agricultural mechanics courses are taught at our respective universities, Figland et al.'s (2020) findings ultimately led to our guiding research question: Would students in similar coursework elsewhere perceive their experience comparably?

Theoretical Framework

We used Murillo-Zamorano et al.'s (2019) Flipped Classroom in Higher Education Model to theoretically underpin our study (see Figure 1).

Figure 1.

Adapted Version of Murillo-Zamorano et al.'s (2019) Flipped Classroom in Higher Education Model



Note. Adapted From "How the Flipped Classroom Affects Knowledge, Skills, and Engagement in Higher Education: Effects on Students' Satisfaction," by Luis R. Murillo-Zamorano, Jose Angel López Sánchez, 1981, Ana Luisa Godoy-Caballero, *Computers & Education*, *141*, p. 4 (https://doi.org/10.1016/j.compedu.2019.103608). Copyright 2019 by Elsevier B. V.

Murillo-Zamorano et al.'s (2019) proposed model indicated that flipped classroom instruction has the potential to directly and positively affect students' knowledge, skills, and engagement, which in turn could directly and positively affect a student's satisfaction with a flipped course. They further hypothesized that a student's skills gained from flipped instruction could affect engagement and that the knowledge gained could independently affect either skills or engagement, both positively and directly. Through their analysis, they found that flipped classroom instruction had a positive and direct influence on a students' knowledge and skills but not directly on engagement. However, they did find evidence confirming the positive and direct relationship among knowledge, skills, and engagement and each variable with overall satisfaction. We used influences from this model to guide the design and discussion components of our study.

Purpose and Objectives

The purpose of our study was to determine students' perceptions of their engagement and learning in a flipped introductory-level agricultural mechanics course at Illinois State University. Our specific objectives were to:

1. Describe respondents' attitudes toward using a flipped classroom;
2. Describe respondents' perceived engagement in a flipped classroom-style course;
3. Describe respondents' perceived enjoyment, workload, and learning when enrolled in a flipped classroom-style course; and
4. Describe respondents' satisfaction with the flipped *AGR 130: Introduction to Agricultural Engineering Technology course*.

Methods

Our descriptive study was designed to determine students' perceptions of engagement and learning in the flipped *AGR 130: Introduction to Agricultural Engineering Technology* (hereafter referred to as AGR 130) course at Illinois State University. After receiving IRB approval, we adapted a valid and reliable instrument previously employed by Russell et al. (2016) to collect data from students who completed the AGR 130 course during the 2021 and 2022 calendar years. The lead author taught four different sections of the AGR 130 during those years. We adapted the instrument by changing the institution name, altering terminology to be consistent with the AGR 130 course, and selecting specific demographic questions to better-align with our student population.

We used Qualtrics to collect our data electronically at the end of each semester. To increase our response rate, we followed recommendations from Dillman et al. (2014) to collect data through five different contacts. Our instrument consisted of three parts. Part one contained questions related to students' previous experience in a flipped classroom and their perceived levels of enjoyment, workload, and overall learning in the course. Part two consisted of Likert-type questions regarding students' perceptions of academic preparedness, levels of engagement, and overall satisfaction of the course. Part three included our demographics questions.

We received 61 usable responses, yielding a 70.9% response rate. We used SPSS© version 26.0 software to analyze our data. To address our research objectives, we used descriptive statistics to assess both student levels of engagement and their perceived levels of learning while enrolled in a course that used the flipped classroom design. The typical respondent of our study was majoring in Agribusiness or closely-related major (f = 26; 42.62%), was female (f = 34; 55.74%), described their ethnicity as White (f = 55; 90.16%), was not of Hispanic, Latino, or Spanish origin (f = 58; 95.08%), reported that their home community included fewer than 10,000 people (f = 22; 36.07%), had previously completed two or three college courses that were taught using a flipped classroom design (f = 25; 40.98%), and did not have any previous experience with high school classes taught using a flipped classroom design (f = 48; 78.69%). The demographic data of all participants can be found in Table 1.

Results

Objective One

We used objective one to describe the repondents' attitudes toward using a flipped classroom in the AGR 130 course. Using a five-point, Likert-type scale, we asked questions to determine students' personal attitude toward the flipped classroom approach (see Table 2). Over three-quarters of the respondents (f = 48; 78.69%) *strongly agreed* they liked the flipped classroom design and would consider taking other courses using a similar approach. Additionally, forty-seven respondents (77.05%) *strongly agreed* they liked using the class time to complete the hands-on laboratory exercises. Only five respondents (8.20%) indicated a strong preference to take the class completely in-person. A majority of the respondents (f = 38; 62.30%) also reported that they learned better by spending their in-person class time on hands-on learning activities rather than in a traditional lecture.

We further sought to determine the respondents' attitudes towards specific components of the online materials provided in the course (see Table 3). Each of the 14 modules in the course contained pre-recorded lecture videos and activities, readings, assignments, and quizzes. Fifty-two respondents (85.25%) *strongly agreed* or *somewhat agreed* they had motivation each week to complete the online component of the course. Further, a majority of our respondents *strongly agreed* the content provided in the online lecture materials had sufficient depth (f = 34; 55.74%) and had sufficient practical application (f = 42; 68.85%). Less than 10% (f = 6; 9.84%) of respondents strongly felt the online content provided was too technical.

Table 1.

Respondent Demographics (n = 61)

Item	*f*	%
Academic major		
Agribusiness (or closely related)	26	42.62
Animal Science (or closely related)	14	22.95
Agricultural Education (or closely related)	9	14.75
Plant Science (or closely related)	11	18.03
Not an agricultural major	1	1.64
Gender		
Female	34	55.74
Male	27	44.26
Non-binary	0	0.00
How would you describe yourself?		
White	55	90.16
Black or African American	1	1.64
American Indiana or Alaskan	1	1.64
Other	3	4.20
Prefer Not to Answer	1	1.64
Are you of Hispanic, Latino, or of Spanish origin?		
Yes	2	3.28
No	58	95.08
Prefer Not to Answer	1	1.64
Home community size		
Farm	16	26.23
Country, town, or city with less than 10,000 people	22	36.07
Town/City with Between 10,000 and 50,000 people	13	21.31
City with more than 50,000 people	10	16.39
Number of previous college courses taught using a flipped classroom design		
0	20	32.79
1	9	14.75
2-3	25	40.98
4-5	4	6.56
> 5	3	4.92
Previous experience with high school classes taught using a flipped classroom design?		
Yes	13	21.31
No	48	78.69

Table 2.

Respondents' Attitudes Toward Using a Flipped Classroom in the AGR 130 Course (n = 61)

Item	Strongly disagree ƒ(%)	Somewhat disagree ƒ(%)	Neither agree nor disagree ƒ(%)	Somewhat agree ƒ(%)	Strongly agree ƒ(%)
I was better engaged in this flipped design compared to a traditional class.	3(4.9)	4(6.6)	4(6.6)	23(37.7)	**27(44.3)**
I learned better from the time spent on learning activities and labs in class than a traditional lecture approach.	0(0.0)	2(3.3)	3(4.9)	18(29.5)	**38(62.3)**
I liked using class time to complete labs / solve problems enhanced understanding of course concepts.	0(0.0)	1(1.6)	1(1.6)	12(19.7)	**47(77.0)**
I liked how this course used a flipped classroom design.	1(1.6)	1(1.6)	4(6.6)	7(11.5)	**48(78.7)**
I am interested in taking other courses using a similar flipped classroom design.	1(1.6)	0(0.0)	4(6.6)	8(13.1)	**48(78.7)**
I preferred to take the class completely in-person and not doing any of it online.	**33(54.1)**	17(27.9)	3(4.9)	3(4.9)	5(8.2)

Table 3.

Respondents' Attitudes Toward the Flipped Classroom Online Lecture Components and Materials (n = 61)

Item	Strongly disagree ƒ(%)	Somewhat disagree ƒ(%)	Neither agree nor disagree ƒ(%)	Somewhat agree ƒ(%)	Strongly agree ƒ(%)
I felt motivated to log in each week and complete the online component of the course.	3(4.9)	1(1.6)	5(8.2)	20(32.8)	**32(52.5)**
The content provided in the online lecture materials was too technical.	13(21.3)	**23(37.7)**	17(27.9)	2(3.3)	6(9.8)
The content provided in the online lecture materials had sufficient depth.	0(0.0)	1(1.6)	4(6.6)	22(36.1)	**34(55.7)**
The content provided in the online lecture materials had sufficient practical applications.	0(0.0)	0(0.0)	1(1.6)	18(29.5)	**42(68.9)**
The length of the online lecture videos was too long.	14(23.0)	18(29.5)	**21(34.4)**	5(8.2)	3(4.9)
The number of online lecture videos provided was sufficient to learn the content within the module.	0(0.0)	2(3.3)	3(4.9)	15(24.6)	**41(67.2)**
The quality of the online lecture videos was sufficient to learn the content within the module.	0(0.0)	0(0.0)	2(3.3)	10(16.4)	**49(80.3)**
I believe the content of the online lecture videos helped me to be successful in the online weekly module quiz.	0(0.0)	1(1.6)	0(0.0)	12(19.7)	**48(78.7)**
I believe the content of the online lecture videos helped me to complete the weekly assignment.	0(0.0)	0(0.0)	0(0.0)	12(19.7)	**49(80.3)**
I believe the content of the online lecture videos helped me to complete the hands-on activities during class time.	2(3.3)	1(1.6)	1(1.6)	14(23.0)	**43(70.5)**

When evaluating the pre-recorded lecture videos, the typical respondent *strongly agreed* the videos were sufficient to learn the module content (*ƒ* = 41; 67.21%), the quality of the videos were sufficient (*ƒ* = 49; 80.33%), and the content of the videos helped to successfully complete the module quiz (*ƒ* = 48; 78.69%), weekly assignment (*ƒ* = 49; 80.33%), and hands-on activities during class time (*ƒ* = 43; 70.49%). Less than 5% (*ƒ* = 3; 4.92%) *strongly agreed* the lecture videos were too long. The pre-recorded lecture videos averaged 20 minutes in length. Twelve modules contained only one lecture video while two modules contained two lecture videos.

Objective Two

We used objective two to describe the respondents' perceived engagement in the lead author's flipped AGR 130 course. To determine levels of engagement, we asked participants questions about the amount of time they spent preparing for class and their levels of engagement while completing course activities. The AGR 130 course is scheduled as a three-hour, hybrid course with two hours of asynchronous online lecture and two hours of in-person instruction. Our respondents self-reported spending an average of 3.54 hours per week (SD = 1.59) outside of our in-person class time completing the online module activities and studying for the course.

We then asked participants questions on how often they completed the specific components within the online module (see Table 4). Over 80% of respondents' reported they always watched the posted lecture videos (*ƒ* = 49; 80.33%), finished their weekly assignment (*ƒ* = 51; 83.61%), and completed the online module quiz (*ƒ* = 54; 88.52%) prior to attending the weekly in-person class. Further, 36 respondents (59.02%) reported *always* taking notes during the lecture videos while 27 (44.26%) reported completing all assigned readings. Fifty-two respondents (85.25%) indicated they were *always* or *most of the time* interested in the content in the weekly modules.

Finally, to determine overall engagement we asked 14 questions to ascertain levels of overall engagement and levels within its three constructs: behavioral, emotional, and cognitive. On a seven-point, Likert-type scale, overall engagement in the flipped AGR 130 course was high (M = 5.98, SD = 1.11). The levels within each individual construct were also high (see Table 5). Additionally, 50 of our respondents (81.97%) *strongly agreed* or *somewhat agreed* to being better engaged in a flipped classroom compared to a traditional lecture-style class.

Table 5.

Type and Level of Engagement with the Flipped AGR 130 Course (n = 61)

Item	M	SD
Overall engagement	5.98	1.11
Behavioral engagement	6.26	1.00
Emotional engagement	6.28	0.90
Cognitive engagement	5.41	1.42

Objective Three

We used objective three to describe the respondents' perceived enjoyment, workload, and learning when enrolled in a flipped classroom-style course. We asked respondents to complete three questions to respond to this objective. We asked participants in comparision to a traditional lecture / lab course of the same level (e.g., 100, 200, etc.) in your degree program, what was their level of (1) enjoyment, (2) workload, and (3) overall learning in this flipped classroom experience? (see Table 6). The participants could select increased, descreased, or similar for each question. The typical respondent reported having an increased level of

Table 4.

Respondents' Preparedness and Interest Toward the AGR 130 Course (n = 61)

	Never	Sometimes	About Half the Time	Most of the Time	Always
Item	*ƒ*(%)	*ƒ*(%)	*ƒ*(%)	*ƒ*(%)	*ƒ*(%)
How often did you watch the posted lecture videos prior to coming to class each week?	0(0.0)	0(0.0)	0(0.0)	12(19.7)	**49(80.3)**
How often did you take notes during the lecture videos?	4(6.6)	1(1.6)	8(13.1)	12(19.7)	**36(59.0)**
How often did you complete all of the required readings prior to coming to class each week?	3(4.9)	3(4.9)	7(11.5)	21(34.4)	**27(44.3)**
How often did you complete the assignments prior to coming to class each week?	0(0.0)	0(0.0)	0(0.0)	10(16.4)	**51(83.6)**
How often did you complete the module quiz prior to coming to class each week?	0(0.0)	0(0.0)	0(0.0)	7(11.5)	**54(88.5)**
How often did you feel interested in the content with the modules each week?	0(0.0)	2(3.3)	7(11.5)	**28(45.9)**	24(39.3)

enjoyment (f = 52; 85.25%) and similar levels of workload (f = 46; 75.41%) and overall learning (f = 28; 45.90%). A small percentage of respondents' reported a decreased level of enjoyment (4.92%) and decreased level of learning (11.48%).

Objective Four

We used objective four to describe the respondents' satisfaction with the flipped AGR 130 course. We asked participants about their satisfaction with the online component of the course, the in-person component of the course, and their overall satisfaction with the course (see Table 7). Fifty respondents' (81.97%) reported being extremely satisfied with the online component of the course, 52 respondents' (85.25%) with the in-person component of the course, and 45 respondents' (73.77%) with the entire AGR 130 course.

Conclusions, Discussion, Recommendations, and Limitations

The purpose of our study was to determine students' perceptions of their engagement and learning in a flipped introductory-level agricultural mechanics course at Illinois State University. We found that respondents: (1) had positive attitudes toward using a flipped classroom in an agricultural mechanics course, (2) had positive attitudes toward the online content used within the course, (3) indicated that they were investing time preparing for in-class activities, (4) reported that they typically completed their assigned activities prior to engaging in the in-class activities, (5) reported high course engagement, (6) indicated their course experience was comparable to or superior to their experiences in traditional lecture-style courses, and (7) were satisfied with their course experience. Similar to Figland et al. (2020), our findings indicate that, from the student perspective, using a flipped classroom in an introductory-level agricultural mechanics course can be a practical approach that yields positive reception from students.

Some of our findings stood in contrast with prior literature. For example, we found that a majority of our respondents reported a high degree of engagement with the online course content. However, Keck et al. (2021) and Radunovich and Acharya (2018) reported that the majority of students do not fully engage with lecture videos in a flipped classroom, even when given a post-video quiz. Perhaps the combination of different types of online activities with a strong connection to the upcoming hands-on, in-class agricultural mechanics activities (e.g., small gas engine troubleshooting, metal fabrication processes, etc.) motivated our respondents to engage with the online course materials at a deeper level versus the respondents in Keck et al's (2021) and Radunovich and Acharya's (2018) studies. We recommend that scholars conduct additional research on the specific components and activities within a flipped classroom and their relationship to course engagement.

On the converse, some of our findings aligned with other scholars' works. For example, in the context of

Table 6.

Respondents' Perceived Level of Enjoyment of, Workload in, and Overall Learning in a Flipped Classroom Experience Compared to a Traditional Course in the Degree Program (n = 61)

	Increased	Decreased	Similar
Item	***f*(%)**	***f*(%)**	***f*(%)**
Perceived level of enjoyment	**52(85.2)**	3(4.9)	6(9.8)
Perceived level of workload	3(4.9)	12(19.7)	**46(75.4)**
Perceived level of overall learning	26(42.6)	7(11.5)	**28(45.9)**

Table 7.

Respondents' Satisfaction with the Flipped AGR 130 Course (n = 61)

	Extremely dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Extremely satisfied
Item	***f*(%)**	***f*(%)**	***f*(%)**	***f*(%)**	***f*(%)**
Overall satisfaction with the AGR 130 course	0(0.0)	0(0.0)	3(4.9)	13(21.3)	**45(73.8)**
Satisfaction of the online component of the course	0(0.0)	2(3.3)	4(6.6)	5(8.2)	**50(82.0)**
Satisfaction of the in-person component of the course	0(0.0)	0(0.0)	2(3.3)	7(11.5)	**52(85.2)**

student engagement, our findings are consistent with those of Russel et al. (2016), who reported higher levels of engagement in flipped classrooms compared to traditional lecture-style classrooms. From the perspective of student satisfaction, we found that our respondents reported a high degree of satisfaction with using the flipped classroom in their course, which aligned with both Figland et al.'s (2020) and McCubbins et al.'s (2018) findings. Moreover, similar to Burke and Fedorek (2017), we found that a handful of respondents simply simply do not like the changes associated with the flipped classroom approach and prefer a passive classroom. However, this was not the case with the majority of our respondents. Our findings lend validity to Murillo-Zamorano et al.'s (2019) theoretical model, as they hypothesized the knowledge, skill, and engagement obtained in a flipped classroom model can lead to increased student satisfaction in the university classroom.

Based on our findings, we recommend that:

1. Instructors of introductory-level agricultural mechanics coursework at other universities consider using a flipped classroom in their own coursework;
2. Following-up on the recommendations of Connor et al. (2014) and McCubbins et al. (2018), faculty in other agricultural disciplines, such as agricultural business and economics, agronomy, and animal science, should consider implementing a flipped classroom in their own courses;
3. This study be replicated in other agricultural coursework at other universities;

We acknowledge that our data were collected from a convenience sample of students enrolled in the AGR 130 course during the 2021 and 2022 calendar years. We thus cannot generalize our findings beyond our 61 respondents. To help improve generalizability, scholars who study using flipped classroom use in agricultural coursework in the future should consider using research designs that employ randomization of human subjects whenever possible. Doing so would help to add to the robustness and utility of future scholarship.

Summary

Our findings, similar to those in Figland et al.'s (2020) study, indicate that using a flipped classroom to deliver an introductory-level agricultural mechanics course is a worthy endeavor that can positively impact students' perceived course experience. Each semester, we are consistently seeing similar results, which suggests that students who are enrolling in the AGR 130 course at Illinois State University tend to prefer this teaching style over a traditional lecture style. Hence, we intend to continue teaching the AGR 130 course with a flipped classroom design for the foreseeable future. Our recommendations include: (1) instructors of introductory-level agricultural mechanics courses consider using a flipped classroom approach and (2) replicating our study to further examine this topic.

References

Burke, A. S., & Fedorek, B. (2017). Does "flipping" promote engagement?: A comparison of a traditional, online, and flipped class. *Active Learning in Higher Education*, *18*(1), 11–24. https://doi.org/10.1177/1469787417693487

Busato, P., Berruto, R., Zazueta, F. S., & Silva-Lugo, J. L. (2016). Student performance in conventional and flipped classroom learning environments. *Applied Engineering in Agriculture*, *32*(5), 509-518. https://doi.org/10.13031/aea.32.11298

Connor, N. W., Rubenstein, E. D., DiBenedetto, C. A., Stripling, C. T., Roberts, T. G., & Stedman, N. L. P. (2014). Examining student perceptions of flipping an agricultural teaching methods course. *Journal of Agricultural Education*, *55*(5), 65-77. https://doi.org/10.5032/jae.2014.05065

Conroy, A. B., Overson, C. E., & Erickson, P. S. (2019). Alumni perspectives of using a flipped classroom and experiential learning at a university dairy farm. *NACTA Journal*, *63*(2), 299-306. https://www.jstor.org/stable/26769654

Dillman, D, A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys: The tailored design method* (4th edition). John Wiley & Sons, Inc.

Edgar, D. W., Retallick, M. S., & Jones, D. (2016). Research priority 4: Meaningful, engaged learning in all environments. In T. G. Roberts, A. Harder, & M. T. Brashears. (Eds.), *American Association for Agricultural Education national research agenda: 2016-2020*. Gainesville, FL: Department of Agricultural Education and Communication. https://aaaeonline.org/resources/Documents/AAAE_National_Research_Agenda_2016-2020.pdf

Figland, W. L., Blackburn, J. J., & Roberts, R. (2020). Undergraduate students' perceptions of Team-Based Learning during an introductory agricultural mechanics course: A mixed methods study. *Journal of Agricultural Education*, *61*(1), 262-276. https://doi.org/10.5032/jae.2020.01262

Herren, R. V. (2015). *Agricultural mechanics: Fundamentals and applications* (7th ed.). Cengage Learning.

Keck, M., Mamo, M., SIndelar, M., Speth, C., & Borwn, S. (2021). Student perception of engagement and learning in a flipped soil nutrient management course. *NACTA Journal*, *65*, 368-374. https://www.nactateachers.org/index.php/volume-65-november-2020-october-2021/3165-student-perception-of-engagement-and-learning-in-a-flipped-soil-nutrient-management-course

McCubbins, O., Paulsen, T. H., & Anderson, R. G. (2018). Examining student perceptions of their experience in a TBL formatted capstone course. *Journal of Agricultural Education*, *59*(1), 135-152. https://doi.org/10.5032/jae.2018.01135

Murillo-Zamorano, L. R., Lopez-Sanchez, J. A., & Godoy-Caballero, A. L. (2019). How the flipped classroom affects knowledge, skills, and engagement in higher education: Effects on students' satisfaction. *Computers & Education*, *141*, 1-18. https://doi.org/10.1016/j.compedu.2019.103608

O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *The Internet and Higher Education*, *25*, 85-95. https://www.sciencedirect.com/science/article/abs/pii/S1096751615000056

Parr, B., & Edwards, M. C. (2004). Inquiry-based instruction in secondary agricultural education: Problem solving—An old friend revisited. *Journal of Agricultural Education*, *45*(4), 106-117. https://doi.org/10.5032/jae.2004.04106

Phipps, L. J., Osborne, E. W., Dyer, J. E., & Ball, A. (2008). *Handbook on agricultural education in public schools* (6th ed.). Thomson Delmar Learning.

Radunovich, H. L., & Acharya, S. (2018). If you flip it, will they watch: Case evaluation of a hybrid course. *NACTA Journal*, *62*, 84-88. https://www.nactateachers.org/index.php/vol-62-1-mar-2018/2698-if-you-flip-it-will-they-watch-case-evaluation-of-a-hybrid-course

Rotellar, C., & Cain, J. (2016). Research, perspectives, and recommendations on implementing the flipped classroom. *American Journal of Pharmaceutical Education*, *80*(2), 1-9. https://doi.org/10.5688/ajpe80234

Russell, J., Van Horne, S., Ward, A. S., Bettis III, E. A., Sipola, M., Colombo, M., & Rocheford, M. K. (2016). Large lecture transformation: Adopting evidence-based practices to increase student engagement and performance in an introductory science course. *Journal of Geoscience Education*, *64*(1), 37-51. https://doi.org/10.5408/15-084.1