Applied Economics Teaching Resources

Teaching and Educational Methods

Enhancing Student Engagement in a Changing Academic Environment-Tested Innovations for Traditional Classes and Online Teaching

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Abstract

Agriculture is a global industry that constantly innovates and increasingly uses cutting-edge technology. A great number of job opportunities exist because this important sector of the economy is looking to recruit motivated and ambitious young people. Meanwhile, the academic environment is changing. Many programs experience increased class sizes and are introducing online curricula. Addressing these simultaneous challenges, eight teaching scholars from agricultural and applied economics programs presented their teaching approaches in a track session at the 2019 AAEA Annual Meeting. This article continues the conversation about specific teaching innovations tested in traditional classroom settings and online environments in an attempt to share lessons learned with a broader audience. Many of the insights presented here are easily adaptable when teaching remotely and will remain relevant once campuses reopen.

1 Introduction

Demand for well-trained college graduates with a major from agricultural degree programs have increased over the last five years. An estimated 57,900 high-skilled annual job openings in agriculture, renewable natural resources, and environment fields were added to the U.S. economy between 2015 and 2020 (Purdue University 2015). The growing local and regional food movement created additional job opportunities, and the USDA already invested over $1 billion to attract new producers to farming and food-related businesses (Vilsack 2016). Although the current unprecedented economic downturn will affect all sectors of the economy, these agricultural-related careers might be relatively less impacted.

Universities and colleges tasked with supplying these graduates have already been adapting to new technologies and methods to improve the quality of teaching. In particular, the use of online resources has continuously increased over the last decade. About one third of students enrolled in higher education took at least one course online (Allen and Seaman 2013; Kentnor 2015), and the rapid switch to remote instructions as a response to the COVID-19 pandemic will likely accelerate changes in the teaching and learning environment. Nevertheless, important questions remain: how can universities further a renewed interest in agriculture and resource management and prepare students for the pressing challenges of our time? More specifically, how can we increase student engagement within changing academic structures toward larger class sizes and remote access? How can we create meaningful connections and applications, awaken curiosity, and develop a desire to go beyond graded requirements?

This article discusses innovative teaching approaches tested in traditional classroom settings and online classes to begin answering these and related questions.[1] We first provide a short overview of the existing literature on student engagement and describe our successful approaches to increase student engagement implemented in traditional classrooms. We then summarize existing literature on teaching in an online environment and present our approaches that modified or re-envisioned the use of online learning tools and social media for large classes. Finally, we conclude by reflecting on the challenges ahead.

2 Innovations in Traditional Classroom Settings

The existing literature clearly documents a positive correlation between student engagement and academic achievement (Carini, Kuh, and Klein 2006; Trowler and Trowler 2010; Lei, Cui, and Zhou 2018). Student engagement can be defined as a multifaceted, dynamic process with behavioral, cognitive, and emotional dimensions (Fredricks, Blumenfeld, and Paris 2004; Wang and Holcombe 2010). More specifically, Fredricks et al. (2004) discuss that engagement requires students' positive conduct, such as following the rules and adhering to classroom norms, as well as participating and involving in academic tasks (i.e., behavioral dimension). They also stress the importance of students' investment in learning and self-regulated strategic studying (i.e., cognitive dimension) as well as students' affective reactions to and connectedness with other students and teachers (i.e., emotional dimension). In other words, student engagement observed as active class participation needs to be fueled by the desire to go beyond class requirements and challenge seeking, as well as a deeper emotional connection with the material, their peers, and instructors (Trowler 2010; Quaye and Harper 2015).

Although student preferences, classroom context, and institutional factors can all contribute to a higher level of student engagement (Fredricks et al. 2004), teacher actions remain central in student-centered pedagogies (Kuh et al. 2006). The term "pedagogies of engagement" was first introduced by Edgerton (2001), although pedagogical developments of the 1990s already emphasized collaborative or cooperative learning, inquiry and problem-based learning, team projects, and authentic learning as a basis for student-centered pedagogies (Barrows and Tamblyn 1980; Johnson, Johnson, and Smith 1991; Jonassen and Rohrer-Murphy 1999). In a survey of 1,246 college students, Zepke, Leach, and Butler (2014) found that the three most important teacher actions to increase student engagement are: providing feedback to improve student learning, teaching in ways that enable students to learn, and being enthusiastic about the subject. Carefully designed tasks can further enhance engagement in learning if they are perceived as authentic, provide students with opportunities to assume ownership of their actions, and allow collaboration (Newmann 1991; Newmann and Wehlage 1993). Helme and Clarke (2001) further find that cognitive engagement is more likely to occur when students are asked to work with peers on novel tasks that have personal meaning. Similarly, Herrington and Oliver (2000) and Herrington and Herrington (2006) emphasize a framework that situates learning activities within real-world circumstances and provides immersive learning tasks in realistic learning contexts. Finally, Burns and Chopra (2017) point out that student learning can be enhanced through industry involvement.

Below we discuss five approaches that translate these findings into teaching innovations implemented in large undergraduate classes. Barkley, Kiesel, and Lacy used in-class assignments, peer-based learning activities, and teaching with experiments to increase student engagement in large classes and improve learning outcomes. Zuo and her colleagues reflect on three implemented approaches to authentic learning aimed at engaging students in global agriculture. Finally, Hanson's description of the Farm Credit Fellows program serves as an example of a successful industry collaboration.

[1] These innovations and shared lessons learned were presented in the track session "Increasing Student Engagement and Attracting Talent in a Changing Academic Environment" sponsored by the Teaching, Learning, and Communications and Agribusiness Economics and Management sections at the 2019 AAEA Annual Meeting. The feedback we received motived us to share our experiences more broadly within our discipline.

2.1 Using Small Group In-Class Assignments Instead of Quizzes

Andrew Barkley teaches a required course in applied microeconomics at Kansas State University. The course is the second semester of a two-semester, Junior-level sequence in intermediate microeconomics applied to food and agriculture, with calculus as a prerequisite. Barkley describes his in-class exercises assigned during this course as *Skill Builders*.

He incorporates these assignments into every lecture. The short assignments cover material from the previous lecture, and take about 5 minutes. Barkley's initial idea was to encourage students to attend every class, as well as to review their notes from the previous lecture. He did so by giving a quiz at the start of each lecture.

Although this worked well for some students, particularly serious students who systematically reviewed the material, other students experienced high levels of performance and/or test anxiety. The classroom environment suffered for students who did not perform well on the quizzes, and he frequently had to deal with incidents of cheating. Barkley decided to replace the quizzes with daily in-class assignments, covering the most rigorous and challenging material from previous lectures.

These assignments gave students the opportunity to apply challenging economic concepts to food and agriculture and to see questions similar to those on upcoming exams. The assignments are completed and submitted by each individual, transforming work and discussions with other classmates from cheating to an encouraged activity. Not only did this new approach result in higher-order learning and better learning outcomes, it also contributed to a positive and less threatening learning environment.

The assignments are typically applications of microeconomics to issues in food and agriculture, including profit-maximization, advertising, the causes and consequences of monopoly and monopsony in food and agricultural markets, and game theory. Students were able to ask for help when working on these assignments, and the grading provides a useful mechanism for reinforcement, encouragement, and feedback. Finally, grading these *Skill Builders* helped Barkley to revise the course material and better align it with student interests and possible career choices.

In summary, although designing and implementing these types of assignments was costly in terms of reduced coverage of course material and additional time spent on preparation, implementation, and grading, the benefits seemed to have outweighed these costs. Benefits include increased class attendance, higher levels of student participation in lectures, enhanced learning outcomes, a more positive class environment, and improved student-teacher relationships. Feedback from students is positive. Quizzes were popular with good students who were motivated to review their notes before each lecture, but were unpopular with struggling and anxious students. *Skill Builders* appear to be a successful way to provide extra practice with difficult concepts and reward class attendance.

2.2 A Peer-Based Learning Approach Supported by Group Projects, Clicker Participation Questions, and Instructional Videos

Kristin Kiesel redesigned the Intermediate Microeconomics course taught in the Agricultural and Resource Economics Department at the University of California, Davis, over several quarters in an effort to incentivize peer-based learning. She started with the introduction of a quarter-long group project that asks students to play a game based on oil production by the Organization of Petroleum Exporting Countries (OPEC). Students are divided into groups representing OPEC countries. They are given initial oil reserves, historic prices, production cost, and the rules of the game.[2] Students then play several rounds of this game and submit production quantities for their assigned countries as low-stakes assignments throughout the quarter. First, they are asked to develop strategies in a scenario that resembles perfect competition. The game then moves to a scenario that represents an oligopoly market structure. Finally, students are

[2] Several descriptions of an OPEC game as a teaching tool are available online. Kiesel's implementation of the game built on instructions posted by Borenstein and Bushnell (see http://faculty.haas.berkeley.edu/borenste/mba212/OPECgame.pdf) and her exposure to a version of this game used by Sofia Villas-Boas during a visiting assistant professor appointment at the University of California, Berkeley, in 2015.

encouraged to form a cartel, and one section is dedicated to allow students to discuss possible cartel agreements.[3] These submissions parallel the coverage of market structures and firm behavior in lecture and allow students to continuously apply the taught material. Kiesel shares the resulting market price and overall supply after each submission during lectures and encourages students to ask for feedback from the TAs or herself. One key aspect of this game is that students are submitting quantities repeatedly under each scenario. It allows students to reflect on their choices under consideration of the shared market outcomes and additional feedback. Prior to a detailed discussion of the game during her last lecture that also serves as a final exam review, students are asked to submit a memo or project report. It allows them to review the material covered throughout the quarter, reflect on their submissions, and describe what they would do differently. This opportunity to review their strategies and describe what they have learned serves as a high-stakes assignment.

Although many students were appreciative of this real-world application, others struggled and did not actively contribute to group discussions. Kiesel continued to refine instructions and created additional resources to support the game. To further support student engagement, Kiesel also incorporated clicker questions into her lectures during the following quarters. These questions appear throughout each lecture and are graded based on participation and correctness.[4] In contrast to taking short weekly quizzes at the beginning of lecture that test whether students complete the assigned readings, students can talk and consult their peers while each question remains open. In a final revision and attempt to strengthen her peer-based learning approach, Kiesel also created and posted learning glass videos that feature students explaining economic concepts.[5] These short videos (10–15 minutes) allow students to review key concepts covered in lecture. Featuring their peers is further intended to motivate students to try to learn from each other and explain the covered material in their own words.

Lecture attendance increased immediately after the implementation of clicker questions. More importantly, however, the group project, the opportunity to discuss responses to clicker questions, and the learning glass videos that featured students reinforced each other. They allowed students to increase their engagement with the material and interaction with their peers. More students started actively participating in lectures and took ownership of the OPEC game, improving learning outcomes significantly. While the introduction of the OPEC game alone allowed 32 percent of the students to improve their individual performance, 73 percent of students were able to improve their performance (measured by a received higher grade for the final as compared to the midterm) once all components were implemented. Furthermore, these innovations significantly improved students' perceptions of their learning as expressed in increased numerical scores and enthusiastic comments on their student evaluations. One student remarked: "Even though I may not earn an A in the course, I was able to engage with the material in a way that most students never get the chance to."

2.3 Teaching with Experiments in Large Classes

Many classroom activities can seem inapplicable to large class sizes. It is more challenging to keep students engaged as class sizes grow. However, with the right amount of preparation, classroom games can be a useful "learning-by-doing" strategy even for large classes. Games do not have to be self-created; there are many games for principles courses published on a website "Games Economics Play," maintained by Delemeester and Brauer (2010). Katherine Lacy adapted a number of these games to introduce material in her principles of microeconomics courses taught in the Economics Department at the University of Nevada, Reno.

[3] Except for the first scenario that combines all groups into one game, four parallel games are played with each section representing one independent game.

[4] One question is randomly chosen from each lecture to assign participation points for that lecture. One point is given if a response was received, and an additional point is added if the question was answered correctly.

[5] Learning Glass technology uses specialized glass and lighting to create a transparent white board that illuminates writing with neon markers while the instructor is able to look directly into the camera. See https://video.ucdavis.edu/media/Competitive+Markets/0_nbjgavbl for an example of a video featuring Kiesel.

Lacy often uses games before introducing the material. This allows students to experience the material firsthand and provides the class with examples to reflect back on when discussing the material. For example, diminishing marginal product can be a challenging concept for introductory economics students. To provide students with firsthand experience of diminishing marginal product, a widget production game is introduced before the production chapter. Students are placed in groups of 7–8 students asked to produce as many "widgets" as possible in a given amount of time starting with 1 worker.[6] The next round introduces a second worker, third round introduces a third worker, etc. When it comes time to introduce diminishing marginal product of labor, Lacy allows students to comment on why they believe production did not increase as fast when adding workers when there were already 5, 6, or 7 students working compared with adding workers when only 1, 2, or 3 students were working. Students often describe the idea of diminishing marginal product of labor, which allows Lacy to formally define the economic term while using the class production data.

In a typical Principles of Microeconomics course, Lacy begins the second class with a game to introduce the circular flow diagram. Because of time constraints in her course calendar, she does not introduce supply and demand using games, but many games exist on the "Games Economist Play" website (Delemeester and Brauer 2010). When introducing consumer behavior in game theory, Lacy has students play a series of prisoners dilemma games and a game called 21 Flags to introduce backward induction. The next two games introduce environmental economics. Specifically, a common pool resource game using a "pool" of extra credit points and a pollution permit game developed by Caviglia-Harris and Melstrom (2015). When it comes time to introduce firm production, Lacy uses the widget production game previously mentioned. Finally, a game developed by Brouhle (2011) is used to introduce the class to Oligopolies.

Reflecting on her lessons learned, she emphasizes that early preparation is the key to a successful learning activity executed during lecture. She found that she could save valuable classroom time by providing the game/experiment instructions to the students before class and asking them to read the instructions beforehand. To ensure students read and understand the instructions, she then started her lectures with a pre-game quiz related to the instructions. This allows her to have a guided instruction discussion to clear up any misunderstanding before the game begins and provides students who did not read the instructions beforehand with information about the game. She also strongly advises not to start the game before the instructions are completely explained. Once students have started talking, all focus on the instructor is lost and not easily recovered.

During the game, she utilizes student response systems (clickers) to collect data and answers.[7] Additionally, early preparation comes in handy when the game does not work out as planned. Having responses and prepared discussions for these situations can help create valuable learning experiences even when things do not go as expected. Finally, Lacy used prizes, such as extra credit points or candy bars to encourage thoughtful participation and motivate students to develop winning strategies for the games. Once the games are completed and before prizes are distributed, she also asked students to complete a game-ending survey during which students summarize what they have learned from the activity in a couple sentences. This provided students with time to reflect on the game outcomes and connected them to the course material. This feedback has also allowed Lacy to adjust the games/experiments and ensure that

[6] Lacy has used many different types of "widget" definitions. The first widget production attempt requested students fold a piece of paper eight times and write "ECON WIDGET" on the paper with a provided sharpie (the limiting factor was the sharpie). However, this method used a lot of paper. Other widget production attempts included folding a piece of paper four times and stapling the four corners, folding paper airplanes and writing "ECON JET" on the wing using provided sharpie, placing paperclips along the outside of file folders, and producing rice by writing "rice" as many times as possible on a 8.5 × 11 inch sheet of paper. The most successful attempt has been the airplane production.

[7] However, it is important to always have a backup plan on how the students can submit answers if the clicker system fails. For example, Lacy brings copy paper to class on game days so if the clicker system is not working as expected, students can put their answers on sheets of paper and display them at the same time. Or if a TA is available, the TA may assist in collecting answers papers and compiling data.

student learning matches her learning objectives for the activity. In game feedback and on teaching evaluations, students have commented on their enjoyment of the games and appreciate the ability to have a more hands-on learning opportunity for more challenging concepts.

2.4 Three Classroom Practices to Engage Students in Global Agriculture

Global agriculture is an important subject area in which we could usefully engage our students. Appreciation of the interconnection and a comprehensive understanding of global agriculture are imperative for students' future success in the agricultural sector. Global perspectives arise naturally within agricultural economics curricula as topics of international trade, global agribusiness, and international economic development are commonly discussed. However, without offering an authentic learning environment, it can be challenging for students to comprehend global agriculture in a real-world context. While study abroad courses/programs are popular in this context, financial barriers and time constraints might put participation out of reach for some students.

Teaching in the Department of Agricultural and Resource Economics, Na Zuo and her colleagues found ways to engage students in global agriculture while learning locally at the University of Arizona. Utilizing the Authentic Learning model (Herrington and Oliver 2000) as the pedagogical framework, they examined three practices to bring real-world authentic context to the classroom. The first classroom practice was conducted in the course *The Economics of Futures Markets,* and it was a ten-week trading simulation on the *StockTrak* platform.[8] Students were provided with $500,000 of imaginary money and executed a number of different transactions based on real-time prices. Students were also asked to identify any events that affected the price of a commodity on which they had an open position and to cite news articles detailing the event. The objective was to encourage students to connect how policy changes, trade barriers, or weather events can affect global commodity prices, building an understanding of the connectedness of global agriculture and international trade. The second intervention was launched in an agribusiness management course, where a case study on a multinational retail chain was used to guide students to practice collaborative decision making. The information and data in the case study of interest provided an authentic context that demonstrated various entry modes to global markets used in a real multinational corporation. The case study supported collaborative construction of knowledge: in a 50-minute case session, students first worked collaboratively in groups on the case questions; then all groups were invited to contribute to a class worksheet, which then guided class discussions. The third classroom practice incorporated real-world example-based instructions in a general education course on the global food economy. It created a teaching and learning environment that utilizes real-world examples, collaborate group discussions, and team projects. Based on student responses, Zuo, Josephson, and Scheitrum (2019) found that students reported an increased understanding of and interest in global agriculture after these interventions were introduced in three classrooms, respectively.[9]

2.5 The Farm Credit Fellows Program: Collaborations with Industry to Enhance Learning

The Farm Credit Fellows program at North Dakota State University is an example of increasing student engagement through unique class structure and industry collaboration. The program blends an agricultural lending class with off-campus training and learning opportunities provided by three local Farm Credit System associations. Erik Hanson asks students to examine three or four unique case studies each year as experiential learning exercises.

These case studies are based on realistic example loan applications created by the participating associations, and students make recommendations for loan approval based on historical income statements, balance sheets, and other application information. Several other case studies are included in the Fellows program's off-campus events. For example, students showcase their skills at a loan discussion

[8] Available at https://www.stocktrak.com/.
[9] All three interventions are further detailed by Zuo et al. (2019).

forum where they analyze case studies alongside loan officers and credit analysts. A case study is also used as the course's final project. Altogether, the Fellows program allows students to repeatedly apply key definitions and calculations learned in class. When tested after the course, Fellows program participants earned significantly higher scores on a financial assessment than students in the university's other agricultural finance courses. Perhaps more importantly, students have multiple opportunities to sharpen their analytical skills and technical communication abilities, and they are particularly excited when they are able to discuss the lending cases with industry professionals. These interactions allow students to gain confidence and build their professional networks prior to entering the workforce. Indeed, Fellows program alumni have strong placements at local Farm Credit System associations and banks.

3 Innovations in Online Classes and the Utilization of Online Tools

In addition to increases in class sizes, higher enrollment numbers have resulted in more online course offerings and an emphasis of online tools in higher education. In 2013, 26 percent of students at U.S. colleges and universities took at least one course online (McPherson and Bacow 2015), and four years later, this number had risen to just over 33 percent (National Center for Educational Conditions 2019). Despite their prevalence in the news, distance education courses offered by distance-only institutions enrolled only 2 percent of all undergraduate students in the United States in 2017 (National Center for Educational Conditions 2019). Students are much more likely to take online courses from institutions with a physical presence. Many land grant universities have been considering online courses as part of their curriculum because they can provide greater access and more flexibility to students. The recent COVID-19 pandemic has precipitated a further interest in considering these options, and many faculty have gotten a crash course in online teaching. Deming et al. (2015) address the effect of online courses on the extensive margin of education and ask whether online learning can affect the education cost curve. Controlling for selectivity (a proxy for educational quality), they find that institutions with more online classes have lower tuition prices. Also, in a recently published paper, Goodman, Melkers, and Pallais (2019) use data from a highly ranked MS degree program in Computer Science at Georgia Tech to provide the first evidence that student access to education via online course offerings can increase overall enrollment.

The use of online tools can take a number of forms. Even when classes are taught in traditional face-to-face classrooms, instructors increasingly use online tools and information technology. Instructors may post slides or recordings of lectures online, enable students to submit homework or receive feedback online, engage students using online economic experiments or games, assess learning outcomes using online quizzes and exams, and encourage peer-to-peer interactions on social media or online discussion boards (Allgood, Walstad, and Siegfried 2015; Picault 2019). These tools can be grouped into four different categories based on their major objectives: (1) "To promote communication and/or facilitate the exchange of information," (2) "To provide cognitive support for learners," (3) "To facilitate information search and retrieval," and (4) "To enable or enhance content presentation" (Schmid et al. 2014, p. 274). Although the use of these tools is even more prevalent than teaching an entire course online, the evidence on the effectiveness of these tools is mixed. Schmid et al. (2014) found that online tools offering students active engagement opportunities via cognitive support tools yielded the largest average effect size in student achievement, although heterogeneity in outcomes persisted. Examples of these types of tools include concept maps, simulations, wikis, different forms of elaborate feedback, spreadsheets, and word processing exercises. Although online posting of presentation tools might not have a large effect on student achievement, Borokhovski et al. (2016) found that technology-supported student-to-student interactions improved student learning significantly. Finally, Allgood et al. (2015) provide a summary of studies that address the use of online learning in economics classes. They conclude that online courses have worse learning outcomes, even after controlling for student selection. However, they also suggest that in cases where studies find no difference in outcomes (e.g., completing homework online or on paper), there may be an opportunity for instructors to adopt these as labor-saving innovations.

In summary, simply *adopting* online tools for teaching will not necessarily improve and in some cases may even worsen learning outcomes. The use of online technology needs to be purposefully *designed* and *well-integrated* with other aspects of the course and the overall learning objectives. Although some tools can be viewed as labor-saving technologies and serve as substitutes for faculty involvement, many will likely have greater benefits for students when we treat them as complements rather than substitutes to student-faculty interaction. Below, we provide three examples of innovative uses of online tools by instructors teaching in undergraduate agricultural and applied economics programs.

3.1 Interacting with Agricultural Policy—The Use of Twitter to Stimulate Student Interest and Engagement

Julianne Treme uses Twitter as a pedagogical tool to promote higher levels of thinking in both her Introduction to Economics course and 400-level Agricultural Policy course taught in the Department of Agricultural and Resource Economics at North Carolina State University. Her goal was to have students actively engage with agricultural policy by creating tweets that relate to current events and her course material. Students were asked to select an agricultural leader/organization for the assignment. They created a private account with an instructor-approved handle and tweeted a predetermined number of times per week over a series of weeks. Treme notes that the assignment can be varied depending on the length of the course/unit. For example, a student in the 400-level policy course is required to tweet a minimum of three times a week for 11 weeks. Students in an introduction to economics course are required to tweet over a shorter number of weeks to satisfy a specific class unit requirement. Each class selects a profile picture/banner to display on all Twitter accounts associated with the project and a class hashtag to easily track all course tweets. The assignment counts for between 8 and 15 percent of their final grade, depending on the length of the project, and serves as a creative alternative to a more traditional policy paper.

One of the key aspects of this assignment is that students are instructed to construct tweets from their leader/organization's perspective. They also have to be related to the course material and current events, and include links to relevant articles. Students are required to interact with other students by providing thoughtful replies to their peer's tweets on a weekly basis. This assignment therefore engages students in higher-order thinking. It works because students are not expected to respond with the "right" answer; they are extending course information as it applies to their knowledge of their leader/organization to address current events in an original way. As a result of the tweets, students develop a repository of resources that can be discussed in class.[10] The rubric Treme created provides clear guidance and outlines exemplary work related to content, interaction with classmates, and course themes. It is included in the appendix for additional context and grading. The instructor requirements associated with this assignment are: (1) initial setup of approved leaders/organizations, (2) monitoring the content of tweets, and (3) grading the tweets based on the rubric. Compared to traditional assignments, the overall time required for this assignment was similar, while the benefits to both students and the course are greater. This assignment has generated increased engagement in the classroom, greater general interest in course material, and more analytical short answer responses. Student feedback has been positive, as students have noted that they enjoyed completing this project because it was a different way to demonstrate their knowledge and a fun way to engage with the class. Students also noted that the Twitter assignment led to a deeper understanding of the material in class because they had real time examples with which to connect. Feedback frequently mentions that the shortened character requirement for tweets makes the project manageable, easier to fit in their schedule, and a great way to keep up with current events.

[10] Treme also created Twitter polls she uses as a class starter.

3.2 Use of Diverse Student Evaluation Tools

Luis Peña-Lévano teaches Quantitative Methods in Food and Resource Economics (FRE) online. This is an undergraduate, mathematic intensive core class for the FRE major, offered every semester. As the sole instructor, he imparts this course to all locations of the University of Florida. It is divided into 10 units (i.e., topics involve matrix algebra, multivariate calculus and optimization, linear programming, and integration), each of which are accompanied by an online pre-recorded lecture. To overcome the challenge of teaching mathematical tools in an online platform, he initially implemented four techniques.

Peña-Lévano's first two implemented learning tools are designed to incentivize students to watch the video lectures: (1) *Pre-labs are* a short assignment of practical problems for which solutions are included in the video lectures. (2) *Quizzes* consist of two to three questions based on similar questions to the pre-labs. These graded small tasks allowed students to gain a better understanding of where they needed to focus their efforts when studying. In addition, it allowed Peña-Lévano to detect areas for improvement. He was able to provide additional examples for a challenging unit before homework assignments were due.

Two additional approaches addressed student and instructor interactions: (3) *In-person Computer Lab Sessions* were hosted by teaching assistants, and attendance was optional. For instance, one of the units involved the use of Excel to solve mathematical problems. Students can directly address any concerns regarding software compatibility or any doubt in how to create simulations. They were able to go over examples presented in the video lectures in person. (4) *Review Sessions* were held by Peña-Lévano every two or three weeks. He directly addressed any questions students had and went over additional exercises to reinforce the learning experience. On average, 50 to 80 percent of the classes attended these sessions. While these innovations required additional time commitments, they have paid off. Learning outcomes have improved. In the course evaluations, students reported that the class is engaging and that the instructor is involved in the learning process.[11]

Peña-Lévano continues to add additional techniques. They include a *Final Mini-Project*, which is a special assignment where students needed to create a short practical problem based on one of the units of the class. It helped students to better understand the topics and use the mathematical tools and principles learned during the course to create a new problem.

3.3 Adoption of *Packback*, an AI-Assisted Discussion Board Tool

Discussion boards can provide students with the opportunity to engage with material outside of class and build on concepts they've learned in class in more open-ended and creative ways than quantitative assignments (e.g., problem sets) may allow. One new tool in the discussion board space is *Packback*.[12] This discussion board tool asks the question "What are you curious about?" Students are thus prompted to post open-ended questions, and an AI-assisted tool gives students real-time feedback on their questions. For example, if a question is too short, not open-ended or does not include a citation, the student will be prompted to edit it in real-time. The AI (or a peer or instructor) can also flag questions, and staff at *Packback* will follow up to provide guidance to the student. Peers can respond to questions and "spark" questions or responses that they find interesting, with the number of sparks serving as an indicator to an instructor of student interest in that discussion. Instructors can "pin" a question to the top of the question list or star questions to create a curated list to prompt students to engage on specific topics or to highlight exemplary questions. Instructors also have the ability to coach or praise a student and provide specific feedback on a student's post. The tool further provides an algorithm-based "curiosity score" for each student's question. This score is based on question length, use of sources and links, and readability of text. It is intended to serve as a proxy for the quality of the student's post. The built-in gradebook tool then allows the instructor to grade students by curiosity points or simple participation.

[11] Further details on these innovations can be found in a recently published article (Peña-Lévano 2020).

[12] Interested readers may learn more about this tool at: https://www.packback.co/.

Zoë Plakias and her colleague Anna Parkman recently began using *Packback* for classes offered in the Department of Agricultural, Environmental, and Development Economics at Ohio State University. Plakias adopted *Packback* in a large in-person introductory microeconomics course in the Spring of 2019. Students were required to post one question and two responses weekly. She required that questions be related to the current or previous week's class topic, and posting of questions accounted for up to 10 percent of the total course grade, based on simple participation. Exemplary questions and interesting topics raised on *Packback* were highlighted weekly in class, and posts that revealed poor understanding of concepts across many students motivated in-class clarifications of that material.

Plakias found that students engaged in vibrant discussions online on a variety of topics and shared personal stories and interests that allowed her to better tailor lectures to student interests and needs. Students also appreciated the opportunity for graded low-stakes assignments. However, she also observed significant heterogeneity in the quality of posts, with the AI unable to detect some aspects of quality. For example, incorrect statements about economics or questions with answers that could be found in the lecture slides or textbook were not flagged and were not reflected in the post's "curiosity score" and because of the large class size (125), students sometimes had difficulty providing original questions or responses. Low quality questions went unanswered entirely. In addition, the cost ($25 per semester) left some students dissatisfied, as they did not see the added value relative to the built-in discussion board tool in Ohio State's learning management system provided by Canvas.

Although the platform was relatively easy to use and its real-time prompts to students can function as a labor-saving mechanism for faculty, getting the most out of a discussion board still requires significant management time on the part of instructors. It remains somewhat unclear to what extent *Packback* actually lowers overall management time. The single best innovation of *Packback* appears to be the prompt—it encourages student-centered learning by incentivizing students to ask questions related to the class material and allows them to direct their own learning. In conclusion, Plakias suggests comparing the functionality of any built-in discussion board tools within your university's learning management system with *Packback* to ensure the benefits are worth the costs to students.

4 Conclusions

Enrollment in higher education has increased across all populations. Many undergraduate programs have started to move courses online and encourage the use of technology and online tools. The rapid move to remote instructions as an emergency response to the Covid-19 pandemic and social distancing requirements will likely accelerate these changes in the teaching and learning environment. However, these developments raise important questions regarding the quality of teaching. This article wants to encourage a thoughtful discussion of necessary innovations and provide useful tips for instructors looking to increase their teaching effectiveness in large undergraduate classes whether content is delivered online or face-to-face.

We started a discussion of how to increase student engagement and adequately prepare students for the many job opportunities in agriculture-related sectors with an organized track session at the 2019 AAEA Annual Meeting. Student engagement can be defined as a dynamic process that combines behavioral, cognitive, and emotional dimensions of learning, results in higher levels of academic achievement, and motivates students to develop life-long, self-regulated, and active learning behaviors. As a discipline, it is further essential that we attract and retain talent to careers in agriculture to be able to address the many challenges posed by labor shortages, supply chain management issues, international trade, climate change, demands for transparency, as well as overall health and environmental concerns.

The economic situation has changed dramatically since the beginning of the COVID-19 pandemic. While the downturn might affect agricultural-related sectors relatively less dramatically than other areas of the economy, new challenges will surely arise. Many of us already needed to respond quickly and not only adjust in our personal lives but also our teaching approaches. These new demands served as a powerful reminder that the development of teaching innovations can be time-consuming, and that the

implementation of ideas does not always go as planned. Student-centered learning and teaching approaches require a continuous commitment and can greatly benefit from an ongoing exchange of effective practices. We hope that by sharing purposefully designed teaching innovations and thoughtful usage of online and social media tools, we will inspire teaching scholars, faculty, and graduate students to join in our efforts to continuously design and redesign classes and curricula to better serve our students.

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Appendix: Twitter Grading Rubric

Element	Exemplary 10	Proficient 8	Partially Proficient 6	Unsatisfactory 2	Points Earned	Possible Points
Reflects Course Themes (Points x2)	The themes, ideas, and essential questions for the class are reflected in tweets. Excellent demonstration of knowledge of course content.	The themes, ideas, and essential questions for the class are reflected in most tweets but not all. Good demonstration of knowledge of course content.	The themes, ideas, and essential questions for the class are represented in less than half of the tweets and/or course content is poorly demonstrated.	No themes, ideas, or essential questions are represented in the tweets.		**20**
Content	Tweets are creatively and succinctly written to stimulate dialogue and commentary. The leader's voice and attitude are reflected in the tweets.	Most tweets are written to stimulate dialogue and commentary. Leader's voice and attitude are reflected in most tweets but not all.	A few tweets are written to stimulate dialogue and commentary. Leader's voice and attitude are reflected in some of the tweets.	Tweets are poorly written and do not stimulate dialogue and commentary. Little understanding of leader and/or leader's attitude not reflected in tweets.		**10**
Interaction Quality with Classmates	Interactions consistently provide meaningful addition to the class discussion such that interactions lead to additional tweet conversations from other classmates.	Interactions with other leaders provide a meaningful addition to the class discussion.	Some interactions and responses to tweets are negative and disrespectful, and/or interactions provide little value to the discussion.	Few interactions with other leaders and/or interactions to tweets are negative and disrespectful, and provide no value to the discussion.		**10**
Total Tweets and Frequency	Creates and sends tweets more frequently than required. (Total tweets exceeds 20 and at least 5 tweets weekly. No retweets.)	Creates and sends tweets as often as required. (Total tweets equal 20 and 5 tweets weekly. No retweets.)	Creates and sends tweets somewhat less often than required. (Total tweets between 15 and 19 and misses one week of tweeting or tweets less per week than required.)	Creates and sends tweets too infrequently to meet the requirements. (Total tweets less than 15 and/or misses two or more weeks).		**10**
Mechanics	N/A	Writes with no errors in grammar, capitalization, punctuation, and spelling.	N/A	Writes with numerous major errors in grammar, capitalization, punctuation, and spelling. (More than 5 errors per tweet).		**8**
				Points		**58**

References

Allen, I. E., and J. Seaman. 2013. *Changing Course: Ten Years of Tracking Online Education in the United States*: *ERIC.*

Allgood, S., W. B. Walstad, and J. J. Siegfried. 2015. "Research on Teaching Economics to Undergraduates." *Journal of Economic Literature* 53(2):285–325.

Barrows, H. S., and R. N. Tamblyn. 1980. *Problem-Based Learning: An Approach to Medical Education*. New York: Springer.

Borokhovski, E., R. M. Bernard, R. M. Tamim, R. F. Schmid, and A. Sokolovskaya. 2016. "Technology-Supported Student Interaction in Post-Secondary Education: A Meta-Analysis of Designed versus Contextual Treatments." *Computers & Education* 96:15–28.

Brouhle, K. 2011. "Exploring Strategic Behavior in an Oligopoly Market Using Classroom Clickers." *Journal of Economic Education,* 42(4):395–404.

Burns, C., and S. Chopra. 2017. "A Meta-Analysis of the Effect of Industry Engagement on Student Learning in Undergraduate Programs." *Journal of Technology, Management, and Applied Engineering* 33(1):1–20.

Carini, R. M., G. D. Kuh, and S. P. Klein. 2006. "Student Engagement and Student Learning: Testing the Linkages." *Research in Higher Education* 47(1):1–32.

Caviglia-Harris, J. L. and R. T. Melstrom. 2015. "Airing Your Dirty Laundry: A Quick Marketable Pollution Game for the Classroom." *Journal of Economic Education*, 46(4):412–419.

Delemeester, G., and J. Brauer. 2010. "Games Economists Play: Noncomputerized Classroom Games." *The Journal of Economic Education* 31(4):406. http://w3.marietta.edu/~delemeeg/games/.

Deming, D. J., C. Goldin, L. F. Katz, and N. Yuchtman. 2015. "Can Online Learning Bend the Higher Education Cost Curve?" *American Economic Review: Papers and Proceedings* 105(5):496–501.

Edgerton, R. 2001. "Education White Paper." http://www.pewundergradforum.org/wp1.html.

Fredricks, J. A., P. C. Blumenfeld, and A. H. Paris. 2004. "School Engagement: Potential of the Concept, State of the Evidence." *Review of Educational Research* 74(1):59–109.

Goodman, J., J. Melkers, and A. Pallais. 2019. "Can Online Delivery Increase Access to Education?" *Journal of Labor Economics* 37(1):1–34.

Helme, S., and D. Clarke. 2001. "Identifying Cognitive Engagement in the Mathematics Classroom." *Mathematics Education Research Journal* 13(2):133–153.

Herrington, A., and J. Herrington. 2006. *Authentic Learning Environments in Higher Education*. Hershey PA: Information Science Publishing.

Herrington, J., and R. Oliver. 2000. "An Instructional Design Framework for Authentic Learning Environments." *Educational Technology Research and Development* 48(3):23–48.

Johnson, D. W., R. T. Johnson, and K. A. Smith. 1991. "Cooperative Learning: Increasing College Faculty Instructional Productivity." *ASHEERIC Report on Higher Education*. Washington, D.C.: The George Washington University. https://files.eric.ed.gov/fulltext/ED343465.pdf.

Jonassen, D. H., and L. Rohrer-Murphy. 1999. "Activity Theory as a Framework for Designing Constructivist Learning Environments." *Educational Technology Research and Development* 47(1):61–79.

Kentnor, H. E. 2015. "Distance Education and the Evolution of Online Learning in the United States." *Curriculum and Teaching Dialogue* 17(1):21–34.

Kuh, G., J. Kinzie, J. Buckley, B. Bridges, and J. Hayek. 2006. *What Matters to Student Success: A Review of the Literature*. National Postsecondary Education Cooperative. https://nces.ed.gov/npec/pdf/kuh_team_report.pdf.

Lei, H., Y. Cui, and W. Zhou. 2018. "Relationships between Student Engagement and Academic Achievement: A Meta-Analysis." *Social Behavior and Personality* 46(3):517–528.

McPherson, M. S., and L. S. Bacow. 2015. "Online Higher Education: Beyond the Hype Cycle." *Journal of Economic Perspectives* 29(4):135–154.

National Center for Educational Conditions. 2019. *The Condition of Education 2019*. https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2019144.

Newmann, F. M. 1991. "Student Engagement in Academic Work: Expanding the Perspective on Secondary School Effectiveness." In J. R. Bliss and W. A. Firestone, eds. *Rethinking Effective Schools: Research and Practice*. Reno NV: Better World Books.

Newmann, F. M., and G. Wehlage. 1993. "Five Standards of Authentic Instruction." *Educational Leadership* 50(7):8–12.

Peña-Lévano, L. 2020. "Personalizing Online Classes: The Use of Evaluation and Participation Tools." *Applied Economics Teaching Resources* 2(2).

Picault, J. 2019. "The Economics Instructor's Toolbox." *International Review of Economics Education* 30(100154):1–40.

Purdue University. 2015. "Employment Opportunities for College Graduates in Food, Agriculture, Renewable Natural Resources, and the Environment United States, 2015–2020." https://www.purdue.edu/usda/employment/.

Quaye, S. J., and S. R. Harper, eds. 2015. *Student Engagement in Higher Education: Theoretical Perspectives and Practical Approaches for Diverse Populations*, 2nd ed. New York: Routedge.

Schmid, R. F., R. M. Bernard, E. Borokhovski, R. M. Tamim, P. C. Abrami, M. A. Surkes, C. A. Wade, and J. Woods. 2014. "The Effects of Technology Use in Postsecondary Education: A Meta-Analysis of Classroom Applications." *Computers & Education* 72:271–91.

Trowler, V. 2010. *Student Engagement Literature Review.* Department of Educational Research, Lancaster University. https://www.heacademy.ac.uk/system/files/StudentEngagementLiteratureReview_1.pdf.

Trowler, V., and P. Trowler. 2010. *Student Engagement Evidence Summary.* Department of Educational Research, Lancaster University. https://eprints.lancs.ac.uk/id/eprint/61680/1/Deliverable_2._Evidence_Summary._Nov_2010.pdf

Vilsack, T. 2016. "New Markets, New Opportunities: Strengthening Local Food Systems and Organic Agriculture." https://medium.com/usda-results/new-markets-new-opportunities-strengthening-local-food-systems-and-organic-agriculture-17b529c5ea90.

Wang, M.-T., and R. Holcombe. 2010. "Adolescents' Perceptions of School Environment, Engagement, and Academic Achievement in Middle School." *American Educational Research Journal* 47(3):633–662.

Zepke, N., L. Leach, and P. Butler. 2014. "Student Engagement: Students' and Teachers' Perceptions." *Higher Education Research and Development* 33(2):386–398.

Zuo, N., A. Josephson, and D. Scheitrum. 2019. "Engaging Students in Global Agriculture: Three Authentic-Learning Classroom Interventions." *NACTA Journal* 63(1a):112–120.