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Contents

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Teaching and Educational Methods

Teaching Information Literacy: A Case Study of the Ripple Effect in Teamwork

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Abstract
The purpose of this study is twofold: (a) describe a teaching case study with college students at a large U.S. university, and (b) highlight how the ripple effect enhances students' level of information literacy. An "information-literate" student recognizes the need for information and is able to locate, evaluate, and effectively use the needed information. We define the ripple effect as the knowledge acquisition through peer communication among members within a small student group. While interpersonal skills are of increasing importance in the workplace, formal incorporation of information literacy in undergraduate agricultural programs is still developing. Thus, it might be of advantage to rely on constructs of social support and active learning. Employers seek individuals with critical thinking skills and the ability to work and collaborate in teams. As a rapidly increasing portion of entry-level jobs in the agricultural industry are replaced with automation, it has become more important that undergraduate agricultural majors enter the workforce with a competitive edge and employable skills. Results suggest the ripple effect in teamwork aids to enhance the students' knowledge of agribusiness information literacy concepts.

1 Introduction

Artificial intelligence and automation in the agricultural industry continue to replace entry-level jobs. Unlike "hard skills" that are quantifiable through degrees and professional licenses, "soft skills" include teamwork, communication, and problem-solving that are not easily replicated by a computer (Noel and Qenani 2013; Society for Human Resource Management 2016). While soft skills have always appealed to employers, decades-long shifts have now made these interpersonal skills especially crucial. Soft skills are important to getting and keeping a job, as they can make the difference between an outstanding and a mediocre employee (Melendez 2019).

Agricultural companies have experienced increasing difficulties finding applicants who are able to communicate clearly, and effectively work on a team with their co-workers, limiting a company's productivity (Noel and Qenani 2013). Research shows that companies are less willing to invest in workers who do not have the soft skills to succeed in the long run, which may be one reason why hiring has lagged its pre-recession pace despite a record number of job openings (Davidson 2016). The increase in the hiring rate since the last recession has been much slower than the job-opening rate, suggesting that the labor market's problems are tied to supply issues. With the labor force participation rate at a 40-year low and employers continuing to express difficulty in finding employees with certain skills, it is likely that the hiring rate will continue to lag behind the job-opening rate (Wilson 2016). Ultimately, current market trends attribute the slowdown in hiring to employers having difficulties finding qualified workers in fields that require both cognitive and soft skills (Deming 2016; Mutikani 2018). Reversing the trend will require that college graduates are prepared with the skills they need for today's labor market (Wilson 2016). Thus, there is a need to emphasize the importance of interpersonal skills in the undergraduate agricultural curriculum (Sternhold and Hurlbert 1998; Devasagayam, Johns-Masten, and McCollum 2012; Berger 2016).

One way to teach problem-solving skills at the college level is through the construct of information literacy. An “information-literate” student recognizes the need for information and is able to locate, evaluate, and effectively use the needed information (Dunn 2002; Association of College and Research Libraries 2013, p. 2). Information literacy enhances an individual’s competency with evaluating, managing, and using information. In fact, various regional and discipline-based accreditation associations consider information literacy as a key outcome for college students (National Forum on Information Literacy 2014).

Previous research suggests that students consider searching information as more crucial than providing a critical evaluation of their findings, and less than half feel confident in their critical thinking abilities (Morrison, Kim, and Kydd 1998; National Center for Post-Secondary Education 2001). Given that market information originates from diffuse sources, it is necessary to locate, compare, and verify information from multiple outlets (Lavin 1995). With the rapid increase in new information technologies, the proficiency in navigating those novel resources becomes especially imperative (Atwong and Hugstad 1997; Benbunan-Fich et al. 2001; Karns and Pharr 2001; Dunn 2002). Information literacy skills are of increasing importance in the workplace and emphasize the need for the formal incorporation of information literacy in undergraduate agricultural programs (Lamb, Shipp, and Moncrief 1995; Morrison, Kim, and Kydd 1998; Johnston and Webber 2003; Schroeter and Higgins 2015).

To teach information literacy, it might be of advantage to rely on social support and active learning, in which the acquisition of knowledge happens in a team of students with cognitive diversity (Reynolds and Lewis 2017). We will call this knowledge acquisition the ripple effect. The ripple effect occurs during the peer communication within a student group where peers with diverse levels of knowledge teach each other when working toward a common grade on a group project. Previous studies suggest that when a high-performing student is working with a low-performing student on a team, the low performer is encouraged to improve and pick up on the skill set of their stronger peers (Topping 2008; Hunt 2017; Shellenbarger 2017). Studies have shown that the team member who takes on the teacher role reinforces their own learning by instructing the students on the team (Briggs 2013). Thus, the ripple effect may provide benefits to both the teacher and the students on the team, and they will be better off working together than they would be individually (Ravanipour, Bahreini, and Ravanipour 2015). To compare the classroom to a working environment, an individual’s work performance is based in part on the accomplishments of the coworkers. The drive and skills of employees—or students—is affected by the drive and skills of the people that surround them (Hunt 2017). As such, the ripple effect represents the transfer of information literacy knowledge that takes place when a team of peers, with diverse levels of knowledge, will motivate and teach each other.

The purpose of this study is twofold: (a) describe a teaching case study with college students at a large U.S. university, and (b) highlight how the ripple effect enhances students’ level of information literacy. Recent studies have shown that diversity on teams is important for solving high-dimensional, high-complexity problems (Page 2018). An increasing number of employers emphasize that job candidates should be prepared with information literacy and the resulting problem-solving thinking skills (O’Sullivan 2002; Karns 2005). In fact, a large-scale survey determined that more than one third of business executives rank information literacy as the most desired skill (Dunn 2002). This increased emphasis on information literacy skills highlights the opportunity for agribusiness educators to utilize the ripple effect in teamwork to achieve these desired learning outcomes.

2 Background: Teamwork Experiences

According to Harris and Harris (1996), teams are characterized as having a common goal or purpose where members can work together to develop effective mutual relationships to achieve a goal. Francis and Young (1979) identified key characteristics of a high-performing team: the team should produce higher quality work together than they could individually, and peers should use their team members’ strengths to enhance their own abilities. On one hand, teamwork and team-based learning is a valuable tool for information literacy instruction because it increases student learning and provokes problem-solving (Erdem 2009; Jacobson 2011). On the other hand, teamwork in the classroom may involve free riding, where some team members do not put in their share but rather let the rest of the team members carry the bulk of the work. Dysfunctional teams may increase student dissatisfaction because of an uneven distribution of work and poor performance (Scott-Ladd and Chan 2008). Hillyard, Gillespie, and Littig (2010) show that students who had past negative experiences with teams were wary of group projects and seemed to bring animosity toward future teamwork.

Kline's (1999) team player inventory (TPI) is one way to measure positive and negative teamwork experiences. The Kline TPI is a set of ten questions split into five positive and five negative statements dealing with teamwork. Table 1 displays the ten statements of the Kline Team Player Inventory.

In completing Kline's (1999) TPI, a student ranks agreement with each of the ten statements using a scale that ranges from *strongly disagree* to *strongly agree*. The positive statements are scored traditionally, while the negative statements are reversely scored. The sum of these ten questions is taken to generate a TPI score ranging from 10 to 50 points. The higher the TPI score, the more an individual enjoys working in teams and believes that teamwork is beneficial. A score between 10 and 20 points is rated a low preference for teamwork, a medium rating of 21–39 points is expressed as a moderate preference for teamwork, and a TPI above 40 points shows a strong preference for teamwork. A higher TPI score may indicate that the individual enjoys working in teams and that teamwork is beneficial. Using the TPI as a measure of student's interest in teamwork, French and Kottke (2013) found that when team members had similar personalities, TPI was a predictor of teamwork satisfaction. Kline's TPI is internally consistent and has been shown to be a valid tool for measuring teamwork constructs (Ilarda and Findlay 2006).

Table 1: Kline's Team Player Inventory (TPI) Statements

	Statements	**Strongly Disagree**				**Strongly Agree**	**Positive or Negative Statement**
1.	I enjoy working on team/group projects.	1	2	3	4	5	+
2.	Team/group project work easily allows others to not pull their weight.	1	2	3	4	5	-
3.	Work that is done as a team/group is better than work done individually.	1	2	3	4	5	+
4.	I do my best work alone rather than in a team/group.	1	2	3	4	5	-
5.	Team/group work is overrated in terms of the actual results produced.	1	2	3	4	5	-
6.	Working in a team/group gets me to think more creatively.	1	2	3	4	5	+
7.	Teams/groups are used too often when individual work would be more effective.	1	2	3	4	5	-
8.	My own work is enhanced when I am in a team/group situation.	1	2	3	4	5	+
9.	My experiences working in team/group situations have been primarily negative.	1	2	3	4	5	-
10.	More solutions/ideas are generated when working in a team/group situation than when working alone.	1	2	3	4	5	+

2 Methodology

Isolating the ripple effect that may enhance students' information literacy skills involves developing a measurement instrument that accounts for a baseline (pre) and an acquired (post) information literacy skill set.

2.1 Data Collection

We conducted our research at a large (>15,000 students) public university in the Western United States. Each academic year is divided into terms of four quarters that each consist of ten to eleven weeks: Fall (September through December), Winter (January through mid-March), Spring (April through June), and Summer (mid-June through the end of August). We chose an introductory undergraduate agricultural marketing course as a convenience sample. This course selection had several advantages: (1) information literacy skills form a critical component of the course, (2) multiple sections of the course take place during the same term, (3) a wide variety of majors attend the course, given that it is an introductory service class, and (4) the course serves as a prerequisite for most agribusiness classes in the College of Agriculture, Food, and Environmental Science.

Students who need this class as a prerequisite may choose to take this class during their sophomore year, while others may take it during their senior year. For the latter group, this agricultural marketing class might be the only one they take during their college career. Information literacy is an important concept in introductory agricultural marketing classes, given that students are expected to assimilate knowledge and then apply it in subsequent upper-division classes that build on this knowledge. Prior to conducting the research, we obtained the University's Institutional Review Board approval that this study was exempt. Our online surveys did not offer the students any incentive to participate. We collected data from twelve sections of the marketing class over seven quarters. Two instructors with similar teaching styles and identical final projects shared the teaching load of this class. We pretested the survey multiple times in a classroom setting with a small sample of respondents (15–30 participants) to identify and eliminate potential problems. Just as with the final survey, the responses from the pretest were coded and analyzed.

2.2 Measurement Instruments

We collected data at two points in time during the course of one teaching term: at the beginning of the term through a pre-course survey, and then again at the end of the term after completion of the information literacy instruction via a post-course survey. We matched pre- and post-surveys using randomly generated respondent identification numbers.

Our measurement instruments included subjective and objective measures of student learning. Subjective learning was measured via self-assessments where students rated their ability at achieving information literacy objectives. These subjective learning questions were developed from the *Higher Education Information Literacy Standards* (Association of College and Research Libraries 2013). Students rated their abilities on a 5-point scale with endpoints ranging from *needs significant improvement* to *excellent*. Table 2 shows the detail of this subjective knowledge question.

In addition, our survey included objective measures of student learning. We used a series of multiple-choice questions to test the student's ability to locate specific types of information using key databases that students were exposed to during instruction (e.g., Mergent Online, MRI Mediamark, Market Share Reporter). See Table 3 for an example of an objective knowledge survey question.

To supplement the two measures of student learning of information literacy, we assessed each student's predisposition to teamwork, as measured by Kline's TPI. Furthermore, we collected information about each students' university standing, number of credit hours during the term taken by each student,

Table 2. Subjective Knowledge Survey Question

"Assume you are doing an agribusiness marketing class homework assignment that requires you to find information about food marketing. How would you describe your ability to achieve each of the following?"

Survey Question	Needs significant improvement				Excellent
1. Know when information is needed	1	2	3	4	5
2. Know the type of information needed	1	2	3	4	5
3. Locate needed information	1	2	3	4	5
4. Determine if the sources are of high quality	1	2	3	4	5
5. Effectively use information you have found	1	2	3	4	5
6. Properly reference sources	1	2	3	4	5
7. Use the library's online sources	1	2	3	4	5

and gender distribution. To increase the explanatory power of the findings with regard to student learning, we collected information about each student's grade point average (GPA, measured on a 4.0 scale), following Bacon and Bean's (2006) suggestion of using GPA in marketing education research studies.

2.3 Design and Procedures

To determine the impact of the ripple effect on students' information literacy, a final agricultural marketing team project served as the vehicle to teach and assess information literacy. At the beginning of the course, students self-selected into groups of three to five members. The student teams completed the final project to gain applied information search experience and to develop their critical thinking, written and oral presentation skills.

Our dedication of additional time and resources to the final course project was fueled by the desire to improve the use of academic library resources. Previous research suggests a perceived barrier to getting students to access the library resources in order to perform their research project (Macklin 2001; Dugan and Fulton 2012).

Table 3. Example Questions Used as Measures of Objective Learning of Information Literacy

Question	Answer Choices	Correct Answer
1) Which database would you most likely use to determine a product's parent company?	a) Hoovers b) U.S. Census c) MRI+ Mediamark d) Gale Marketshare Reporter e) I do not know, uncertain	a) Hoovers
2) What database would you most likely use to determine food industry trends?	a) MRI+ Mediamark b) U.S. Census c) MarketResearch.com d) Gale Marketshare Reporter e) I do not know, uncertain	a) MarketResearch.com
3) Which resource provides indices that show the likelihood of a consumer to purchase a certain product?	a) First Research b) Hoovers c) ABI/Inform d) MRI+ Mediamark e) I do not know, uncertain	b) MRI+ Mediamark

Table 4. Library Course Guide

Category	Resource
Company Information	Mergent Online ABI Inform Wards Business Brands and Their Companies
Industry Information	Mergent Intellect-First Research Mergent Online
Market Research and Consumer Demographics	Market Share Reporter MRI Mediamark Factiva Global Market Information Database: GMID US Census
Product Information	USDA National Nutrient Database
News and Data	ProQuest Newsstand LexisNexis Academic Google News USDA Economic Research Service

Instead of just sending the students to the library to complete their information search for the final project, we set aside a full two-hour class for a crash course on key marketing databases. The two-hour class aimed to ensure that each student could learn how to effectively access the necessary databases to complete the final term project. Thus, the course project created a symbiosis between essential agricultural marketing research skills and the library's information assets. Table 4 displays the list of library course guide databases assigned to the students to retrieve the necessary data to complete the final term project.

The project asked the student groups to analyze the marketing and supply chain of a branded food product. Each student team prepared an analysis showcasing the strengths, weaknesses, opportunities, and threats (SWOT) of the product's performance in the agribusiness marketplace, backed up with facts, including sales and market share information. In addition, student teams defined the product's target market and recommended changes to the marketing mix.

Overall, the final project honed information literacy skills by requiring the use of agricultural marketing information databases. Student teams recommended changes to the marketing mix based on the food product's performance and trends in the agribusiness marketplace. At the end of the course, the project was submitted as a two-page infographic, complemented with a short team presentation to the class (Schroeter and Higgins 2015).

3 Results

Table 5 shows the results from the survey, with regard to demographic, academic, and Kline's TPI information. Within the sample of 544 students across twelve sections of the agricultural marketing class, 139 teams formed to work on the final information literacy project. Given the total class enrollment of 600, this leads to a response rate of 90.67 percent. Of the 544 students sampled, 50.74 percent were female, consistent with the gender breakdown in the college's enrollment (California Polytechnic State University Enrollment UGRD GRAD Profile 2016).

Students in the sample spanned from freshmen to seniors. However, juniors and seniors largely dominated this sample, at 44.68 percent and 26.60 percent of the group, respectively. Sophomores

Table 5. Teamwork, Academic, and Demographic Information

Variable	Categories	(*n* = 544)
	Teamwork	
Response rate	Enrollment	600
	Response Rate	90.67%
Number of teams		139
Kline's TPI (0–50)	≥40	15.81%
	21–39	82.17%
	0–20	2.02%
Final project grade		82.21%
Average Correct Information Literacy Questions	Pre-survey	30%
	Post-survey	61%
Average Self-Rated Information Literacy Ability (out of 5)	Pre-survey	3.61
	Post-survey	4.12
	Academics	
Academic standing	Freshmen	3.19%
	Sophomore	25.53%
	Junior	44.68%
	Senior	26.60%
Average credit hours during quarter		15.39
Required course		88.05%
Agribusiness Major		59.01%
GPA	3.51–4.00	9.01%
	3.01–3.50	27.39%
	2.51–3.00	42.28%
	2.01–2.50	16.73%
	Less than 2.00	2.02%
	Demographics	
Gender	Male	49.26%
	Female	50.74%

represented 25.53 percent of the sample, while freshman represented just 3.19 percent of the sample. This undergraduate food and agricultural marketing class was required for 88.05 percent of the students in the class, and the majority of the students majored in agribusiness. The average GPA of the students in the sample was 2.89 prior to the start of the course. The majority of students had a GPA between 2.51 and 3.00, with the second highest group showing GPAs between 3.01 and 3.50.

In the pre-survey, students scored low on the objective portion, which was consistent with their initial lower ratings of information literacy ability. Students averaged 30 percent correct answers on the objective knowledge questions. The post-survey showed that by the end of the quarter, scores increased to 61 percent correct responses, a statistically significant difference ($p = .000$). Along with the objective knowledge increase, the subjective knowledge increased. The self-rated information literacy ability showed a significant increase with an average pre-survey value of 3.61 (out of 5), and the average post-survey ability of 4.12 (please see table 2 for details about the question and end points).

Kline's TPI measures the extent to which an individual group member is positively or negatively predisposed to teamwork. The average student TPI was 33.74 (out of 50), which indicates a moderate preference for teamwork. The majority of the students (82.17 percent) had a TPI between 21 and 39, while 15.81 percent of the students scored a TPI greater or equal to 40, showing a strongly positive attitude toward teamwork. Only 2.02 percent scored a TPI lower than 20, which means a negative predisposition toward teamwork. Table 6 shows the average scores on each of Kline's TPI statements.

The two statements that ranked highest were positive statements, where both of the statements assessed the creative nature of teamwork. With an average score of 4.15 out of 5, the statement "More solutions/ideas are generated when working in a team/group situation than when working alone" ranked highest. The statement "Working in a team/group gets me to think more creatively" ranked second, with an average score of 3.77. Students rated two negative statements lowest, with the bottom statement implying the free rider issue of teamwork "Team/group project work easily allows others to not pull their weight" with a value of 2.0.

The post-survey asked students to rate their perceived influence of various course resources on their individual acquisition of information literacy knowledge. Using a 5-point scale, where 1 = *not at all influential* and 5 = *extremely influential*, students rated how much various class elements contributed to their learning of information literacy: library course guide session on the databases, final course project, course assignments, and prior experiences. Students rated the final course project and the assignments as the most influential aspects with regard to their acquisition of information literacy knowledge. Out of a total of 5 points, the course project was rated as the most influential element with an average score of 4.33, with the course assignments rated as 4.01, and the library database session at 3.83.

4 Limitations and Directions for Future Research

It is typical for a single instructor to show variations in energy, mood, and level of knowledge between terms, and possibly even weeks of instructing a single course. Thus, while we attempted to standardize the class instruction, there was a natural variation within the class due to the two instructors' different personalities. Another potential limitation is that we do not know whether individually assigned projects would have led to similar results. Thus, one direction for our future research could compare the level of information literacy acquired through individual versus teamwork.

We provide a unique contribution to the literature by providing a teaching case study and collecting data to assess how to enhance information literacy in agricultural marketing research. The availability of

Table 6. Kline's TPI Statements (Average = 34, *SD* = 6.16)

Kline's TPI Statement	Mean (*SD*)
More solutions/ideas are generated when working in a team/group situation than when working alone.	4.15 (*0.88*)
Working in a team/group gets me to think more creatively.	3.77 (*0.94*)
Team/group work is overrated in terms of the actual results produced.	3.65 (*0.99*)
My experiences working in team/group situations have been primarily negative.	3.63 (*1.07*)
I enjoy working on team projects.	3.53 (*1.02*)
My own work is enhanced when I am in a team/group situation.	3.33 (*0.99*)
Work that is done as a team/group is better than work done individually.	3.30 (*0.94*)
Teams/groups are used too often when individual work would be more effective.	3.18 (*0.98*)
I do my best work alone rather than in a team/group.	2.72 (*0.96*)
Team/group project work easily allows others to not pull their weight.	2.00 (*1.03*)

this information will guide utilizing teamwork in student learning of information literacy. Future research opportunities may explore the role of team dynamics on information literacy in order to understand the contexts that contribute to the success of one team versus another.

5 Conclusions and Implications

Our study presents a unique contribution to previous research in three areas: first, our study presents a case study of utilizing teamwork with college students. Based on their TPI scores, students indicated an overall positive predisposition to teamwork, indicating the creative problem-solving nature of teamwork. Student teams with varying backgrounds, skills, and learning abilities might provide a working environment that poses a greater opportunity to learn from one another. Furthermore, this group work setting might be more effective than other course elements, resulting in each student improving their knowledge of the assigned course work. Students indicated that the final group project was most influential in contributing to their information literacy skills. Compared with the pre-course survey, students doubled the percentage of correct project knowledge questions on the post-course survey. This finding confirms past research that suggests that students benefit by learning directly from a peer because of the created team learning environment functioning as a constructive and supportive way to enhance learning and inner motivation (Nielsen, Johansen, and Jørgensen 2018). High-performing students may benefit by reinforcing their own knowledge by instructing lower performers in the group (Fuchs, Fuchs, Hamlett, and Karns 1998; Briggs 2013). The added exposure of the peer communication relationship creates an additional tool for students to increase their information literacy skills. Hanken (2016) suggests that peer learning is beneficial for students in higher education, especially when applied to a real-world learning opportunity.

Second, our study emphasizes the potential of group work to improve information literacy and learning outcomes, with the goal to make agribusiness students more employable and competitive in a working environment. Paired with the final project on information literacy, teamwork may be an additional tool to enhance critical thinking—a valued skill among new hires. When students work together, they take part in cultivating a shared acceptance of a common goal and in joint problem-solving (Gaunt and Westerlund 2013; Nielsen, Johansen, and Jørgensen 2018). The ripple effect may advance the positive impact of teamwork even further, demonstrating the impact of teamwork on an individual's level of information literacy. Critical thinking, group collaboration, and problem-solving are among the most desirable traits for new hires in the agribusiness labor market (Noel and Qenani 2013). Employers could take advantage of this finding because teamwork serves as an additional tool to enhance other valuable skills. Consequently, to prepare a strong applicant pool, it is necessary for college students to evolve and learn information literacy skills to keep up with industry standards.

Third, with the digital age consuming students in full force, employers and educators have expressed a need for individuals to understand the quality, credibility, and effectiveness of the information they are finding (Korobili and Tilikidou 2005; Blaszczynski, Haras, and Katz 2010; Devasagayam, Johns-Masten, and McCollum 2012). Today's social media and other sources present the idea of "fake news," which often deceives students by passing as authentic information. Popular search engines, such as Google, customize searches, which filter results based on what you are more likely to click rather than what the most common results are for the particular search (Pariser 2012). Therefore, learning soft skills such as information literacy, is crucial to prepare students to evaluate and analyze the plethora of information that is available to them.

Given the nature of our study, the data provides the grounds for worthy discussion about the role of information literacy in undergraduate agricultural education and the teaching methods that may enhance critical thinking. Employers in the agribusiness industry seek individuals with strong critical thinking and good communication skills, and those who can effectively work with teams (Boland and Akridge 2004; Travis 2011; Noel and Qenani 2013; Berger 2016). These skills even surpassed some of the most sought-out tools agribusiness undergraduate programs tend to focus on, including knowledge of markets, accounting, finance, and even internship or work experiences (Boland and Akridge 2004). Teamwork, the third most in-demand job skill (Berger 2016), reinforces the relevance of our research in regard to the competency of new hires. Working with others is a desired skill at all aspects of every job; no matter the industry, function, or level of superiority, teamwork remains to be at the core of operation (Travis 2011; Berger 2016). Strengthening the information literacy skills of undergraduates' in conjunction with teamwork will give students the opportunity to market themselves as a competitive perspective employee in the job market.

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Teaching and Educational Methods

Facilitating Higher Order Learning: Examining Student Outcomes after a Course Redesign

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Abstract
We study student learning outcomes following the redesign of an undergraduate macroeconomics course. Changes were made to focus students' learning efforts and time in-class on the application and analysis of key concepts. To evaluate changes to student learning outcomes, we use thirteen questions that appeared on final exams both before and after the redesign. The analysis shows that after the redesign student performance on application and analysis questions improved, while performance suffered on memorization and understanding questions. With this paper, we provide a description of our experience and method for others to use in assessing changes in performance after redesigning a large, introductory-level course.

1 Introduction

Despite research that suggests student learning and engagement outcomes improve with a variety of instruction styles, the majority of introductory economics courses are taught using a standard lecture format (Lage, Platt, and Treglia 2000). Surveys of academic economists teaching undergraduate courses at postsecondary institutions in the United States find that more than 80 percent of instructors use traditional chalk-and-talk lectures for instruction in introductory courses (Watts and Becker 2008; Watts and Schaur 2011; Goffe and Kauper 2014). This is a high percentage, particularly when compared with other disciplines where just over half of the instructors use the customary lecture format (Cashin 2010). Across fields, the evidence on the value of varying teaching styles and active learning is abundant, challenging traditional instructor-centered teaching-by-telling methods (Bonwell and Eison 1991; Prince 2004; Freeman et al. 2014). Considering nontraditional, nonlecture-based instructional methods, recent research finds evidence of improved student performance, measured by higher test scores and overall exam performance (DeNeve and Heppner 1997; Brooks and Khandker 2002; Nguyen and Trimarchi 2010; Caviglia-Harris 2016), as well as greater interest in the discipline (Johnston et al. 2000; Lage et al. 2000; Jensen and Owens 2001; Hawtrey 2007; Yamarik, 2007).

Little research has quantitatively evaluated active learning and similar methods within the agricultural and applied economics classroom. Investigation into these techniques is important, particularly for introductory and/or survey courses in the field. These courses often provide the opportunity to instruct students in their first (and sometimes only) economics course; this opportunity should influence the objectives of the course. In these contexts, specific attention must be paid to what we want students to learn, what we want students to understand and be able to apply, and what we want students to walk away with at the end of the course. In this paper, we work in this context to provide evidence on student learning as measured by exam performance. We contribute to the literature on applied economics instruction by examining changes in student learning outcomes from modifications to course objectives and teaching styles to emphasize practice, learning-by-doing, application, and analysis. As such, we add to the conversation on pedagogy and related teaching effectiveness, and further comment on service instruction within the agricultural and applied economics profession. We also provide a description and method for assessing changes in performance after redesigning a large, introductory-level course for other instructors. This description is particularly relevant for courses that rely on often coarse, multiple-choice questions for evaluating student learning outcomes.

We examine “the redesign,” which we define as the changes made to a large-enrollment macroeconomics introductory course. The objective of the redesign was to shift learning outcomes toward the higher order taxonomic dimensions of application and analysis from lower order taxonomic dimensions of memorization and understanding (Anderson, Krathwohl, and Bloom 2001). This shift was motivated in part by the population taking the class: most students were neither agricultural economics nor economics majors, and likely would not take another economics class in their collegiate career. Therefore, the primary objective of the course was to help students develop economics application and analysis skills that could be later used in life, beyond the classroom. We rely on the revision of Bloom’s cognitive taxonomy by Anderson et al. (2001), which emphasizes knowledge across all cognitive levels: factual, conceptual, procedural, and metacognitive. In the redesigned course, we work across these cognitive levels and build within taxonomic domains; this not only relegated memorization as a skill, but also prioritized conceptual knowledge in analysis and application over factual knowledge (Allgood and Bayer 2017).

The redesign was completed for an introductory course, with a large number of enrolled students as nonmajors. Outside of this context, when teaching students within the major, instructors often perceive a curricular responsibility to teach disciplinary language and practice foundational concepts and skills. This helps students build field vocabulary and supports students’ ability to demonstrate elaborate thinking in upper-division economics courses. In an introductory course for nonmajors, a more flexible set of objectives is permitted focused on application and analysis of economic concepts and broad ideas (Sundberg and Dini 1993; Knight and Smith 2010; Hurney 2012).

To capitalize on the context, the course redesign modified both course objectives and presentation of course content. The redesigned course emphasizes “doing” instead of “knowing,” focusing on engaging students by encouraging them to practice using macroeconomic tools. This focus shifted course structure from twenty-eight 75-minute lectures to a four-module structure with fewer in-class professor-led meetings. Modules were composed of related context and include lectures, independent quizzes, group in-class projects, a brief essay, and module exams. This arrangement represented a partial “flip” of the course (Roach 2014). After the redesign, in-class lectures were shortened, and students were expected to take on independent learning. This involved learning the basics about data and models through textbook readings and short videos edited from past recorded lectures. Though the structure of the course changed, the topics presented and the associated learning objectives did not. Detailed information about the course, including specific examples of assignments, are presented in Josephson et al. (2019).

To examine how these course modifications changed student learning outcomes, we examine student performance on exams. We focus the analysis on thirteen questions that appeared on final exams both before and after the redesign. Of these thirteen questions, six were categorized as elements of lower-order taxonomic dimensions and seven were categorized as elements of higher-order taxonomic dimensions. Using these questions allows us to directly compare performance before and after the course redesign to evaluate how the course changes influence learning as mapped directly to course objectives within higher- and lower-order taxonomic dimensions.

In this paper, we provide evidence on how student learning outcomes change following modifications to an introductory course that created a new emphasis on higher-order learning. We also comment on what students may take away from applied economics courses. Though a course may use its resources well, the structure of the course including objectives and their presentation determines what students take from the class, as well as how they apply that evidence—beyond the classroom. In this paper, we hope to encourage instructors to evaluate what students learn from their courses. We also provide a description and method for doing so. Evaluation and reflection can help instructors to determine if appropriate objectives have been set for their students and if their emphasis is in line with these objectives.

2 Data and Methodology

Our analysis relies on student-level data that were collected before and after the course redesign. Demographic information and student performance data are used from the following semesters: spring 2012, fall 2012, fall 2013, spring 2014, and fall 2014.[1] IRB approval was obtained for use of these data. The course redesign occurred during the spring of 2013 and was implemented in fall 2013. Data from the spring 2012 and fall 2012 semesters were coded as pre-redesign, and fall 2013, spring 2014, and fall 2014 data were coded as post-redesign. Importantly, despite the redesign, all courses were taught by the same professor, and so professor-level effects are likely to be the same across semesters.

2.1 Population and Demographics

Enrollment in the course ranges from 220 to 400 students per semester. A majority of students (72 percent) are in their first or second years of college. Very few students are agricultural and applied economics or even economics majors (9 percent). Only half are enrolled in the College of Agriculture. The course satisfies a social science requirement for most colleges at the university, and the majority of enrolled students take the course to fulfill this requirement. By and large, the course is the first and only economics course that students take at the college level.

Student demographics are presented in Table 1. Figures are presented for students' year in school (i.e., freshman vs. nonfreshman), major (i.e., economics or applies economics vs. all other majors), international status, and underrepresented minority (URM) status. Of the 1,413 students included in our sample, 596 were freshman (42.6 percent), 127 were economics or applied economics majors (8.99 percent), 132 were URMs (9.4 percent), and 88 were international students (6.2 percent).

Table 1. Demographics of Total Sample (*N* = 1413)

Demographic	***N*** (Percent of Sample)
Underrepresented minorities (URM)	132 (9.4%)
International students	88 (6.2%)
Freshman	596 (42.6%)
Agricultural, Applied, or General Economics Major	127 (8.99%)
Demographics not reported	13 (0.9%)

[1] To balance the amount of data from before and after the redesign and to avoid effects that may be created from long-term learning on the part of the instructor, teaching the course over multiple semesters and years, we only use data through the fall of 2014, though data collection continues.

2.2 Final Exams and Student Performance Data

Of interest in this paper are student performance data. We measure student performance through responses (a binary response: correct or incorrect) to final exam questions. Final exams both before and after the redesign were given during the university's finals week. The weight of the exam and number of questions on the exam shifted slightly: before the redesign, there were sixty questions on the exam, though after there are fifty questions on the final exam. Also, before the redesign, all exams in the semester were 60 percent of the grade, while after they are worth 50 percent. This includes the final exam, which was 30 percent of the grade before the redesign, and after is worth 20 percent. Although exams are potentially a high stakes tool for measuring student learning outcomes, most students would be familiar with the format and type of questions—as well as some of the specific questions themselves—because they appeared as part of the homework study questions.[2] These questions are intended to serve as a study tool and can be repeated and practiced many times by students. Thus, although the environment of the exam may be inherently a high stakes format, the questions should be familiar to most students, in both style and content.

The format of exams did not change; exams are composed of multiple-choice questions with questions progressing by order of topics within the course, although questions are not presented in a set order. To evaluate changes in student learning outcomes, as a result of the redesign, we began with an initial set of twenty-two questions, which were asked at least one semester before and one semester after the redesign. To ensure that the questions were coded appropriately, questions were distributed to three external content experts for evaluation in validity and mapping to a taxonomic dimension. Using formal classification (Rovinelli and Hambleton 1977), reviewers were asked to rate the face validity of each question on a 3-point rating scale (3 = item is valid and correctly classified, 2 = uncertain, 1= item is invalid and incorrectly classified). Then, to determine alignment with the instructor's mapping of test questions to course outcomes, evaluators were also asked to assign each question to a dimension of Bloom's cognitive taxonomy, following the Anderson et al. (2001) redesign. The dimensions *remember* and *understand* are classified as lower-order; *apply*, *analyze*, *evaluate*, and *create* are considered higher-order classifications.

These evaluation criteria resulted in the exclusion of several questions from analysis.[3] Inclusion required that no item receive a single invalid rating (2 questions eliminated), and all items received at least 2 valid ratings (1 question eliminated). As the authors classified questions into higher or lower-order dimensions of Bloom's taxonomy, inclusion also required agreement of at least two raters with author classification (6 questions eliminated). The remaining thirteen questions comprise the unit of analysis outcomes for student learning in the course. The appendix includes details on the thirteen questions considered in the analysis, including the question itself, the correct answer, the semesters in which it was included on the final, the taxonomic dimension, and the order (higher or lower) classification.

2.3 Methodology

To evaluate changes in student learning outcomes, we compare performance on the thirteen individual exam questions by measuring the number of students who answered the question correctly before and after the redesign. Because exams are multiple choice, students either answered the question correctly or incorrectly. To evaluate the impact of the redesign, we measure whether the number of students who answered the question correctly increased, decreased, or stayed the same.

[2] More information available in Josephson et al. (2019) about the specific assignments and relationships between questions across assignments.

[3] All of the questions that were invalidated by this process (nine of twenty-two questions) were all macroeconomic questions. In the review process, reviewers disagreed on the typology, as well as on the validity of the questions. As a result, these questions are excluded from our analysis, making the course content to appear more of an introductory general economics course, though it is a macroeconomics course.

To evaluate the statistical differences, we use t tests and chi-squared tests, testing the change in mean performance after the redesign, compared with before the redesign (where μ represents the sample mean: $\mu_{after} - \mu_{before} = 0$ and $\mu_{after} = \mu_{before}$). These tests allow us to evaluate the changes in average student performance on final exams, before and after the course redesign.

3 Results

Of the thirteen questions, six were categorized as lower-order taxonomic dimension questions, while seven were categorized as higher-order taxonomic dimension questions. We find that students perform significantly worse on four out of six of the lower-order questions after the course redesign. Additionally, students did not perform significantly better on any lower-order questions post-redesign. We find that students perform significantly better on three out of seven of the higher-order questions, but significantly worse on one out of seven of the higher-order questions. Two lower-order and three higher-order questions showed no significant change. These changes are presented in Table 2 and Figure 1.

Discussing these results in more detail, we see that only the memorization and understanding questions showed a significant decrease in performance. Specifically, those questions that asked about events in history showed the greatest decline in student performance. This is attributable to the change in emphasis on higher-order learning and to the conceptual versus factual knowledge levels. As an example, consider question 11 (see the Appendix), which asked: "Among the causes of the 'Great Moderation' of the 1980s, 1990s and 2000s were…," with four choices listing various causes. Before the redesign, a list was presented in lecture with the correct answer explicitly stated and thus the answer to this question could have been memorized. After the redesign, this information was not explicitly presented in the same way,

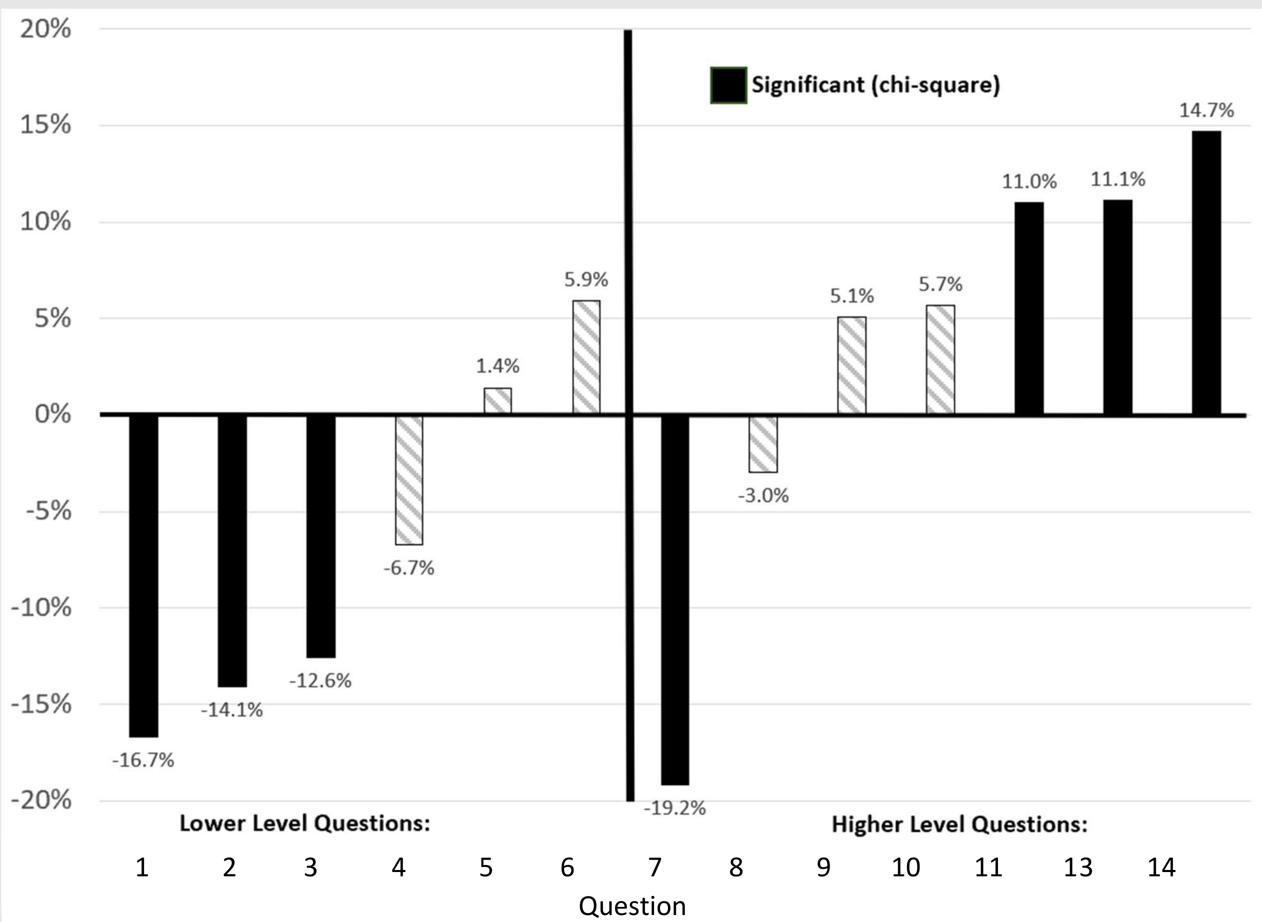

Figure 1: Change in Student Performance on Exam Questions Before and After Redesign

Table 2. Question-Level Change in Student Performance After the Redesign

Question[a]	Order Classification	Sample Size (N)	Chi-squared (p value)	t statistic (p value)	Marginal Change in Student performance[b]
10	low	532	22.4 (<.00001)	-4.59 (<.00001)	-16.7%***
11	low	1,192	25.4 (<.00001)	-5.00 (<.00001)	14.1%***
12	low	1,413	47.9 (<.00001)	-7.15 (<.00001)	-12.6%***
160	low	1,047	6.1 (.013)	-2.61 (.009)	-6.7%***
112	low	587	0.1 (.731)	0.34 (.731)	1.4%
75	low	570	2.2 (.142)	1.47 (.141)	5.9%
98	high	936	47.8 (<.00001)	-6.08 (<.00001)	-19.2%***
53	high	570	0.8 (.359)	-0.91 (.362)	-3.0%
100	high	1,047	2.3 (.127)	1.51 (.131)	5.1%
106	high	826	3.11 (.078)	1.74 (.082)	5.7%
34	high	826	11.5 (.0007)	3.32 (.0009)	11.0%***
156	high	826	11.5 (.0007)	3.32 (.0009)	11.1%***
101	high	1,047	41.0 (<.00001)	5.58 (<.00001)	14.7%***

[a] See the appendix for question text and descriptions.
[b] *** indicates statistical significance at the 1% level of significance.

but instead requiring outside reading or watching instructor-created videos. This change in presentation and new requirement of outside reading seems to have resulted in a decline in student performance, with the percentage of students answering this question correctly falling by 14.1 percentage points.

With this performance decline, a natural question arises: are students doing this work outside of class? We consider two additional questions that appeared on exams: the first whose answer is presented both in an online video and in the textbook, and the second whose answer comes directly only from the textbook. We consider performance on these exam questions relative to the overall test average. This allows us to consider a measure of how students are dealing with different material, which is only presented outside of class, without our direct observation. The first question considered is about the functions of money.[4] On average, 89 percent of the students answered this question correctly, while the average score on the exam was 75 percent. This question is not one which could be answered analytically. So, students either already knew the answer, guessed correctly, or they learned it from the reading or the video. The second question is about Social Security and again could not be answered analytically. In this case, 92 percent of the students answered correctly. Again, this suggests that students either knew the answer already, guessed correctly, or did the reading. These two questions anecdotally suggest that students do the assigned reading and interact with videos and other learning material outside of class. This indicates that there may be something in some questions, such that without additional instructor-led discussion, students have difficulty effectively using what they have read in an exam context.

Given the course objectives, of particular interest is the finding that the application and analysis questions saw significant improvement. These questions generally asked about historic events, but the events were phrased as "natural experiments" so as to practice the application of the model. For example, question 34 (see Table 2) asked: "During the 1970s OPEC oil producers cut their crude oil exports, which increased oil prices. Which diagram shows the results of this restriction?" Students chose one of four aggregate demand and supply diagrams. To answer the question, students would have to know that aggregate supply depends on resource costs, and that a rise in resource costs would decrease aggregate supply. Then, they would have to recognize which of the diagrams showed a decrease in aggregate supply. This type of multiple step analysis was frequently undertaken in the redesigned course, as course resources were shifted to practice the use of the model for economic analysis. Students would spend time in class working through these types of problems. While before the redesign, practice would have been required outside of class, in the redesigned format, time was also allocated in class for explicit practice and student collaboration in this practice. It is therefore encouraging and suggests that these teaching methods were effective, as after the redesign the percentage of students answering this question correctly rose by 11 percentage points.

4 Discussion

To further understand these results and their implications for student learning and related outcomes, we turn to Bloom's cognitive taxonomy and the common struggle between content curation and active learning. Bloom's taxonomy is in frequent evolution, as in Anderson et al. (2001) who incorporates a knowledge dimension. The taxonomy represents a series of increasingly cognitively challenging skills for students and a workable framework for instructors when considering the type of thinking they wish students to model upon successful completion of their courses (Athanassiou, McNett, and Harvey 2003; Scully 2017). For this course redesign and for other instructors hoping to redesign their courses, the classification of learning outcomes on Bloom's taxonomy provided transparency that helped the instructor incorporate active learning more frequently into the class (Winkelmes 2013).

Even as faculty and instructors desire greater critical thinking skills from their students (Myers 2008), many instructors remain reluctant, if not overtly resistant, to prioritizing class activities that would foster more cognitively demanding skills like those in the taxonomic dimensions of analysis, application, and evaluation. For some, eschewing lecture can reduce the rigor of the course (Calkins and Light 2008), while sometimes it is perceived that content is king, and time is simply not available for any active learning activity, regardless of the intended course outcomes (Onosko 1991; Henderson and Dancy 2007; Miller and Metz 2014). Unfortunately, this paradigm dominates in what has been labeled "The Cult of Content"

[4] The video for this topic is fairly well watched, ranking seventeenth, among fifty-one videos, in number of plays.

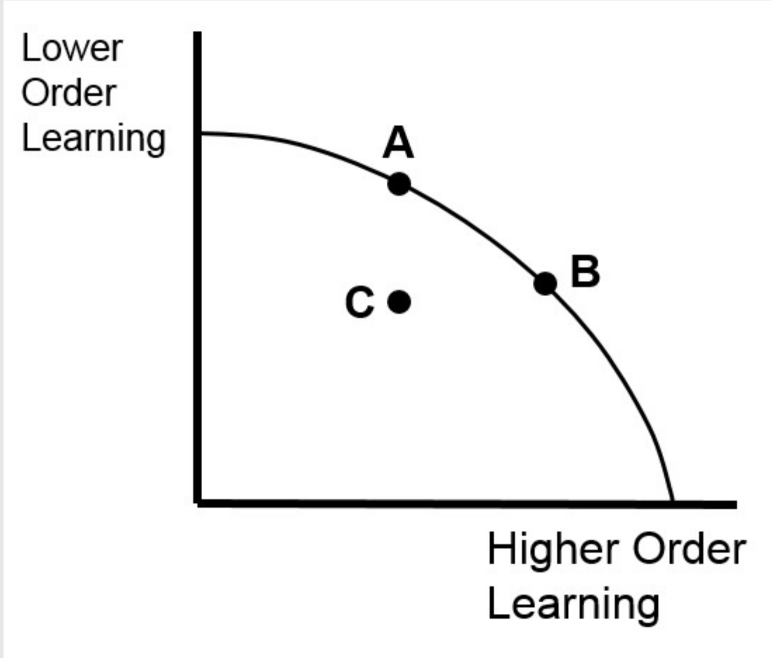

Figure 2: Production Possibility Frontier of Taxonomic Achievement

(Johnson and Swan 1961) and results in the assumption "that students will 'magically' obtain ... process skills somewhere during their four years of study" (Coil et al. 2010). One conception of this idea lies in the concept of a production possibility frontier, as presented in Figure 2. Axes show the level of student lower- and higher-order learning. The pre-redesign course is represented by point A, with more emphasis on lower-order learning. The redesign shifts resources from lower- to higher-order learning. Therefore, if lower-order learning were an absolute requirement for higher-order learning we would observe movement from point A to point C in Figure 2: there is a loss in lower-order learning, and there is no gain in high-order learning. Our results are better modeled as a shift from point A to point B, where the change in resource use reduced lower-order learning but led to an improvement in higher-order learning.

This production-possibility-frontier-style change can be further examined with an example: real gross domestic product (GDP) growth. One of the specific learning objectives of the course is for students to learn how to use real GDP to describe the condition of the economy as well as to analyze issues and policy proposals related to that concept. Learning that during recent expansions real GDP has grown by about 2 percent per year will be useful to students so that in life they can, for example, analyze the economic proposals of political candidates that promise higher growth rates. Considering this specific concept: some knowledge of how GDP is measured is necessary for applying real GDP growth to current issues. This knowledge likely includes the main components of GDP, how a price deflator is used to address the influence of inflation, and how to calculate a percentage change from one year to the next. Many of the details of GDP accounting are not needed for this analytical purpose. The treatment of criminal activity, the value-added approach to avoiding double-counting, and the various ways of measuring a price deflator are interesting and important, but are not necessary in order to interpret falling real GDP as a possible recession, or that 5 percent annual growth would be extraordinarily fast in the United States. Students can fail to remember these details and still succeed in applying their conceptual knowledge of real GDP growth. This type of learning is essential for student success in higher-order learning (and thus the course goal to apply and analyze material) but requires very little lower-order learning (in particular, no memorization of the specifics of GDP).

Of course, this is not to say that memorization and other lower-order learning are wholly unnecessary. Some memorization is foundational. Students did significantly worse on one higher-order question after the redesign. The question asked: “Suppose in a market, supply increases and the quantity demanded increases. Which of the following could be true?” The answers listed changes that would shift demand and supply curves. The correct answer was “Technology improved, so equilibrium price fell and equilibrium quantity increased.” But success on this question fell by 19.2 percentage points after the redesign. We believe the reason was the concept of quantity demanded. Students had to know that an increase in quantity demanded was indicated by a movement along the demand curve. However, many students did not recognize this term and interpreted it as a movement of the demand curve itself. Before the redesign, this terminological difference was covered in lecture repeatedly. After the redesign, it was covered in the textbook, shown in video clips, asked about in assignments, and demonstrated in class a couple of times. However, compared with the emphasis in the pre-redesign, the focus in the redesign was not sufficient to solidify student understanding. This suggests that memorization and understanding, in some cases, are foundations for application and analysis. For these concepts, attention and time may continue to be necessary to ensure student success and learning; in this case, it is not possible to simply move to application and analysis of ideas—memorization and understanding are fundamental to doing so.

These findings speak directly to the reality that many students take a single economics class in their university career. What students learn depends directly on the objective of the course and how the information, which will lead students to that objective, is presented. Course design and goals should acknowledge these circumstances. In the case of this course, emphasis on these higher-order outcomes is appropriate. In their lives outside of college, students will likely not be called on to define the specific points of GDP or to indicate the causes of the Great Moderation. However, they will benefit from the ability to appreciate and understand the outcomes associated with falling home prices, stock market values, lending, inflation, and even real GDP growth; these macroeconomic figures are those which non-economists are likely to see each month. These numbers can be useful for personal planning and are often cited by politicians and pundits. An understanding of these topics will thus serve them well in life in a way that memorization and specific definitions are unlikely to. Were this a first course to be taken by economics majors, more emphasis on foundational material might be appropriate and/or necessary for building field-specific vocabulary and creating security and understanding of foundational concepts. But, for this course and others in applied economics, redesigning the class to focus on higher-order, conceptual learning helps to serve students by building skills that they can apply throughout their lives.

Future work should consider exploring these ideas and specifically the outcomes of course redesigns in different classes, as well as in the context in which more students are in-major, with more economics and applied economics courses ahead of them. Additionally, greater exploration of student learning outcomes in multimodal, active learning courses in agricultural and applied economics generally, would be interesting to instructors in the field.

5 Conclusion

In the fall of 2013, a large enrollment introductory macroeconomic course was redesigned, moving away from the standard chalk-and-talk lectures toward higher-order thinking and active learning methods. The course emphasis shifted from memorization and understanding of concepts to application and analysis of ideas using the macroeconomic model and data. In this paper, we examine student performance on lower- and higher-order final exam questions, based on an analysis of thirteen questions that appeared on final exams before and after the redesign. We find that student learning outcomes shifted: students performed significantly worse on four out of six of the lower-order questions but performed significantly better on three out of seven of the higher-order questions.

In this paper, we provided evidence on student learning as measured by exam performance, after a redesign to a large enrollment, introductory course. We examined changes in student learning outcomes from modifications to course objective and teaching style to emphasize practice, learning-by-doing, application, and analysis. For others who may be interested in doing the same, we provide a description and method for assessing changes in performance after redesigning a large, introductory-level course. These methods are particularly appropriate for courses that rely on often coarse, multiple-choice questions for evaluating student learning outcomes.

Introductory courses often provide the opportunity to instruct students in their first economics course; this opportunity influences the objectives of the course. Careful attention must be paid to what we want students to learn, what we want students to understand and be able to apply, and what we want students to walk away with at the end of the course.

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Appendix: Questions Used in Analysis

Table A1: Questions used in Analysis

Question	Semester Included	Taxonomic Dimension	Order Classification	Question Wording
10	F12, F14	Understand	Low	After World War II, the U.S. Treasury effectively controlled monetary policy. They did this by: a. setting the interest rates on Treasury bonds, then requiring the Federal Reserve to adjust the money supply to reach those interest rates. b. setting income tax rates, then requiring the Federal Reserve to adjust the money supply to reach income tax revenue targets. c. setting the exchange rate of the dollar, then requiring the Federal Reserve to adjust the supply of the dollar in exchange markets to reach that exchange rate. d. assigning General Patton and the Third Armored Division to surround the Federal Reserve's headquarters with tanks. CORRECT ANSWER: A
11	S12, F12, F13, S14	Understand	Low	Among the causes of the "Great Moderation" of the 1980s, 1990s and 2000s were: a. the stimulating effect of the Vietnam, Gulf, and Iraq wars, the collapse of savings and loans, and the pro-cyclical monetary policy of the Federal Reserve. b. the Plaza Accord, which stabilized exchange rates, the absence of major stock market fluctuations, and the pro-cyclical fiscal policy of the U.S. Congress. c. the absence of big wars or supply shocks, improved inventory control by businesses, and counter-cyclical monetary policy by the Federal Reserve. d. the widespread adoption of beige for interior decorating, the invention of the minivan, and the daily broadcast of the Mr. Rogers television show. CORRECT ANSWER: C
12	S12, F12, F13, S14, F14	Memorize	Low	Among the causes of the Great Depression were: a. uncertainty surrounding World War II, crowding out of private investment and increased welfare spending. b. the United States abandoned the gold standard, banks depleted the deposit insurance fund, and big interest rate cuts by the Federal Reserve. c. a large tax hike, bank failures, and the Federal Reserve's failure to cut interest rates substantially. d. counter-cyclical monetary policy, big defense spending increases, and the death of Herbert Hoover. CORRECT ANSWER: C

Table A1 continued.

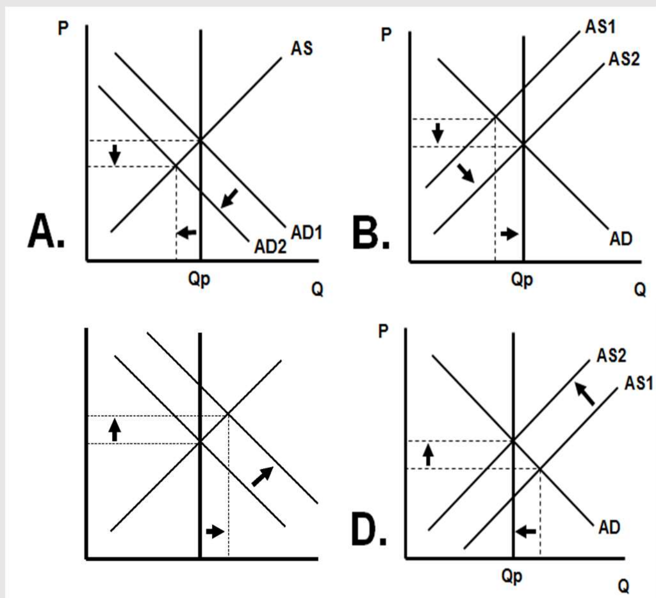
34	F12, F13, F14	Analyze	High	During the 1970s, OPEC oil producers cut their crude oil exports, which increased oil prices. Which diagram shows the results of this restriction? SEE GOODS MARKET DIAGRAM CORRECT ANSWER: D
53	F12, F13	Apply	High	If the opportunity cost of butter in Argentina is 2 guns, and the opportunity cost of butter in Zambia is 4 guns, then: a. world resources are allocated more efficiently if Zambia exports butter to Argentina and Argentina exports guns to Zambia. b. world resources are allocated more efficiently if Zambia exports guns to Argentina and Argentina exports butter to Zambia. c. world resources are allocated more efficiently if Zambia exports guns and butter to Argentina, and Argentina does not export to Zambia. d. world resources are allocated more efficiently if Zambia does not export to Argentina, and Argentina exports guns and butter to Zambia. CORRECT ANSWER: A
75	F12, F13	Understand	Low	In the Plaza Accord of 1985, representatives of five countries with large economies decided to: a. prevent their central banks from making monetary policy, so their Treasury Departments could fix interest rates on government bonds. b. sell dollars in exchange markets, to bring down the exchange value of the dollar and help reduce the U.S. trade deficit. c. buy dollars in exchange markets, to support the exchange value of the dollar and help reduce the U.S. trade deficit. d. allow their central banks to make monetary policy, by forcing their Treasury Departments to stop fixing interest rates on government bonds. CORRECT ANSWER: B
98	S12, F12, F13	Apply	High	Suppose in a market, supply increases and the quantity demanded increases. Which of the following could be true? a. The price of a substitute increased, so equilibrium price fell and equilibrium quantity increased. b. Consumer incomes increased, so equilibrium price and quantity increased. c. Technology improved, so equilibrium price fell and equilibrium quantity increased. d. Input costs increased, so equilibrium price increased and equilibrium quantity decreased. CORRECT ANSWER: C

Table A1 continued.

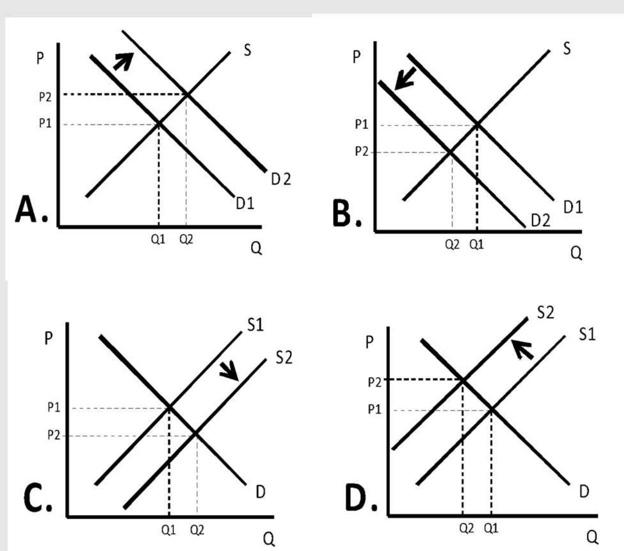
100	F12, F13, S14, F14	Apply	High	Suppose property taxes are one of the costs of providing rental housing. Which of the above diagrams describes what will happen in the market for rental housing? SEE SUPPLY AND DEMAND DIAGRAM CORRECT ANSWER: D
101	F12, F13, S14, F14	Apply	High	Suppose recovery raises the incomes of consumers. Which of the above diagrams describes what will happen in the market for ramen noodles, which is an inferior good. SEE SUPPLY AND DEMAND DIAGRAM CORRECT ANSWER: B
106	F12, F13, S14	Analyze	High	Suppose the price of crude oil decreases. Which of the above diagrams shows what is likely to happen in the market for gasoline? SEE SUPPLY AND DEMAND DIAGRAM CORRECT ANSWER: C
112	S12, F14	Understand	Low	The "Great Inflation" of the 1960s and 1970s got its start when: a. President Dwight Eisenhower refused to let his Vice President, Richard Nixon, push for tax cuts to head off a recession in 1960. b. President John Kennedy and Defense Secretary Robert McNamara increased taxes to pay for added military spending during the Berlin crisis in 1961. c. President Lyndon Johnson made a deal with Federal Reserve Chair William McChesney Martin to keep interest rates low but failed to get a tax hike through Congress until 1968. d. President Richard Nixon and Federal Reserve Chair Arthur Burns dismantled the price controls that the Johnson administration had imposed to stop Vietnam-era inflation. CORRECT ANSWER: C
156	F12, F13, S14	Apply	High	The year 2008 saw falling home prices, falling stock market values, reduced lending by banks, and a higher value of the dollar. Which diagram best represents this: SEE GOODS MARKET DIAGRAM CORRECT ANSWER: A

Table A1 continued.

160	F12, F13, S14, F14	Memorize	Low	Three ways to equilibrate the exchange market are: a. adjustments to the price of gold, the price of silver, and the ratio between the two. b. changes in tariffs, changes in quotas, and changes in administrative procedures at ports. c. adjustments in fiscal and monetary policy, capital controls, and flexible exchange rates. d. changes in open market operations, the discount rate, and the required reserve ratio. CORRECT ANSWER: C



GOODS MARKET DIAGRAM



SUPPLY AND DEMAND DIAGRAM

Teaching and Educational Methods

Hedging with Futures: An Experiential Learning Game

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JEL Codes: A20, Q02, Q13
Keywords: Experiential learning, futures, hedging, teaching

Abstract
Hedging is often an integral concept in agricultural futures and marketing courses as well as extension marketing workshops. Textbook and chalkboard examples offer students of these courses the ability to understand the concept and learn the mathematics. However, this mode of instruction is less intuitive and does not have a real-world feel. The purpose of this paper is to present an interactive hedging game that was developed to provide students with a more realistic hedging experience that improves the understanding of the mechanics of hedging. Under the premise of an eastern Nebraska corn producer using actual data, a spreadsheet was designed that displays market information to the students who then must make decisions about the number of futures contracts to trade. Pre- and post-game results indicate a positive learning outcome, and students responded favorably when asked if the game enhanced their understanding of hedging.

1 Introduction

Courses related to futures markets and risk management are commonly available at colleges and universities. Within the realm of agriculture colleges, this course is typically offered within the agricultural economics or agribusiness curriculum. While course content and concepts may vary, a common objective is the purpose and functionality of hedging with futures. Also, university extension specialists often offer programming on marketing and risk management to farmers. Hedging theory and chalkboard examples provide an understanding of the concept, but the application and practical aspect of hedging is difficult to achieve in a classroom setting.

Simulated trading market experiences offer students of futures marketing courses the ability to make trades and learn about the mechanics of the futures marketplace—for example, margin accounts, commission, and trading gains or losses. Still, these experiences are typically in the vein of speculation since students are simply buying and selling futures contracts and often with limited rhyme or reason.

The American Association for Agricultural Education National Research Agenda's fourth research priority area is "Meaningful, Engaged Learning in All Environments" (Edgar, Retallick, and Jones 2016). This type of framework is not a new phenomenon in college pedagogy. Experiential learning, active learning, game playing, and many other hands-on exercises that are utilized in classrooms have been employed for decades (a useful, but likely incomplete, set of resources related to the examination and history of these can be found through: Boehlje and Eidman 1978; Blank 1985; Knobloch 2003; Andreasen 2004; Caudle and Paulsen 2017).

Given the lack of a hands-on opportunity, an experiential/interactive learning experience was desired with regard to agricultural hedging and price risk management. The purpose of this article is to outline the development and application of an in-class hedging game created that puts students in the role of an agricultural producer making decisions about futures market positions, which relate to production and cash marketing.

2 Hedging Game: Overview

Futures market hedging is the act of establishing an opposite futures market position of equal size to that of the cash market position (Purcell and Koontz 1999). The hedging game places students into the role of an eastern Nebraska corn producer. It utilizes historical data for Omaha cash corn prices (available from USDA, Agricultural Marketing Service recorded by the Livestock Marketing Information Center, LMIC), December corn futures (from the Chicago Board of Trade via LMIC), and Washington County, Nebraska corn yields (from USDA, National Agricultural Statistics Service 2015). Prices and yields used within the game were from 1998 to 2014. The game was built in the fall of 2015, and prices and yield were normalized to this time frame so that year specific price or production outcomes would not be prevalent (this is described in further detail later).

At the start of the class period, students are provided with the game setting (appendix A), which is often provided in the prior class period or via an online classroom in an effort to be more efficient with time. Prior to the start of the game (optional), pre-emptive questions are asked in an effort to assess learning outcomes whereby the same questions are asked after the game concludes. The game is set in eastern Nebraska, since the data stem from that location, and a farm size of 1,000 acres is used to simplify calculations. Students are informed that they are to make decisions about the number of futures contracts to trade at three periods during a growing season (planting, crop emergence, and mid-summer). At each time period, a chart that depicts the futures market price for the December corn contract, dating back to the start of the calendar year, with the current available price explicitly noted is provided to the students (Figure 1—top left, bottom left, and top right panels, respectively). Students are then offered the opportunity to take a position in the futures market at the given price, but this is not required.[1] Harvest follows the mid-summer period, which is the end of the crop year and offers all final outcomes—actual cash price, final futures price, and actual yield (Figure 1—bottom right panel). At this point, all open futures positions are liquidated. Actual cash and futures revenue and profit (losses) are calculated. This procedure is repeated for additional crop years until the lecture period nears its end. Approximately seven minutes are reserved at the end to wrap up the game, ask post-game assessment questions (optional), and answer student's questions related to the game concepts.

3 Hedging Game: Specifics

The data for the game stem from USDA, Agricultural Marketing Service cash prices for Omaha, Nebraska, USDA, National Agricultural Statistics Service corn yield for Washington County, Nebraska, and Chicago Board of Trade December corn futures prices from January to mid-November (i.e., harvest) of each year from 1998 to 2014. To alleviate potential across year price and yield discrepancies, prices were inflated to a more current time period (2015), and yield was trend adjusted to reflect 2014 technology. The former was accomplished by setting the base year as the most recent price year and indexing all other prices to that base. More specifically, the index formula is:

$$Index_t = \frac{Nominal\ Price_t}{Nominal\ Price_{base\ year}} \tag{1}$$

where the nominal price stems from the mean of reported cash and futures price in the specific year, $t = 1998\ to\ 2015$, and the selected base year was 2015.[2] Prices were then adjusted by dividing the nominal price for each year, t, by the calculated index value for the same year. Yield was adjusted based on the following OLS regression procedure:

[1] Prior to the spring 2019 semester, students were only allowed to take short positions with futures contracts, to maintain the truest sense of a short hedger. However, out of curiosity, I relaxed this restriction for crop years two through four in the spring 2019 term.

[2] These calculations are located in the supplemental spreadsheet: "Corn_Cash&Fut," row 2 for index calculations and "Corn_adj" for adjusted prices.

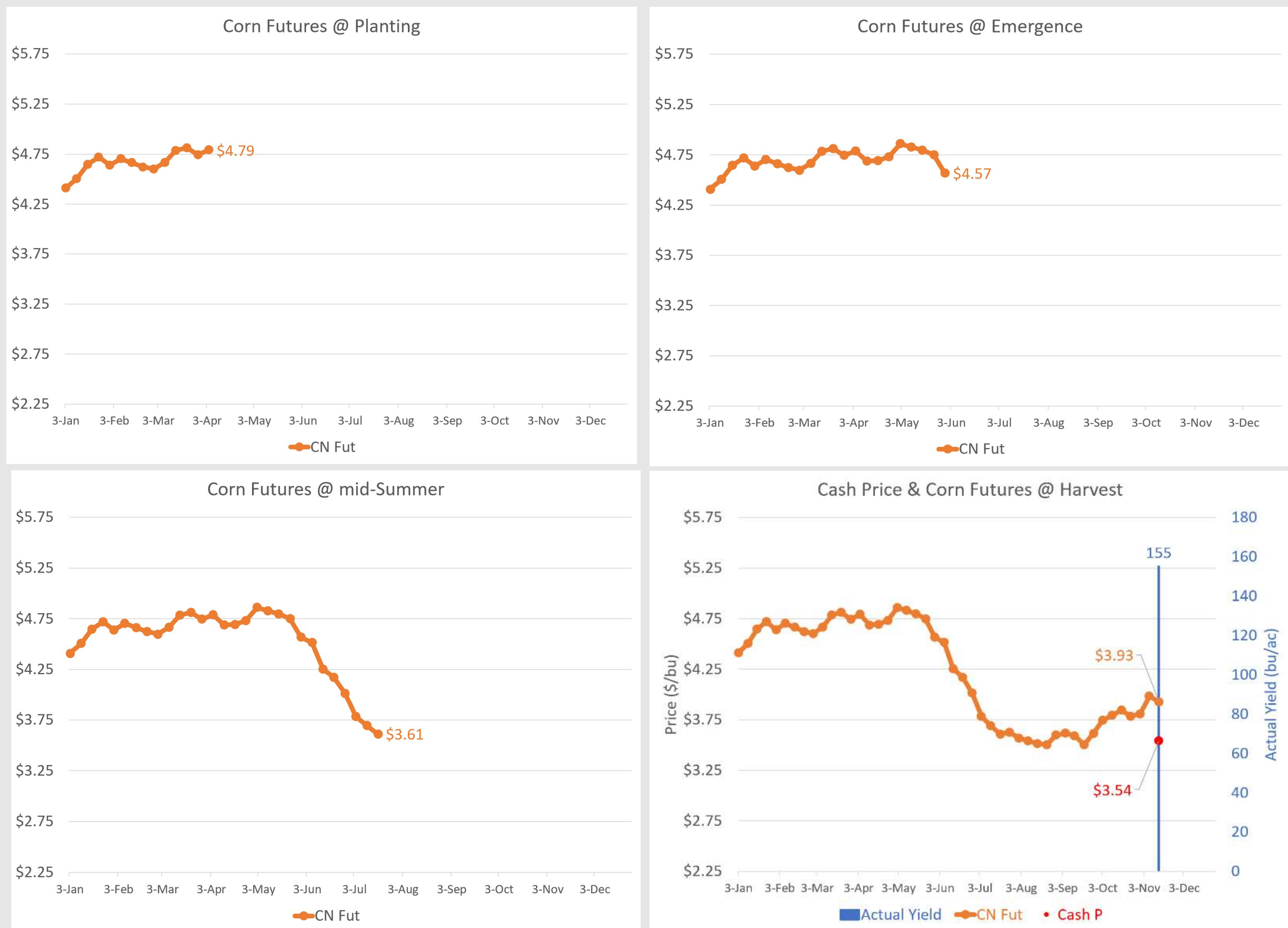

Figure 1: Charts of Futures Market Price Path for 3 within Growing Season Time Periods and the Final Harvest Period

Note: Top left panel is futures price at planting; bottom left is futures price at crop emergence; top right is futures price at mid-summer; and bottom right is harvest when all prices and yield are known with certainty.

$$Yield_t = \alpha + \beta Trend_t + \varepsilon_t \tag{2}$$

where yield data from 1960 to 2014 comprised the estimate; however, only 1998 to 2014 trend adjusted yields are incorporated into the game.[3]

Basis values are provided to students based on the typical *Cash Price* minus *Futures Price* derivation and stem from the six-week period surrounding the defined harvest period of mid-November. An average basis is offered to the students as an expected basis at the initial planting period so that an expected cash price can be formulated. Cost of production is included in the game to aid with the concept of management decision making and risk planning but does not have a well-defined framework. Costs for a game-specific crop year, i, are determined using the following procedure:

$$Cost_i = \max\left(85\% \times \overline{FP}_{planting} \times Random, median\ FP_{planting}\right) \tag{3}$$

[3] These results are located in the supplemental spreadsheet: “Yld Hist.”

where, $\overline{FP}_{planting}$ is the average adjusted planting time futures price of the harvest contract for all years used, 1998–2015, and *Random* is a random number between 0.85 and 1.15. Costs have an upper bound of the median harvest contract futures price at planting.[4]

The teaching notes offer an explanation of how to conduct the game in-class. Additionally, supplemental videos provide more detail on the features of the game: specifically, a visual of how the in class game is conducted (video 1), an overview of the data and how these are incorporated into the game play (video 2), and the online form used for the student's submission of decision responses (video 3).[5]

4 Learning Outcomes

This game was created and introduced in the fall 2015 semester without a measure for learning outcomes. Beginning in Spring 2018, students were asked four questions before and after the hedging game (respectively, pre and post), and no changes were made to the questions. Overall results of the pre- versus post-game questions are provided in Table 1. The questions asked were:

Question 1: [Multiple Choice] A hedge can be placed … (a) only at the end of the planning period, (b) only at the beginning of the planning period, (c) only at specific intervals during the planning period, or (d) at any time during the planning period.

Answer: The correct answer would be (d), and the purpose of this question stems from the game setup, which only allows students to make periodic hedging decisions. It is important to reinforce during the game that these decisions are not beholden to specific intervals or only at the beginning or end.

Question 2: [True/False] Hedging decisions of buyers/sellers cannot be adjusted/altered until the end of the period.

Answer: The correct answer is False, and similar to the previous question, this is asked to ensure that participants understand that futures positions can be entered/exited at any time.

Question 3: [True/False] A producer who makes frequent use of futures, options, and forward contracts should have a higher expected price than a producer who always sells at harvest.

Answer: The correct answer is False, as hedging is not a way to increase profits but merely a price risk management tool.

Question 4: [True/False] Futures markets can always be used to lock in a profit.

Answer: The correct answer is False, while price risk can be mitigated with futures, basis risks could reduce the ability to *always* lock in profits.

Most students understand the mechanics of hedging and how an actual producer is able to use the futures market to hedge price risk as evidenced by the percentage of correct answers to the pre-game questions. I employ the game at the end of the semester (typically within the last week of class), so this

[4] These calculations are found in the supplemental spreadsheet: "4chart-1" (cells W4:W11).
[5] Videos can be found at: Video 1: Game Play at https://youtu.be/KlKe8NVEfqw; Video 2: Data and Other Background Information at https://youtu.be/7Saj0ccbP3o; and Video 3: Online Student Submission Form and Tabulation Sheet at https://youtu.be/OvHQiUCgWBw.

Table 1. Hedging Game Pre- and Post-Question Overall Score Results

Question	Percent Correct (Pre)	Percent Correct (Post)
Question 1	76.92%	86.32% **
Question 2	79.49%	84.62%
Question 3	48.72%	52.99%
Question 4	72.65%	74.36%

Note: *N* = 117 (spring 2018: 23 students in attendance; fall 2018: 49; spring 2019: 45)
Significance at the 5% level denoted by "**" and based on a pooled *t* test.

was expected given that the concepts have been taught for an extended period of time. Even so, the results of the pre- and post-game questions do point to a positive learning experience. Question 1, *"A hedge can be placed …"* resulted in a significant improvement after the game is played. As described in the notes and video, an emphasis is made to explain that a futures market (or any forward price) hedge can be initiated at any point in time that the market is open, which bears out in the pre- and post-game learning outcomes. Question 3, *"A producer who makes frequent use of futures, options, and forward contracts should have a higher expected price than a producer who always sells at harvest,"* resulted in the lowest number of correct answers both before and after the game, with a minor albeit insignificant improvement.

Further analysis of the pre- and post-game question learning outcomes are provided in Table 2, which uncovers individual outcomes as opposed to the aggregated results described in Table 1. Here each student's pre-game answer was compared with their post-game answer to determine the individual level of improvement. The left-most column describes students who incorrectly answered a question before the game, but then correctly answered after the game. Again, question 1 shows the most improvement. A point of encouragement, Question 3 revealed improved outcomes but tended to be wrong most often both before and after. On the other hand, more students regressed when answering Question 3, relative to other questions, in that they correctly answered it in the pretest but got it wrong in the posttest.

Students were also asked if the game increased their understanding of hedging. Responses to a five-point Likert scale response (strongly disagree to strongly agree) is provided in Figure 2. The

Table 2. Hedging Game Pre- and Post-Question Individual Outcome Results

Question	Percent Improved	Percent Correct Pre and Post	Percent Wrong Pre and Post	Percent Regressed
Question 1	16.24%	70.09%	6.84%	6.84%
Question 2	10.26%	74.36%	10.26%	5.13%
Question 3	14.53%	38.46%	36.75%	10.26%
Question 4	8.55%	65.81%	18.80%	6.84%

Note: Students were grouped into one of the four categories (Improved, Correct Pre and Post, Wrong Pre and Post, Regressed). *Improved* indicates the student incorrectly answered the specific question in the pretest and subsequently correctly answered the specific question in the posttest. *Correct Pre and Post* indicates the student correctly answered the specific question on both the pre- and posttest. *Wrong Pre and Post* indicates the student's answer to the specific question was incorrect on both the pre- and posttest. Finally, *Regressed* indicates the student correctly answered the question in the pretest but incorrectly answered in the posttest. Percentages provide a measure of the total number of students in each group (*N*=117); across each row should sum to 100 percent (after accounting for rounding).

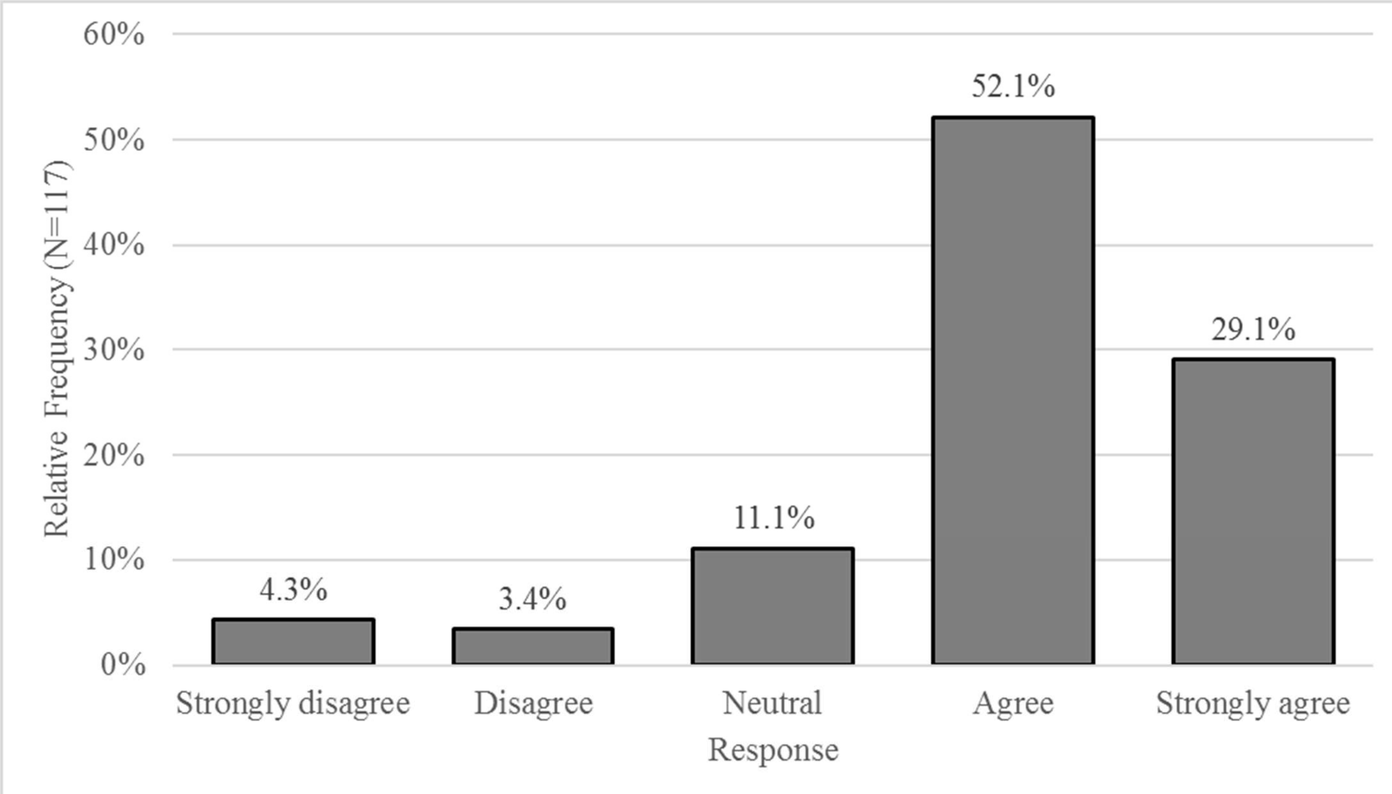

Figure 2: Student Response to the "*This exercise increased my understanding of hedging*" Question

majority of responses indicate a positive outcome with 81.2 percent of students indicating agree or strongly agree.

5 Summary

The concept of hedging is critical in futures marketing courses and for extension marketing and risk management education. The concept may also apply to other market-related agricultural economics/agribusiness courses or extension education programming. Classroom examples and out-of-class assignments provide a mechanism for students to grasp the calculations and final outcomes; however, the reality of hedging is more difficult to convey. An in-class hedging game was created that offers instructors of these courses an opportunity for an experiential learning exercise with a "real-world" example brought into the classroom. Given that the game stems from a single computer that can be displayed on a large screen, the game transports easily for extension specialists offering training in the field (paper tabulations may be best suited for this form of application as opposed to online submission of decisions).

Results of pre- versus post-game questions indicate the opportunity does increase the knowledge of hedging mechanics and risk management attributes. The applicability of the game is another positive aspect, as students indicated the game benefited their understanding of the hedging process.

Possible future changes to the game include: (1) incorporate more instantaneous feedback to the student, (2) utilize the game periodically throughout the semester as opposed to once at the end of the term, and (3) incorporate basis hedging.[6] Quicker crop year results could be accomplished with an individual tabulation sheet (spreadsheet) provided to each student in advance. The number of students who own personal laptop computers or tablets that are able to access spreadsheet software (either Excel

[6] Thanks to the reviewer for offering the suggestion of basis hedging.

or Google Sheets) has grown to a degree that few, if any, would not fit this criterion. Therefore, having this as an additional tool would be easy to implement. The one drawback would be the swapping between the online submission form and the spreadsheet during the game. Utilizing the game periodically during the semester is simply a matter of reorganization of the course timeline and easily accomplishable. Basis hedging would be an extension of the game that has not been implemented and tested at this point; however, a modified student record sheet that includes this component is offered in appendix D, along with the sheet that I have previously used (instructions are included as a note with the record sheet).

Additional extensions for the game include: (1) more precision with respect to price and production, (2) increased reality by incorporating margin calls and transactions costs, and (3) improved information within each crop year—for example, crop progress and quality, updated cost of production, weather history and forecast, and market analysts' forecasts.

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Teaching and Educational Methods

Using Data Analytics and Decision-Making Tools for Agribusiness Education

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JEL Codes: A22, A29, Q13
Keywords: Agribusiness, data analytics

Abstract
The agriculture sector has entered a new era wherein every stage of the supply chain involves gathering an increasing amount of data. Most of these data are generated in real-time and require rapid analysis that can support optimal decision making for agribusinesses to remain competitive. Consequently, employers desire that students gain data analysis skills in agribusiness classes to best inform optimal decision making. This paper discusses how data analytics have been incorporated into an agribusiness management course.

1 Introduction

The agriculture sector is increasingly gathering and analyzing more data. Indeed, every stage along the supply chain is generating an increasing amount of new data in real time from the sensors on planting equipment and combines to imagery from satellites and shelf scanners used by food retailers, to name a few. The gathering of real-time data has also altered the demand for high-speed analysis that can support optimal decision making in agribusinesses. Indeed, analytics plays a key role in successfully utilizing the power of big data, which includes the aggregating and combining data from other sources, and developing advanced models to make predictions that enhance decision making (Sonka 2014). Gillespie and Bampasidou (2018) identified that "there is a large gap between AEAB (agricultural economics and agribusiness) undergraduate and graduate programs in terms of analytics, with some undergraduate programs offering little or no quantitative analytic training" (343). The authors pose a question regarding agricultural economics and business undergraduates, "Is the AEAB profession missing an opportunity to brand its graduates not only in terms of their expertise in the business of agriculture, but also as strong entry-level quantitative analysts?" (Gillespie and Bampasidou 2018, 343). Without contemporary data analytics components in agribusiness courses, agribusiness students may be left with a digital skills gap. Alternatively, without agribusiness content in a data analytics course, students may not know how data analytics can inform optimal decision making in agribusinesses.

1.1 Agricultural Digital Skills Gap and Agriculture Data Analytics

> *As the agricultural industry embraces technological advances, it is demanding a new, highly skilled workforce. Many of the initial jobs are being filled by workers coming from outside the traditional farming industry: Silicon Valley entrepreneurs in software, big data, and hardware; experts in drone and satellite imagery; research scientists from leading universities. However, there is a growing need for more employees with agricultural expertise in addition to technology skills* (Pattani 2016, Opportunities Abound For High-Skilled Workers section, para. 1).

An opportunity exists to combine agribusiness education and data analytics skills for agribusiness students to serve as "links" between new agricultural data technologies and agribusiness management.

By exposing students to more concepts of data analytics in an agribusiness course, students can be better able to connect with potential employers and be able to provide a clearer vision of ways to apply the latest data analytic methods in agribusiness firms to promote optimal decision making, efficiency, and competitiveness.

Agribusiness faculties, however, are currently presented with the challenge of how to best expose students to greater data analytics topics in a way that supports their success. Traditional agribusiness courses are already content rich, and data analytics is a broad topic that is often taught through separate courses. Moreover, data analytics methods and software programs change as a result of technological advances that are as yet unknown.

We responded to the challenge by encouraging students to "learn to learn" because we believe that they will need to continue their education and remain informed of changes in data analytics throughout their careers to be successful. The learn to learn philosophy means that our course objectives are not to render students fully competent in the use of each data analytic method that we cover. Rather, we want them to gain exposure to different methods, develop an appreciation for the relevancy of data analytics in agribusiness decisions, and gain a basic understanding of data analytic methods for continued learning. The broad exposure to different data analytic methods in an undergraduate advanced agribusiness course can serve three purposes: (1) the data analytics skills the students are exposed to can be further perfected in an agribusiness capstone course where the student focuses on an agribusiness case they are interested in, where they use a single method more thoroughly, (2) exposure to data analytic methods may influence some students to decide to pursue graduate degrees, and (3) the broader knowledge of data analytics methods can be further perfected in training programs at an agribusiness firm they work for. Indeed, many firms are providing more in-depth in-firm training in data analytics and are partnering with universities to provide advanced data analytic education for their employees (McKinsey and Company 2017).

Continuing education in data analytics also corresponds well with land-grant universities' missions for extension. The continuing education of data analytics methods provides an immense opportunity for land-grant universities to provide relevant agribusiness education not only to students, but to existing extension audiences and to a growing number of nontraditional clients. The primary purpose in this paper is to provide a discussion on how we incorporated data analytics into an agribusiness management course with the ability to use similar techniques and problems developed here for extension education and agribusiness industry clients.

2 Incorporating Data Analytics into an Agribusiness Course

The first step in developing an undergraduate data analytics curriculum involves finding a data analytics textbook or data analytics resource that could be coupled with traditional agribusiness course content. We identified a textbook, entitled *Business Analytics: Data Analysis & Decision Making* (Albright and Winston 2014), that outlined many of the data analytics concepts we were seeking to teach in the course. As an added bonus of utilizing this textbook, the students were given a free 2-year academic license to use the Palisade Software Suite,1 which includes a number of Excel-based decision tools, including @RISK, PrecisionTree, TopRank, BigPicture, StatTools, NeuralTools, and Evolver. The agribusiness course was a 3-credit course held three days a week. The third class of each week was set aside to focus exclusively on data analytics. Our goal was to connect data analytics concepts to a traditional agribusiness topic covered in that week. Data analytics and agribusiness content were paired, as illustrated in Table 1.

For the data analytics lectures, outlines and exercises provided by the textbook were utilized with slight changes made for applications to agribusiness problems. To connect the data analytics assignments to real agribusiness management cases, agricultural data was collected and connected to past

[1] The Palisade Software Suite's tools can be viewed in detail at the Palisade's website at https://www.palisade.com/products.asp.

agribusiness decisions or to potential problems that could be analyzed in an agribusiness setting. Each assignment was developed like a separate case study. In connecting each assignment to real agribusiness decision-making scenarios using real data, students developed an appreciation of the relevance of the data analytic methods covered. The data collected for each assignment mostly included information from annual reports obtained from the Securities and Exchange Commission (SEC), datasets from Kaggle.com, and data and information from Bloomberg terminals. Table 2 shows the specific data analytic assignments given to the students throughout the semester. Each of these assignments have been made available as Excel workbooks, where the analysis is partly set up to use with the corresponding Palisade Decision Tool. In addition, in association with this article are teaching notes online.2 The teaching notes covers the background of the case, assignment questions that could be asked, and the authors' answers to the questions asked.

The data analytics content was delivered through a live webinar. The webinar also served as a means to provide a hands-on data lab experience to a traditional lecture class of 90 students. The webinar was recorded and allowed students the freedom to follow along at their own pace. The students could pause or rewatch parts that they may have failed to grasp because they were unfamiliar with the software or data analytics concepts. As an added benefit, the recorded webinars could be further used to develop a short course on data analytics that could be made available as continuing education material for agribusiness firms.

The data assignments allowed students to work in groups of five or less to develop a PowerPoint presentation with text and visuals using data analytics to answer the questions asked. After each assignment was graded, a representative from the group with the top score presented the group's PowerPoint presentation to the class so that the students could see the quality of work done by their peers and to create an opportunity for the students to present and discuss their findings and recommendations using the data analytics concepts they learned.

Table 1. Agribusiness Content Connected to Data Analytics Concepts for an Agribusiness Management Course

Agribusiness Content	Data Analytics Concept
Decision Rights	Decision Making Under Uncertainty
Pricing with Market Power	Time Series Analysis and Forecasting
Economics of Strategy	Optimization and Simulation
Divisional Performance Evaluation	Portfolio Risk Analysis
Understanding the Business Environment	Neural Network Analysis

[2] The data analytics assignments and teaching notes are available by request through the AETR website at https://www.aaea.org/publications/applied-economics-teaching-resources.

Table 2. Agribusiness Management Data Analytics Assignments: Problem Types, Data Analytics Methods, Software Programs, and General Case Study Questions

Problem Type	Data Analytics Method	Software	Case Study Question
Decision-Making Problem	Decision Analysis	Precision Tree	Should CHS develop a fertilizer plant in Spiritwood, North Dakota? Does being a cooperative change the decision?
Forecasting Problem	Forecasting	StatTools	Do markdown events affect meat demand at Walmart Super Centers? What federal/state food policies appear to affect meat demand most?
Optimization Problem	Linear Optimization	Risk Optimizer	What dairy ration ingredient mix has the lowest cost given changes to the price of commodities? How can the risk be mitigated through contracts?
Portfolio Risk Analysis	Simulation	@Risk	Should Green Plain Inc. expand its feedlot investments to complement its ethanol facilities? Is diversification to reduce risk a viable strategy for a public corporation?
Machine Learning Problem	Neural Network	NeuralTools	Are there advantages in using machine learning to detect borrower default? How do changes in the broader economy affect the default rate?

2.1 Overview of Data Analytics Assignments

Data Assignment #1: In data assignment 1, the students had to perform a decision (tree) analysis using the Precision Tree software. The analysis explored the feasibility of building a nitrogen plant given base case assumptions on exploratory costs, fixed costs of the plant, the plant life in years without reinvestment, a discount rate, expected nitrogen product margins (with associated probabilities of occurrence), plant utilization, and the subjective probability of the CEO to whether the plant would be found to be technologically feasible. The students were asked whether they would recommend to the CEO to further pursue development of the plant to determine if the plant could be built with the estimated amount of fixed costs and obtain the expected product margins. Most of the values used in the analysis were based off of a farmer-owned cooperative, CHS Inc. (formally known as Cenex Harvest States), decision to explore building a nitrogen manufacturing plant in Spiritwood, North Dakota, and were found in their annual and quarterly SEC reports. Figure 1 shows the expected monetary value of the decision to pursue building the nitrogen plant given the uncertainty of the product market and whether the plant would be found to be feasible using the base case assumptions from the decision analysis. The initial branch of the tree indicates the expected monetary value of choosing to explore the feasibility of the plant was greater ($169,723 greater than $0) than not choosing to explore the plant given the assumed probabilities, costs, and payoffs. Using expected monetary value alone, the students would recommend to the CEO to explore the feasibility of the plant. However, students were asked to perform a number of analyses to determine the sensitivity of the decision to the assumptions used and were asked to reevaluate the decision. Further discussion was connected to decision rights (control and residual rights) in agribusinesses. Specifically, should being organized as a cooperative versus a corporation require an alternative design of the decision analysis?

Data Assignment #2: In data assignment 2, the students explored the factors that influence fresh and frozen meat department weekly sales at Walmart Supercenter stores. The students performed a multiple regression analysis using the StatsTools software to make out-of-sample forecasts of weekly fresh and frozen meat department sales in 2012 (see figure 2). The data used was gathered from a data analytics competition on Kaggle.com that Walmart sponsored to recruit data analytics employees. The students evaluated the same question asked in the Kaggle.com competition—do holiday markdown events affect demand in the stores? The students were also asked to evaluate the model specification given to them, and determine what variables may be missing to better understand the effect of markdown events on weekly meat sales. This data assignment was connected to the agribusiness topic of using market power and discriminatory pricing strategies to affect demand and maximize profit. Further discussion was focused on how to measure spatial market power in the model. Specifically, how could the level of competition be measured at each supercenter store to understand consumer responsiveness to markdown events?

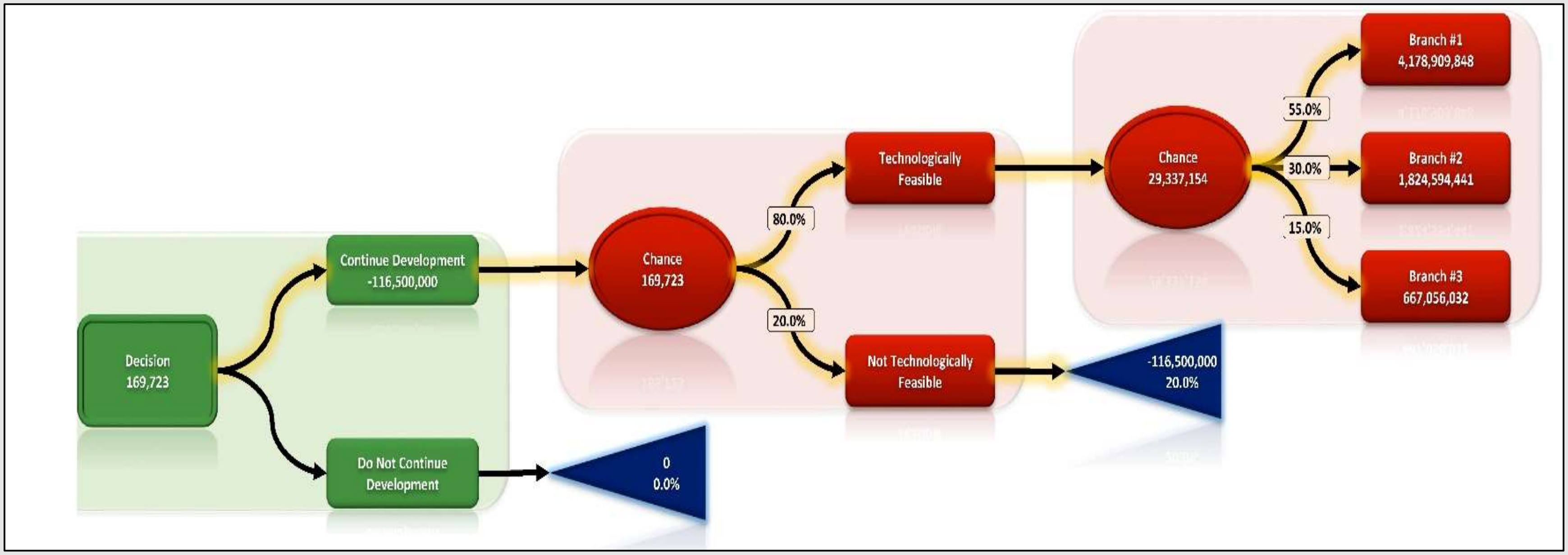


Figure 1. Decision Analysis of Building a Nitrogen Plant

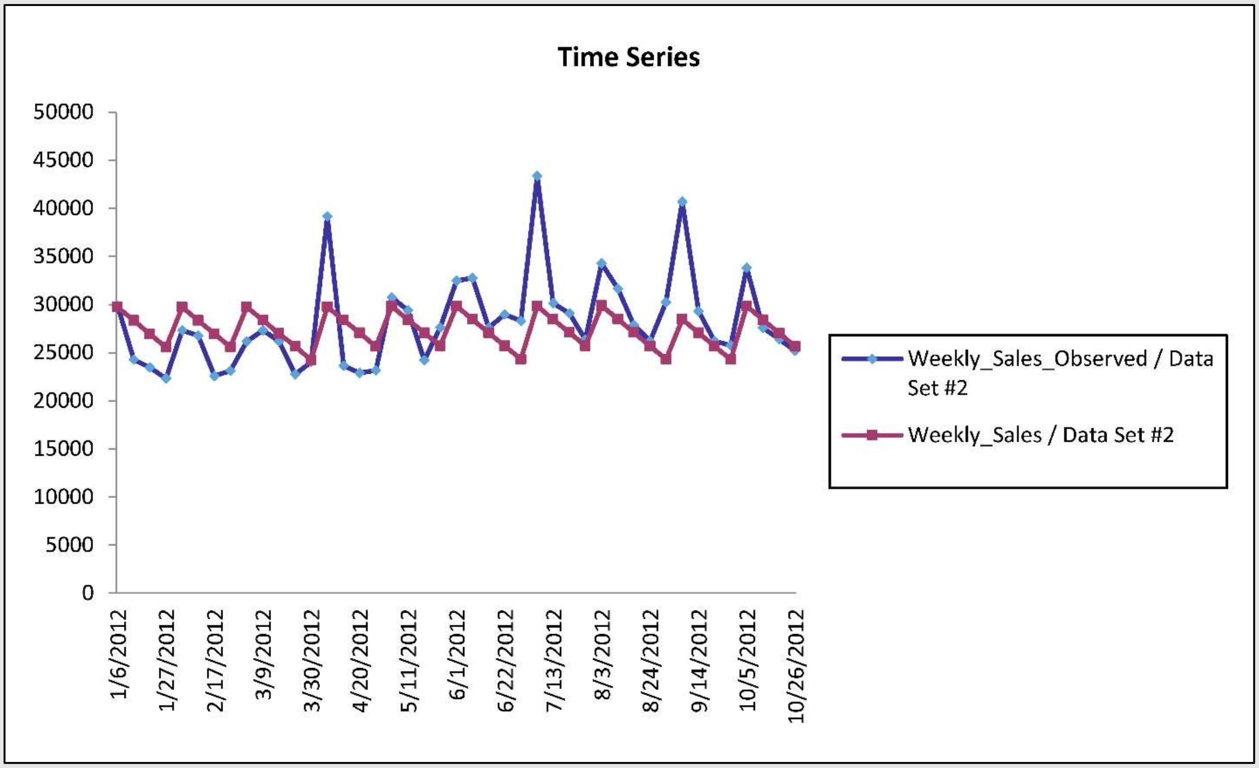


Figure 2. Forecast of Walmart Fresh and Frozen Meat Department Weekly Sales at a Supercenter Store

Data Assignment #3: In data assignment 3, students had to determine the lowest cost dairy feed ration a feed mill should acquire, mill, and blend, given assumptions on the feed nutritional composition, commodity availability, commodity prices, and milling capacity. To find the lowest cost ration mix, students performed linear optimization and simulation using Excel's data solver and the @Risk software and risk optimization tool. The students then simulated the change to the lowest cost ration if the prices of the ingredients changed. The students also examined the risk to the feed mill's income over the ingredient cost, given the uncertain nature of the price of the ingredients and the inability of the feed mill to change their feed price with the same frequency that ingredient prices change (see figure 3). The students were asked to explain what strategies (e.g., contracts and hedging) are available to the feed mill to mitigate the risk to net income.

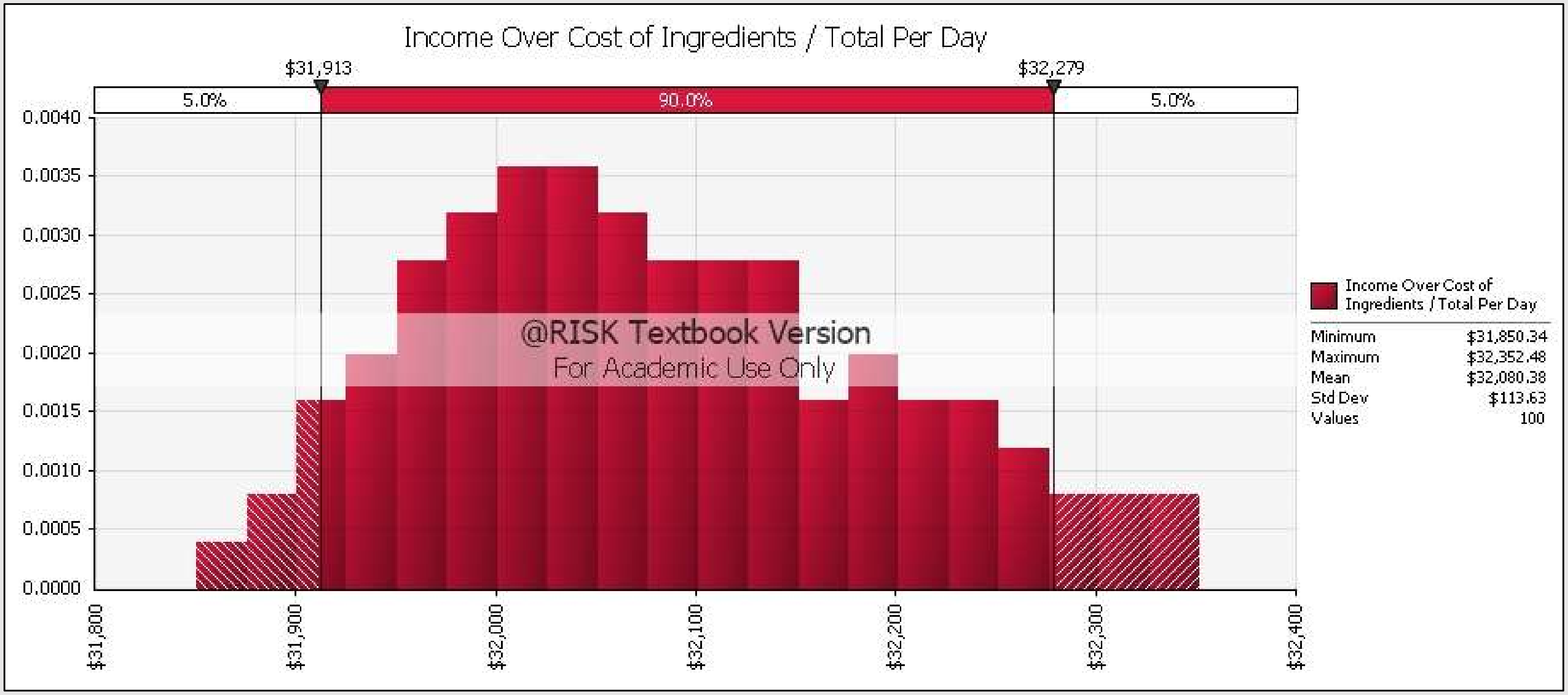
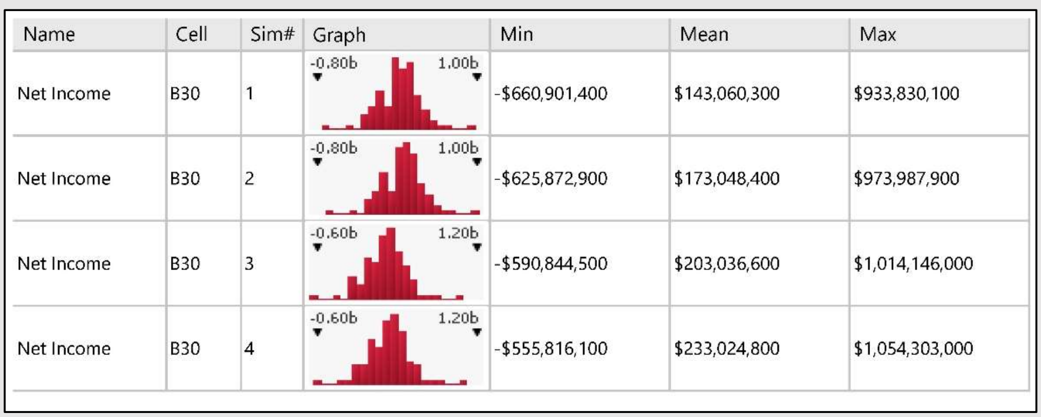


Figure 3. Risk Simulation Results for a Feed Mill's Income over Ingredients Cost for a Dairy Ration Using @RISK

Data Assignment #4: In data assignment 4, the students examined an agribusiness firm mainly focused on producing ethanol, but also had a separate division engaged in feeding cattle. The students allowed prices of outputs and inputs in the firm to be unknown and simulated the effects to net income for the firm. The students learned how to model more accurately multiple input and output prices using a correlation matrix. The price distributions and correlations of unknown inputs were based off historical price data gathered from the Bloomberg terminal to more accurately reflect the risk to the firm. The students then explored the changes to risk and return if the firm decided to expand the cattle feeding operation to complement the existing ethanol facility investment (see figure 4). The case this assignment was based on was Green Plains Inc.'s recent expansion of their cattle feeding operations to complement the multiple ethanol facilities they own. The students were further asked if investment in a separate business segment for the sole purpose of risk reduction is a viable strategy for a public corporation.

Data Assignment #5: In data assignment 5, the students examined a machine learning model (neural networks) compared with a logistic regression to identify the credit risk of customers seeking loans. The assignment was based on the types of credit risk determinations that are common in a multitude of agribusinesses involved in lending or providing credit to their customers. The students were asked to compare the performance of identifying borrower default using the machine learning technique versus logistic regression. Also, students were asked to determine the relative variable importance of credit indicators to default risk. For example, students found that the number of accounts past due over 120 days was the most important variable found by the neural net, followed by the total number of credit accounts opened and number of financial inquiries on the customer's credit report (see figure 5). The data used was gathered from Kaggle.com and was provided by Lending Club, based on their customer loan data during the 2007–2015 period. Further discussion was focused on how borrower defaults rates and demand for loans increased after 2008 as a result of the financial crisis.



Name	Cell	Sim#	Graph	Min	Mean	Max
Net Income	B30	1	-0.80b 1.00b	-$660,901,400	$143,060,300	$933,830,100
Net Income	B30	2	-0.80b 1.00b	-$625,872,900	$173,048,400	$973,987,900
Net Income	B30	3	-0.60b 1.20b	-$590,844,500	$203,036,600	$1,014,146,000
Net Income	B30	4	-0.60b 1.20b	-$555,816,100	$233,024,800	$1,054,303,000

Figure 4. Net Income Risk Analysis for a Firm with Ethanol Production and Cattle Feedlot Production (Each risk analyis explores an increasing capacity of cattle feeding to complement ethanol production of the firm.)

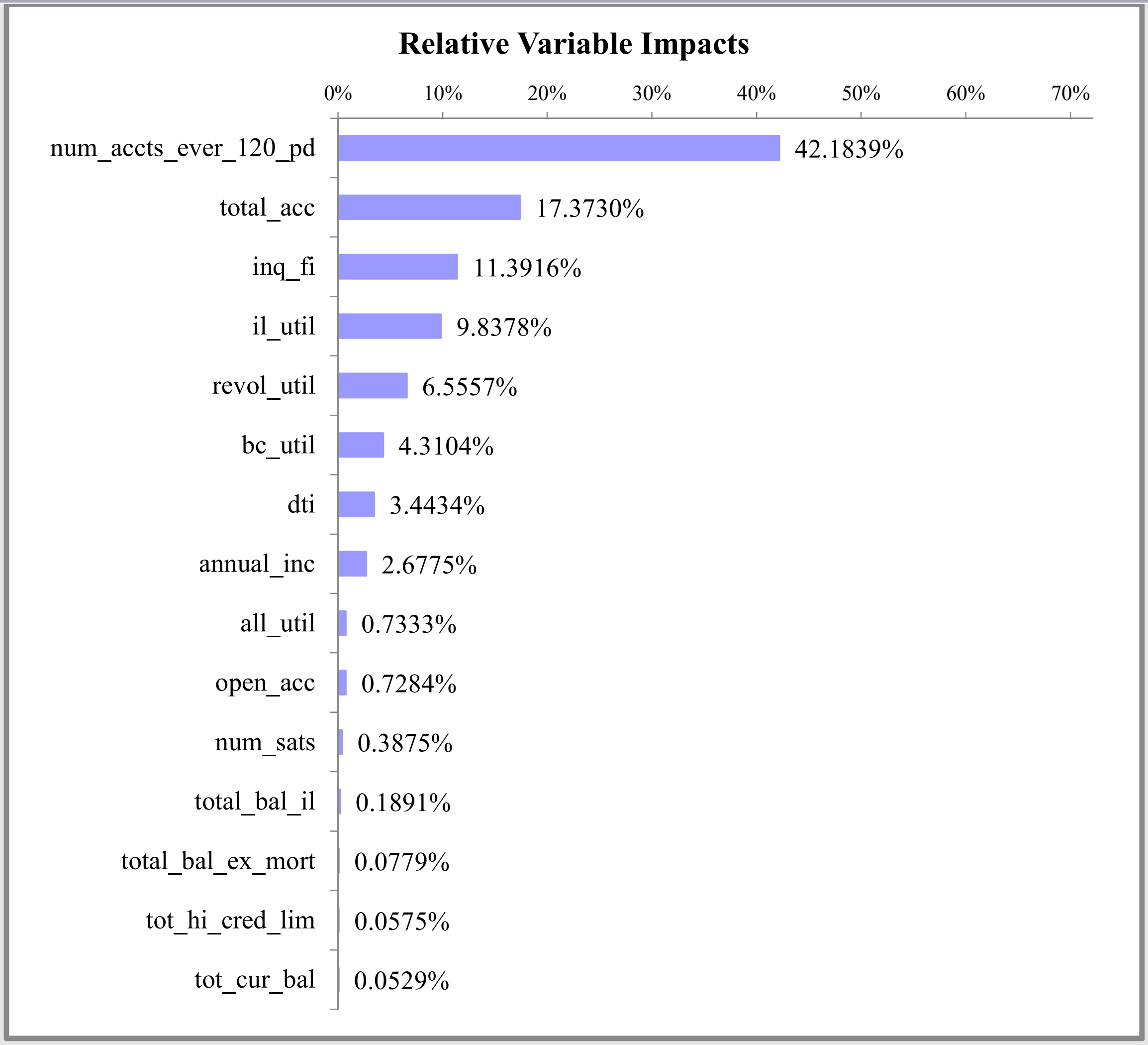


Figure 5. Relative Variable Impacts to Loan Default Risk Using a Neural Network

2.2 Data Analytics Case Study

The groups completed a final project for which they were given the opportunity to select an agribusiness problem on their own to examine using one of the data analytics concepts used in the course. The grading rubric used for the final project is shown in table 3. The groups largely chose to do a decision analysis or measure risk of returns. The agribusinesses students chose to focus on problems ranging from the decision to expand a family farm to should large multinational agribusinesses such as Cargill, ADM, Bunge, Dupont, and so on expand to improve performance. Many students utilized the Bloomberg terminals financial analysis data on companies' net income and growth rates compared with companies in the same business segment but operate at different scales.

Table 3. Case Assignment Grading Rubric

Grading Category	Elements Necessary for Full Credit
Describe the agribusiness's current business environment.	Provide a brief but comprehensive discussion of how changes to technology can affect the current business environment the agribusiness operates in. Also, provide an accurate description of the competitors, customers, and suppliers. Identify important laws and regulations that can influence firm value for the agribusiness.
Describe the agribusiness's current strategy.	Describe the industries the current agribusiness is engaged. Define the level of competition the firm experiences. Describe whether the agribusiness firm competes for price, quality, or service. Describe if the firm has market power.
Describe the agribusiness's current organizational architecture.	Describe the units, divisions, or hierarchy of the firm. Describe decision rights of the owner(s) and parties that transact with the firm (employees, suppliers, lenders, shareholders, etc.). Discuss any known incentive payment schemes and reward systems. Discuss any known performance evaluation systems.
Describe a potential change to the business environment that would necessitate a change to the organizational architecture.	Describe changes to the business environment, strategy, or organizational architecture that can affect firm value.
Describe a change to strategy or organizational architecture that would adapt to the new business environment.	Describe actions the agribusiness could do to adapt to the change in their business environment to protect firm value.
Develop a data analysis that can inform on the agribusiness's current or future firm value.	Perform a data analysis that informs on potential changes to firm value that you previously discussed.
Interpret the data analysis performed.	Interpret the analysis accurately.
Make a recommendation to the agribusiness firm given that your data analysis could improve firm value.	Make recommendations that fit the analysis findings.

3 Discussion and Concluding Remarks

A few insights arose from the develop of the methods, materials, and assignments for the agribusiness management course.

1. *Mac users beware—Palisade Software Suite is not Mac friendly*. As an alternative for students with Mac computers, students were made aware of computer labs on campus labs where the Palisade Software Suite was installed, which they could use to work on their assignments.
2. *Having good teaching assistants is critical*. Students will have many functional questions about the assignments and software, even with the recorded webinars and textbook. Having teaching assistants (TAs) watch the recorded data analytics webinar and work through the assignment problems beforehand to ensure that they understand the assignment is important. Our TAs also provided feedback on areas that had not been effectively covered. A large majority of the students sought help from the TAs outside of class during the TAs' office hours.
3. *Combining traditional agribusiness concepts with data analytics creates a considerable amount of content.* There was much material to cover, and full competency was not our goal. Rather, we wanted the students to gain hands-on experience to examine agribusiness issues using data analytics that could create a basis from which to connect with potential employers. The broad knowledge of data analytic concepts would allow them to demonstrate they are familiar with data analytics. We set a course goal for the students to develop a "learn to learn" approach for them to become fully competent with contemporary data analytic methods and to examine real-world agribusiness issues.
4. *Students need to have a good understanding of statistics, preferably a basic econometric class, and proficiency using Excel*. The students that had a good understanding of statistics and had studied econometric models previously were able to complete the assignments and understand the results. However, a portion of the students were deficient in basic statistics and were not proficient using Excel to achieve the assignment objectives. Changes to the agribusiness curriculum may be necessary to achieve a minimum level of competency of data analytics for a broader group of students.

This agribusiness content could be extended to extension audiences through various means of dissemination. The student webinar recordings could be packaged together with supplementary materials and offered as a self-paced course for an agribusiness audience to learn to develop their own firm-specific analyses. Further, the materials could provide a base to offer to an agribusiness firm a short course to improve the data analytic skills of their employees. The material could also serve as a base to develop a webinar and/or workshop series focused on agribusiness data analytics for extension clients. Some extension clients may not have the time to learn data analytic skills or how to use the above decision tools, but could gain from a more generic risk analysis done by an extension specialist. For example, the optimized feed rations done in data assignment 3 could be disseminated in webinars, workshops, or extension publications to regional dairy farmers and updated with the latest prices and distributions for ingredients.

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Teaching and Educational Methods

Personalizing Online Classes: The Use of Evaluation and Participation Tools

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JEL Codes: A20, A22
Keywords: Online, teaching, evaluation, active learning, learning interaction

Abstract
Self-directed online learning is challenging for many students. Limitations in interaction with the instructor, difficulty in focusing in the major messages of the course, and not active encouragement in the video lectures are common constraints. In this article, I present a case study in which I implemented in my classes two methods to overcome these limitations: the use of online evaluation tools and in-person review sessions. Utilizing regression modeling and the qualitative information of the class evaluations, I argue that the use of these methods has presented positive impact in the learning process of the students and improved the interaction between instructor and student.

1 Introduction

In recent years, online classes have become a more frequent alternative to taking courses on campus in many universities and colleges. Approximately 6.7 million students took at least one class online during Fall 2011, which is about one third of students enrolled in higher education (Allen and Seaman 2013; Kentnor 2015). Growth of distance education is steady and positive. The number of students taking an online course increases at an annual rate of 3.7 to 3.9 percent per year (Allen and Seaman 2016). However, online teaching faces several challenges and barriers (Horvitz et al. 2015). These include:

(1) *Low motivation for active learning*: Much of the online learning is self-directed, where success depends on attractiveness of the content and clearness of the instructions (Drange, Sutherland, and Irons 2015). Online videos often do not capture the attention of students, and many students may just watch part of the content that may help them to solve the assignments required for the course.

(2) *Student and instructor interaction limitations*: This is mainly accomplished through email, which is seen often as impersonal (Liu et al. 2007; Shea 2007). In addition, teaching mathematics in economic courses online may be challenging because students may have questions while watching the video lectures. This becomes a major issue with the increase in the number of students participating in the course.

(3) *Software compatibility issues*: When working with computer simulations for economics, many students may face difficulties when solving these exercises because of external factors such as the utilization of different types of operative systems (i.e., Windows, Linux, or MacOS), or versions of the software (Excel 2013 vs. Excel 2019; Perreault et al. 2002).

These challenges raise some important questions: How do you encourage active learning in online courses? How do we motivate students to watch videos lessons? How do we deliver the core messages of a course in an online platform? These concerns are especially critical when teaching economics, which involves the use of mathematical tools. Thus, there is a need to find an integrated methodology that is able to overcome these challenges to provide a similar experience as classes taught face-to-face.

In this article, I address these challenges by presenting several methods assessing active learning and engagement in student-instructor interaction through the use of online evaluation tools, and in-person review sessions and computer labs. Economic instructors may implement the proposed methodologies and adapt them to their specific courses at any higher-education level. This paper presents a brief description and procedure of each method and how to implement them, including a case study that discusses the implementation, evidence on students' performance, and students' perceptions of the class.

2 The Case Study

2.1 Course Background

During 2019, I was in charge of teaching an online the course entitled "Quantitative Methods in Food and Resource Economics (FRE)." This is a required upper division undergraduate course for FRE and agribusiness majors, which involves the use of math and economic theory, including the use of matrices, multivariate calculus, linear optimization, and computer simulations of economic problems. "Quantitative Methods in FRE" is divided into 10 units. Each unit is delivered via online lectures. The framework of each unit is described in Figure 1. This class is offered every semester.

This class has some special features, including: (1) in Spring 2019 the class was offered only online for the first time; (2) I am the sole instructor, with no in-person option; (3) the instructor is not located on the main campus; and (4) this core course is also a base and prerequisite for many other courses in the major. Therefore, this course required careful planning, especially because of the intensive use of math and Excel simulation, which is challenging for many students.

2.2 Methods to Personalize Online Classes

To address the challenges presented by online courses, I developed the following series of methods, which are classified depending on the concern being addressed. The first category is active learning, in which the instructor attempts to motivate students to engage in the online lessons and watch the video lectures through the use of two tools: *pre-labs* and *quizzes*. The second group is the personalization of online classes, in which the goal is to interact with students face-to-face on specific occasions, providing *review sessions* and *computer labs*.

Pre-labs are small tasks that may include a set of theoretical and practical questions that are required to be fulfilled before labs or assignments. Pre-labs are extensively used in biology and chemistry sciences because it allows students to learn the conceptual material and be prepared before the actual lab experience (Cann 2016). Thus, I developed one pre-lab per unit. The pre-lab task is intended to guide students to learn the most important concepts of the economics lecture videos. It is usually turned in four days before the homework assignments. Each pre-lab contains short theoretical questions and about four to five practical problems. The solutions to each question are presented in the video lectures. Thus, to finish the pre-labs, students must watch all videos to find the answers. The class also has *online quizzes* for each unit. These quizzes are variations of the pre-lab problems and are short in nature, usually two or three questions with a duration of 15 to 30 minutes. Both tools encourage students to watch the videos because the pre-labs and quizzes are graded. Solving these small tasks allow students to have a better idea where

Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
System of Equations	Functions	Matrix Algebra	Foundation of Derivatives	Application of Derivatives
Unit 6	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**
Multivariate calculus	Matrix in Optimization	Linear Programming	Computer Applications	Integration

Figure 1. Units of the "Quantitative Methods in FRE"

to focus their efforts. In addition, it allows me as an instructor to detect areas for improvement before homework assignment deadlines, to be able to provide more examples for challenging units.

The next two techniques address the in-person experience: *computer labs* and *in-person review sessions*. Unit 9 offers computer applications of economic problems (input-output tables and linear programming problems) using Microsoft Excel. Many students may face difficulties when solving the exercises because of external factors such as the utilization of different types of operating systems (i.e., Windows, Linux, or MacOS), or versions of the software (Excel 2013 vs. Excel 2019). For this reason, the Teaching Assistant (TA) of the class hosts optional computer labs, where the TA assists the students with examples presented in the video lectures. Thus, students have a better perspective on how to solve the computer applications.

The class has three exams (two midterms and one final exam). On average, three units of material are covered for an exam. Thus, the professor hosts review sessions every two or three weeks, which overall is the week before the midterm exams. The instructor travels to the main campus to meet with the students and assist with any questions from the class and provide a study guide for the exam, which summarizes the major concepts and methodology learned in the class. In addition, during these sessions, the instructor provides additional exercises to reinforce learning objectives.

2.3 An Evaluation of Personalization Methods

These methods were implemented in the "Quantitative Methods in FRE" class in Spring 2019. Overall, the structure is the following: midterms, homework assignments, pre-labs, and quizzes (Table 1).

A total of 53 students took the class in Spring 2019. To evaluate the effectiveness of the pre-labs and quizzes or homework assignments, a linear regression was estimated as shown in equation (1):

$$HW_i = \beta_0 + \beta_1 PL_i + \beta_2 Q_i + \varepsilon_i, \tag{1}$$

where HW_i represents the grade on the assignment (0–30 points), PL_i is the score on the pre-lab (0–10 points), Q_i is the score in the quiz (0–15 points), and $\varepsilon_i$is the error term that is assumed to be mean zero, IID, and normally distributed (no heteroscedasticity or clustering were detected in preliminary evaluations of the data[1]). In case there are more than one quiz or pre-lab for each assignment, the average of the tasks was taken.

In addition, I collected qualitative information with respect to students' perceptions of the tools used in the class through anonymous surveys and students' teaching evaluations at the end of the semester. Questions regarding the effectiveness and perception on the review sessions, quizzes, and pre-labs were asked on the survey (Figures 2 and 3), and additional comments on the class organization and structure

Table 1. Distribution of Tasks in "Quantitative Methods in FRE," Spring 2019

Description	Quantity	Value per task	Total points
Pre-Labs	9	10	90
Quiz	13	15	195
Homework	9	30	270
Excel Application	1	30	30
Midterms	2	100	200
Mini-Project*	1	15	15
Final Exam	1	200	200
TOTAL			1,000

[1] Results of evaluations for heteroskedasticity and heterogeneity are available from the author upon request.

Are the pre lab assignments adequate and helpful to understand the content of the class?

1		0 %
2		0 %
3	5 respondents	10 %
4	17 respondents	33 %
5	29 respondents	57 %

Figure 2: Midsemester Survey Response with Respect to the Pre-Labs

Are the quizzes adequate and helpful to understand the course?

1		0 %
2	1 respondents	2 %
3	7 respondents	14 %
4	16 respondents	31 %
5	27 respondents	53 %

Figure 3: Midsemester Survey Response with Respect to the Quizzes

were also asked in the faculty evaluation (for information regarding the questions in the surveys, please see the supplemental material).

3 Results and Discussion

Over the course of the semesters, there were a total of 1,000 points that students could earn (Table 1). A total of 477 observations were analyzed in the regression (53 students over 9 assignments). The average performance for each task is provided in the descriptive statistics in Table 2. Overall, students obtained an average value between 25 to 29 points on the assignments. Nevertheless, there was a standard deviation of 5 to 6 points in each assignment. The most challenging unit for the students was unit 7 (use of matrices in optimization).

The estimated linear regression of homework assignments (HW) with respect to pre-labs (PL) and quizzes (Q) is the following:

$$HW = \underset{(0.10)}{14.96} + \underset{(0.09)}{0.68}PL + \underset{(5.47)}{0.39}Q + \varepsilon \qquad (2)$$

The standard errors are in parentheses. The coefficients of the regressions are statistically different from zero at the 1-percent level of significance. The regression provides important insights. Overall, students that do not complete any pre-lab or quiz score only 50 percent on the assignments (15 out of 30 points). Pre-labs have a positive connection with assignments. On average students get 7 points higher when successfully solving the pre-lab problems. Quizzes also have a strong positive correlation with performance on assignments.

A mid-semester survey was provided to the class, in which 51 out of 53 students responded, resulting in a 96-percent response rate. The results show that most of the students find the pre-labs (Figure 2) and quizzes (Figure 3) adequate and helpful to understand the content of the class (90 percent and 84 percent of students, respectively).

The final course evaluation was filled out by 45 students (approximately 85 percent of the class). In the overall assessment, students praised the class as engaging and different from other online classes. The overall rating was 4.78/5, which provides a good indicator of the quality of the class. The text responses praised the enthusiasm of the instructor, review sessions, the quality of the video lectures, and the assignments, among some of the comments (provided in the supplementary section):

> *"I thought the course was very good. Everything was set up and organized from the beginning of the semester, and it was very easy to follow along. There were not many printed materials, as it was an online class, but the course materials did include most things such as video lectures and notes, which were very useful. I really enjoyed how the class was set up to first have the pre-labs to give you an introduction to the concepts, then the quizzes to begin application, and the assignments, which were full application of the concepts. It was a gradual increase of difficulty that was appropriate."*

Table 2: Average and Standard Deviation of Each Task Assigned in the Class

N = 478

	Available	**Unit 01**		**Unit 02**		**Unit 03**		**Unit 04**		**Unit 05**		**Unit 06**		**Unit 07**		**Unit 08**		**Unit 10**	
	Pts.	*Avg.*	*St.D*	*Avg.*	*St.D*	*Avg.*	*St.D*	*Avg.*	*St.D*	*Avg.*	*St.D*	*Avg.*	*St.D*	*Avg.*	*St.D*	*Avg.*	*St.D*	*Avg.*	*St.D*
Pre-lab	**10**	**9.6**	*1.6*	**9.8**	*1.4*	**9.3**	*2.3*	**9.5**	*1.5*	**9.5**	*1.6*	**8.7**	*2.9*	**7.8**	*3.9*	**9.2**	*2.6*	**9.3**	*2.0*
Quiz A	**15**	**14.4**	*2.0*	**14.4**	*2.9*	**13.4**	*3.5*	**13.7**	*3.1*	**12.5**	*3.0*	**13.1**	*3.8*	**12.1**	*3.4*	**14.0**	*2.5*	**13.2**	*3.4*
Quiz B	**15**			**13.7**	*3.2*									**13.0**	*2.7*	**12.5**	*2.7*	**13.8**	*4.0*
Assignment	**30**	**26.7**	*4.7*	**27.6**	*4.7*	**25.6**	*7.2*	**26.4**	*6.2*	**25.6**	*6.6*	**25.7**	*6.4*	**25.4**	*5.6*	**25.8**	*4.4*	**28.9**	*5.7*

Avg. : Average score in the assignment. *St. Dv.* : Standard deviation in the assignment.

(Note: Some units have two quizzes)

"I like how this course is organized. Good balance between lecture videos, assignments, and exams."

"The class was fair. Good online class. I like how the professor came to campus for in-person exam reviews."

"The review sessions are very helpful, and the professor and TA are always eager to help whenever I have questions. They show great concern for the students in the class."

"The course has taught me a lot. At first I was intimidated by it because calculus isn't my forte; however, the instructor explains his materials well and is very helpful towards his students."

"Paced well, assignments are easy to understand, reminders were wonderful."

On the other hand, there were other comments that suggested some improvements:

"Actually really enjoyed it. I learned a lot! Wish we would have used the book more, but I got most of my practice from assignments and pre-lab work."

"I believe the pre-labs were not always necessary depending on the difficulty of the module. For certain modules, I believe just a quiz and assignment would have been enough to learn the module."

To summarize, the efforts to personalize the online course have been praised by the students in their class evaluation reviews because they feel that the class is engaging and that the instructor is involved in the learning process. They found very valuable the effort of the professor in providing in-person review sessions, as they were able to solve inquiries regarding the class and reinforce the knowledge gained in the video lessons. The in-person computer labs were also useful for the students, especially for those who were working with Microsoft Excel for first time. However, one major drawback of this technique is the time commitment for the professor, as this requires substantial time to review the pre-labs and the time involved to conduct the review sessions.

4 Conclusions

In recent years, online classes have become a more frequent alternative to taking courses in many universities and colleges. However, teaching online classes faces many challenges, such as lack of interaction between students and instructors; and lack of focus from the students on the major concepts provided in the online video lectures. How do we include active learning in online courses? How do we improve the interaction with students to provide a similar experience as face-to-face class sessions? This article provides some insights to these questions. Two techniques may be used to improve the active learning: (i) pre-labs, which are short questions based on the videos, which can help students to focus on learning the major concepts; and (ii) quizzes, which provide further practice before attempting the homework assignments. To overcome the limitation of the student-instructor interaction, this commentary proposed the use of review sessions and computer labs, which require the instructor to meet with students face-to-face to reinforce major learning objectives, applications, and concepts of the class. These personalization methods were implemented in a required economic class and obtained positive reviews from students. Overall, students praise the effort of the professor to personalize the class, and some students perceive it as beneficial to have the online lessons together with in-person review sessions as a different learning experience.

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Teaching and Education Commentary

The Do Now: A Simple, but Effective Active Learning Strategy

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Abstract
Students often have difficulty applying concepts discussed in lectures. Using practical guidance that allows for flexibility in implementation, I highlight the Do Now as a short, practice exercise that promotes just-in-time instruction. My approach stresses application of course concepts to improve student self-efficacy and performance. A supplemental teaching note provides additional guidance on implementation.

1 Introduction

Think about it. You can take one route 10 times as a passenger, but you will not remember the directions until you drive the route yourself, usually more than once. Why, then, would we expect students to remember and drive routes if we do not give them time behind the wheel? It should not be surprising that what we discuss in lecture does not necessarily translate into learning. Students must work through examples themselves, see where they have made mistakes, and reflect on what they can do differently to get a better result (Prince 2004).

This article provides guidance on implementing the Do Now,[1] a one- or two-question practice exercise typically assigned at the start of class. The Do Now is common in elementary and secondary education, and there is some mention of its use in university teaching (Shen and Frances n.d.). As described informally online, the Do Now can range from lesson summaries to quizzes but normally includes written exercises that are completed individually.

Here, I provide *my take* on the Do Now as it applies to undergraduate teaching of math, statistics, or other problem-oriented courses that students tend to find inherently difficult. My approach is purposely less focused on logistics and purposely more focused on student learning objective. The benefit of the Do Now is in the "doing."

2 Background

The Do Now allows students to practice solving problems in a low-stakes environment, an experience that fosters self-efficacy (Bandura 1977), which is especially important when math (or, anything that resembles math) is involved (Pajares 1996). Relative to structured, in-class activities, the Do Now is easier to implement, requires less pre-class preparation, and uses less class time (typically, five to seven minutes). Given the dominance of lecture in the teaching of economics (Goffe and Kauper 2014) and many other disciplines (Jones 2007), the Do Now is a simple tool that may be used to make class time more interactive, regardless of class size. It allows instructors to assess students' progress toward meeting objectives and to provide timely feedback to advance the learning process (Cauley and McMillan 2010).

After realizing (the hard way) that students have difficulty applying concepts discussed in lecture, I introduced the Do Now in my econometrics course. As *anecdotal evidence* of its effectiveness, students'

[1] The original source of the term is unknown.

perception of whether they "gained a good understanding" of course content, as anonymously reported on course evaluations, increased from an average of 3.8 on a 5-point scale (response rate of 48 percent) in one semester to 4.5 (response rate of 65 percent) in the following semester during which the Do Now was implemented.

The following student comments (unadjusted for writing errors) provide insight regarding the importance of incorporating practice problems throughout the course. When describing the "weakest aspects of this course or instructor" before the introduction of the Do Now, one student stated, "I think that students could be much more prepared for her tests with practice problems, q&a's, and exercises ...." Another student commented that the instructor "rarely tries to keep students engaged with practice problems or applications." In contrast, when describing the "strongest aspects of this course or instructor" after the introduction of the Do Now, one student stated that "the practice problems and the case analysis helped me to get a feeling of how we can apply those concept in real life situations." Another student noted, "Doing practice in class was the most helpful thing that we did. Just listening to the slides on such a difficult subject is hard—it's better to see the concepts in action."

Although the Do Now is not mentioned explicitly, students' comments suggest that the inclusion (or lack) of practice problems affects their learning and ability to succeed. Because the words *hard* and *difficult* often appear in my course evaluations, my challenge is to find ways to help students meet the standards that I set when designing the course. The Do Now has helped in that process.

3 Implementation

The effectiveness of the Do Now depends in equal parts on (1) choosing the right problem and (2) spending adequate time debriefing.

3.1 Choosing the Right Problem

Designing a good Do Now problem requires some trial and error; and, depending on need, problems may take on various forms. A good problem has three basic characteristics:

1. *It is objective based*: Consider what you want students to accomplish. Then, identify an appropriate application problem. Avoid recall questions, opinion-based questions, and questions with yes/no answers.
2. *It is moderately challenging*: Remember, we want to build self-efficacy; overly difficult problems that result in repeated failures can have the opposite effect (Bandura 1977). In contrast, overly easy problems can be perceived as busy work.
3. *Its expected completion time is no more than two minutes*: Work through the problem yourself, step by step. Doing so helps you fully consider the time and process involved in completing the problem and provides a point of reference for debriefing. Expect students to take two to three times, or even as much as five times, as long as you do. If the expected completion time is more than two minutes, tweak the problem.

Presenting the problem is easy. Simply write "Do Now" on the board or PowerPoint slide with the question underneath. Limit your presentation of the Do Now to information, equations, or figures needed for problem solving (Beatty et al. 2006). Figure 1 provides textbook-based Do Now examples from my econometrics course and demonstrates how to apply the problem-selection criteria. Figure 2 presents an example incorporating peer-reviewed research. Each Do Now relates to a learning objective and requires an application of course concepts that is feasible in two minutes. When assigned, each Do Now would be considered moderately challenging.

While students work, walk around to observe. Since cooperative exercises are incorporated elsewhere in my course, I allow, but do not require, students to work together. That is, I do not impose structure on how students do the problem. In any case, I recommend consistency in your preference regarding individual versus group work so that you virtually eliminate time spent giving instructions. Students quickly realize that the instructions truly are in the name.

	Do Now Example	Application of Problem-selection Criteria
(a)	**Do Now** **Let $Y \sim N(3, 9)$. What is $Pr(Y > 0)$?** **Hint:** • **Step 1:** Standardize. • **Step 2:** Convert. • **Step 3:** Search.	**(1)** Assesses the ability to compute probabilities using the standard normal distribution **(2)** Requires relating the normal and standard normal distributions in multiple steps **(3)** Doable within 2 minutes
(b)	**Do Now** **Assume the following estimated equation, where *price* refers to the price of a home, *nox* refers to the level of air pollution, and *rooms* refers to the number of rooms in the house.** $\widehat{log(price)} = 9.23 - 0.72\, log(nox) + 0.31 rooms$ 1. **What is the precise interpretation of each estimated slope coefficient?** 2. **Is the price of a home relatively elastic or inelastic with respect to the level of pollution?**	**(1)** Assesses the ability to meaningfully interpret empirical results using econometric conventions **(2)** Requires identifying and interpreting slope coefficients based on functional form **(3)** Doable within 2 minutes
(c)	**Do Now** **A researcher plans to study the causal effect of police on crime using data from a random sample of U.S. counties. He plans to regress the county's crime rate on the (per capita) size of the county's police force.** 1. **What is the most important variable you would add to the regression to correct for omitted variable bias (OVB)?** 2. **Explain if the OVB resulting from excluding that variable is likely positive or negative.**	**(1)** Assesses the ability to detect and correct omitted variable bias **(2)** Requires making a recommendation, then reassessing a model to draw conclusions **(3)** Doable within 2 minutes

Figure 1: Application of Problem-selection Criteria to Do Now Examples

Note: The problem-selection criteria include choosing an application problem that is (1) objective based, (2) moderately challenging, and (3) doable within two minutes. Example (a) is adapted from Stock and Watson (2015, p. 58). Example (b) is adapted from Wooldridge (2016, p. 171). Example (c) is adapted from Exercise 6.6 in Stock and Watson (2015, p. 210), reprinted by permission from Pearson Education Inc., New York, NY.

3.2 Debriefing

Time spent debriefing varies but usually takes three to five minutes. In general, debriefings are R.A.D. and involve three steps: **R**eveal, **A**sk, and **D**emonstrate.

1. *Reveal the answer* (**R**): If there is not one right answer, open with a brief discussion of two or three student answers. Kindly acknowledge inaccuracies, and celebrate valid responses.
2. *Ask about process* (**A**): Doing so reveals how students are thinking about the problem and where they are having difficulty. Consider asking students to identify approaches to the problem, the most important information needed to solve the problem, or the hardest part of the process. Discussing why alternative responses are incorrect is also instructive, especially when many students arrive at the same incorrect answer.

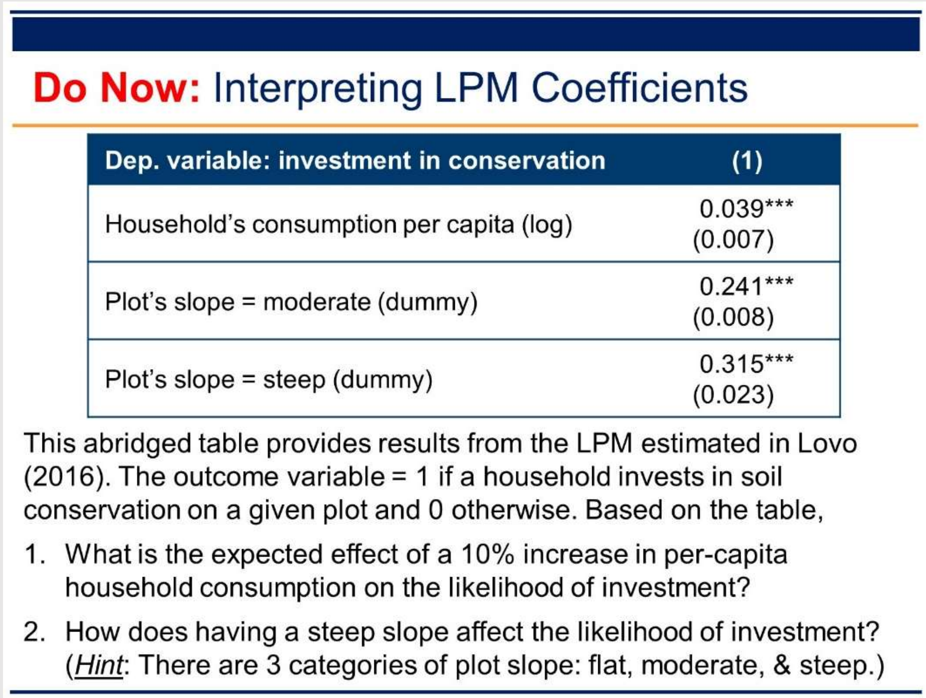

Figure 2: A Do Now Focused on Select Results from Table 3 in Lovo (2016): "Tenure Insecurity and Investment in Soil Conservation. Evidence from Malawi."

Note: LPM refers to the linear probability model. As an assignment, students read Lovo (2016). The table above is abridged to focus only on results needed to assess students' abilities to interpret estimated coefficients on variables of different forms. We discuss the paper at length. As initial practice, students interpret the results of the main variables of interest (not shown). This Do Now is used as a follow-up example for additional practice.

3. *Demonstrate the recommended approach* (**D**): Explain why the approach is recommended but acknowledge other possible approaches. Note that the recommended approach is not necessarily a sequence of required steps but rather a way of thinking through the problem-solving process. However, if explaining a multi-step problem, avoid skipping steps because doing so tends to confuse students, and remember to provide tips for aspects of the problem that students found difficult.

Debriefing is meant to be a fluid discussion, so try to be flexible in how you move through the different steps. Revealing the answer is normally the quickest part of debriefing. Devote more time to discussing process and recommended approaches to guide students toward self-regulation and to emphasize the evaluation of various problem-solving strategies (Schoenfeld 1987).

Since students may make incorrect statements or share strategies that you or others believe are relatively ineffective, the debriefing process is not always a "comfortable" one. As facilitator, you must create an encouraging environment both verbally and nonverbally so that students trust the process (Cauley and McMillan 2010). Rocca (2010) provides a summary of instructor behaviors that positively and negatively affect student participation (194–197). If you model supportive and respectful communication, your students will follow suit, and the integrity of the exercise will be upheld.

Be careful not to get lost in the discussion. To avoid spending too much time debriefing, keep in mind your original objective, and guide the discussion in that direction.

4 Guidance on Potential Variations

My principal recommendation is to strategically use the Do Now as a low-stakes, formative assessment that focuses on application. Below I provide general advice regarding five potential variations.

1. *Stagger with increasing difficulty*: Break up a lecture with a Do Now that mirrors an example you recently discussed, and consider displaying recommended steps along with the exercise. To start the next class, use a problem that requires the same knowledge but presents the information in modified form, requiring deeper thought about the content.
2. *Use a two-part problem to provide a hint*: The first part focuses on retrieval and the second focuses on application. For example, ask students to recall a formula or other critical information. Then, ask a question that requires them to apply that information.
3. *Embed the Do Now in a think-pair-share exercise to add structure* (Maier and Keenan 1994): Have students think about the problem for 30 to 60 seconds, then instruct them to work through the problem in pairs. Debriefing inherently includes a sharing aspect.
4. *Let students inform the topic*: At the end of class, assign a one-minute paper in which students identify concepts for which they would like additional practice or clarification (Stead 2005). Skim the responses after class to determine a common theme, and assign a Do Now to facilitate a mini review.
5. *Assign a challenging problem as a take-home exercise*: At the start of the next class, facilitate debriefing as a pair-share exercise, allowing students two minutes to compare work before engaging in whole-class discussion.

Lastly, because the Do Now is an early warning system, it could prove more difficult than expected. If so, one strategy is to stop the class at the two-minute mark, note points of confusion, and provide a quick redirection. Then, give students one or two minutes to continue working. If redirection is insufficient, consider walking students through the problem, reiterating important concepts. Then, move on with your lesson, but start the next class with a similar problem. If the Do Now was assigned toward the end of class, let students complete it at home, and use it as the starting point for the next class. Remind students why the exercise is important so that they perceive the use of class time as beneficial. For extrinsic motivation, consider awarding participation credit for completion of problems and including similar problems on exams.

5 Conclusion

The Do Now is simple, flexible, and effective. It is a one- or two-question practice exercise that requires less prep time and less class time than more structured, in-class activities; hence, it may be used in every class period or, as I recommend, selectively throughout the course. The Do Now provides opportunities to assess students' progress in meeting objectives and to provide just-in-time instruction. The keys to its effective use are choosing an appropriate problem and allowing adequate time for debriefing. Expected outcomes include increased student self-efficacy and, ultimately, improved student performance on summative assessments. A supplemental teaching note provides guidance to further assist in implementation.

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