Reshaped for Higher Order Learning:
Student Outcomes in the Redesign of an Undergraduate Macroeconomics Course

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Abstract

We consider the impact on student learning of the re-design of an undergraduate macroeconomics course. Changes were made to move from lower- to higher-order taxonomic dimensions, with emphasis on application and analysis. We use 13 questions which appeared on final exams before and after the re-design to evaluate changes in student learning outcomes. The analysis shows that after the re-design students improved performance on questions classified as higher-order, while performance suffered on lower-order questions. These results suggest that the re-design was a shift in teaching and learning resources, not an overall improvement that impacted equally all taxonomic dimensions. The course before the re-design may have used its resources well, though following the re-design the reallocation of resources improved application and analysis over memorization and understanding.

Keywords: undergraduate instruction, Bloom's taxonomy, high-order taxonomy, macroeconomics

JEL Codes: A20, A22

Data suggests that the majority of introductory economics courses are taught using a traditional lecture format, despite research which suggests student learning and engagement outcomes improve from a variety of instruction styles (Lage et al. 2000). Suggestive evidence on the value of varying teaching styles and active learning is abundant, challenging the traditional instructor-focused "teaching by telling" method (Bonwell & Eison 1991, Prince 2004, Freeman et al. 2014). Despite this surfeit of evidence, quantitative evaluations of the outcomes resulting from a change in teaching methods and the impact on student performance remain limited (Sorcinelli 1991, Freeman et al. 2014). In this article, we seek to contribute to the literature on economic instruction by quantifying the outcomes, measured as change in performance on exam questions, from a series of changes which included varying instruction styles in an introductory macroeconomics course.

In a 2005 survey of academic economists teaching undergraduate courses at postsecondary institutions in the United States, 83 percent of instructors reported using traditional lectures for instruction in introductory courses (Watts & Becker 2008). This is a somewhat high percentage, compared with other disciplines, where approximately 59 percent of instructors are reported to use traditional lectures (Cashin 2010). Across disciplines, evidence suggests that varied teaching and styles, including inverted classrooms, group projects, and active learning have positive effects on students (Bonwell & Eison 1991, Prince 2004, Freeman et al. 2014). This includes evidence of both improved student performance, measured by increased test scores and exam performance (DeNeve & Heppner 1997, Brooks & Khandker 2002, Nguyen & Trimarchi 2010, Caviglia-Harris 2016) as well as greater interest in the discipline (Johnston et al. 2000, Lage et al. 2000, Jensen and Owen 2001, Hawtrey 2007). Within the economics field, previous literature has suggested that topic matter lends itself well to varied

instructional methods (Clerici-Arias & Taylor 2000, Becker 2004). While there is evidence that student performance on exams improves with these varied learning preferences, in economics in particular there is abundant evidence that student interest in the subject also increases. Lage et al. (2000) encourage the use of an inverted classroom, due to ability to engage many different learning preferences and evidence that students prefer the flipped classroom style. Similarly, Jensen and Owen (2001) find that decreased use of lecture and increased emphasis on group and collaborative learning promoted student interest and further encouraged them to take more economics courses and to even become economics majors in the future. Hawtrey (2007) determines that students have a general preference for active learning activities, particularly those which are experimental in nature. Finally, some of the strongest evidence for cooperative and active learning in economics comes from Yamarik (2007) who finds that cooperative learning leads to better academic performance, as measured by test scores.

Following results such as these, after more than twenty years with a lecture-based structure, in the fall of 2013, changes were made to a large-enrollment introductory course, composed largely of freshmen and sophomores. In this article, we refer to these changes as "the re-design". The main objective of the re-design was to shift learning outcomes towards the higher-taxonomy orders of application and analysis, from lower-taxonomy orders of memorization and understanding. This involved changing the structure of the course from twenty-eight 75-minute lectures to a four module structure with fewer in-class meetings. Each module included some lectures, but also independent quizzes, group in-class projects, a brief essay as well as question and answer sessions before a module exam. This arrangement represented a partial "flip" of the course. The number of lectures was approximately halved and

lectures were modified to emphasize application and analysis of macroeconomics, using data and models to analyze economic events and policy choices from the past and present.

After the re-design, in-class lectures were shortened and students were expected to take on independent learning. This involved learning basics about data and models through textbook readings and short videos edited from past recorded lectures. Additionally, each module included several assignments: 1) six guided study quizzes, 2) a group project, 3) a spreadsheet assignment and 4) a brief peer-graded essay. An exam followed each module, with a comprehensive final exam serving as the forth module exam. The spreadsheet assignment was used both before and after the course re-design, but the quizzes, group project, and essay were each new components. We discuss each of these briefly below.

First, the six "guided study" quizzes were composed of five multiple choice questions each and allowed students to test themselves on their knowledge of the basics. The quizzes drew randomly from a larger pool on each basic topic, and students could repeat each quiz until they achieved a perfect score. The random draw resulted in quizzes which were different with each attempt. Students trying for a perfect score of five correct answers might take each quiz two or more times, so that they may see ten or more quiz questions. These quizzes represented a low-stakes study tool.

Next, group projects utilized the jigsaw approach for preparation before the project in-class. Each student was randomly assigned to a four-person group. Each member of the group became an "expert" on a different topic, by studying and taking a quiz about a different aspect of the in-class project. Then, each of the four took a different quiz in advance of the in-class group work. For example, in the second module, one student would answer quiz questions about gross domestic product, another about inflation, a third about unemployment, and a fourth about

interest rates. Each group would then complete a project in-class, which was a set of questions that required contributions from each student, involving each student's quiz topic. The jigsaw quizzes prepared each student to contribute to the discussion, and created individual accountability to the group.

Third and finally, as a capstone to each module, students would read a media article or excerpts of a government document about an economic issue, and write a short essay analyzing the issue by applying the data and model. Essays were peer-graded using Purdue's Gradient peer review software.[1]

Exams were multiple choice, as summative, multiple-choice exams still serve as the primary method for determining student grades in introductory economics courses (Rebeck 2011). After the re-design, more application and analysis questions and fewer memorization and understanding questions were included. A number of questions from the pre-re-design final exam continued to be included post-re-design, to allow evaluation of the re-design's impact on student learning. We evaluate changes in student performance on these questions so as to evaluate how the course changes affected students' learning, measured by performance on exams. The analysis considers 13 questions: 6 of which were categorized as elements of lower-order taxonomic dimensions and 7 of which were categorized as elements of higher-order taxonomic dimensions.

Overall, the course re-design attempted to shift learning towards the higher order taxonomic dimensions of application and analysis in several ways. First, lecture content was re-focused to highlight these objectives. Second, since practice is needed to learn to apply economic concepts to analyze issues (Ericsson et al. 1993, Prince 2004), the guided study quizzes provided a means to practice and an incentive to do so. Third, the spreadsheet assignment required analysis of data. Fourth, the jigsaw quizzes and group projects engaged students in applied

problem-solving. And finally, the peer-graded essays asked for free-form analysis of issues, practice for the post-course world where issues are presented by the media. Taken together, these efforts reallocated time-on-task towards higher-order taxonomic dimensions.

DATA AND METHODOLOGY

Data Collection

Demographic and student performance data were collected from the following semesters: spring 2012, fall 2012, fall 2013, spring 2014, and fall 2014. All courses were taught by the same professor. Data from the spring 2012 and fall 2012 semesters were coded as "pre-redesign". Re-designs to the course format described above occurred during the spring of 2013 and were implemented in fall 2013. Fall 2013, spring 2014, and fall 2014 data were coded as post-re-design data. IRB approval was granted through the university to analyze these data retrospectively.

Demographic Data

We consider student demographics as such characteristics may be influential in student performance (Yamarik 2007). We consider year in school (i.e., freshman vs. non-freshman), term GPA, international status, and underrepresented minority status (URM). For more detail about these groups, please see Table 1.

TABLE 1 ABOUT HERE

Next, in order to verify that demographic differences could not account for detected changes in student performance, multiple chi-squared analyses were run on the different possible

data sets (e.g., spring 2012 + fall 2012 vs. spring 2014). We did not find any differences which would significantly influence our results. Specific comparisons are available in the appendix.

Student Performance Data

The structure of the re-design was such that not all exam questions were used every semester. The complete data set of twenty-two questions includes all questions that were asked at least one semester before and one semester after the re-design. We consider thirteen in this article as determined by the following process. In order to ensure validity, the twenty-two questions were distributed to three external content experts for evaluation in validity and mapping to a taxonomic dimension. Following Rovinelli and Hambleton's (1977) item classification guide, 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). To determine alignment with the instructors 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) re-design.[2] The dimensions remember and understand are classified as lower-order, while apply, analyze, evaluate, and create are considered higher-order classifications. Our analysis includes only the multiple choice questions common to both exams, rather than a standardized assessment like the Test of Understanding in College Economics (TUCE) exam, primarily because the TUCE was not used prior to implementing different teaching methods. Thus, it would not have been possible to compare student performance both pre- and post-redesign.

Evaluation criteria resulted in the exclusion of several questions from analysis. Inclusion required that no item receive a single invalid rating (2 questions eliminated) and all items received at least 2 ratings of valid (1 question eliminated). Since 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 for student learning in the course. The appendix includes details on the thirteen questions considered in the analysis, and the semester(s) in which they appeared.

RESULTS

Of the thirteen final questions, six were categorized as lower-order taxonomic dimension questions ("lower-order questions"), while seven were categorized as higher-order taxonomic dimension questions ("higher-order questions"). Students performed significantly worse on four out of six of the lower-order questions after the course re-design. They did not perform significantly better on any lower-order questions post-re-design. Students performed significantly better on three out of seven of the higher-order questions, and 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 can be seen in Figure 1.

FIGURE 1 ABOUT HERE

Table 2 also shows the statistical change in performance for each question.

TABLE 2 ABOUT HERE

ANALYSIS AND DISCUSSION

Only memorization and understanding questions, in particular, those which asked about events in history, showed a significant decline in performance. For example, question 11 (available in the appendix) asked: "Among the causes of the 'Great Moderation' of the 1980's, 1990's and 2000's were," with four choices listing various causes. Before the re-design a list was presented in lecture, and the answer to this question could have been memorized. After the re-design the percentage of students answering this question correctly fell by 14.1 percentage points.

Only application and analysis questions saw significant improvement. These 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 (available in the appendix) asked: "During the 1970's 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. Students would have to know that aggregate supply depends on resource costs, and that a rise in resource costs would decrease aggregate supply. They would have to recognize which of the diagrams showed a decrease in aggregate supply. As course resources were shifted to practice the use of the model for economic analysis, after the re-design the percentage of students answering this question correctly rose by 11 percentage points.

Considering these results, we turn to the structure of Bloom's cognitive taxonomy. The taxonomy is presented as a pyramid, which implies that memorization and understanding are a foundation for application and analysis. Students must memorize terms and procedures and understand how they work together in a model. Only then are they able to apply the model to analyze a problem or issue. Thus, our results do not support this pyramidal arrangement. After the course re-design students performed better on application and analysis questions, but

performed worse on memorization and understanding questions. Full knowledge of the memorization and understanding topics was not necessary for successful application and analysis.

This shift in learning can be pictured as a production possibility frontier, as seen in Figure 2. Axes show the level of student lower- and higher-order learning. The pre-re-design course is represented by point A. The re-design shifts resources from lower- to higher-order learning. If learning was perfectly pyramidal – where lower-order learning is an essential foundation for higher-order learning – then on the diagram we would observe movement from point A to point C. The loss in lower-order learning is substantial and there is no gain in high-order learning. Course resources would not have been used efficiently. 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.

FIGURE 2 ABOUT HERE

For a specific example of why this may be the case, consider real gross domestic product growth. One of the course goals 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. Learning that during the current expansion real GDP has grown by about 2 percent per year would be useful in analyzing the economic proposals of presidential candidates who claim their programs would create growth of 4 percent or 5 percent per year. Some knowledge of how GDP is measured is necessary for applying real GDP growth to current issues. This knowledge probably includes the main components of GDP (consumption, investment, government purchases, exports, and

imports), how a price deflator is used to eliminate the influence of inflation, and how to calculate a percentage change from one year to the next. However, 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, the various ways of measuring a price deflator, are interesting and important – but they 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 knowledge of real GDP growth.

Of course, some memorization is foundational. Students did significantly worse on one higher-order question after the re-design. 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." Success on this question fell by 19.2 percentage points after the re-design. The reason was the ever-tricky term "quantity demanded." Students had to memorize the fact that an increase in quantity demanded meant a shift up an unchanging demand curve. Many did not recognize this term, and interpreted it as a shift of the demand curve itself. Before the re-design this terminological difference was covered in lecture repeatedly. After the re-design 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-re-design, the focus in the re-design was not sufficient. When memorization and understanding really are foundations for application and analysis, emphasis in class may continue to be necessary.

CONCLUSION

In the fall of 2013 a large enrollment introductory macroeconomic course was re-designed, moving away from lectures towards more engaging learning methods. The course emphasis shifted from lower order learning to application and analysis using the macroeconomic model and data. This study uses student performance on lower- and higher-order final exam questions to compare learning before and after the re-design. Based on an analysis of thirteen questions which appeared on final exams before and after the re-design, 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.

The most obvious implication of our results is that allocation of course resources matter for student results. Time-on-task shifted towards higher-order learning after the re-design, resulting in a movement along the production possibilities frontier from emphasis on lower-order to higher-order achievement. Less emphasis was placed on lower-order learning. After the re-design students improved their performance on higher-order exam questions, but saw their performance on lower-order exam questions worsen. Thus, shifting resources produced results, both positive and negative.

The change in students' performance implies that teaching and learning resource allocation towards higher order learning goals appears to have affected learning outcomes.[3] However, the shift of resources came at a cost. Although students improved their performance on higher-order final exam questions after the course re-design, performance on lower-order questions declined. These results imply that the re-design was a shift of teaching and learning resources from one kind of learning to another, not a general improvement in methods that

equally affected all learning orders. The course before the re-design may have used its resources well, but in pursuit of different achievement goals.

NOTES

[1] The efficacy of this software and the outcomes of peer grading are presently under review by the authors of this article. More information available upon request.
[2] Bloom's Cognitive Taxonomy is a structure used to classify education goals and objectives. The taxonomy is comprised of 6 domains in order from less to more complex: remember, understand, apply, analyze, evaluate, create. This taxonomy was originally completed in the 1956 and revised in 2001.
[3] Student evaluations also indicated that the course encouraged them to think critically at higher rates after the re-design. Evaluations of the course and instructor worsened for several semesters, then recovered.

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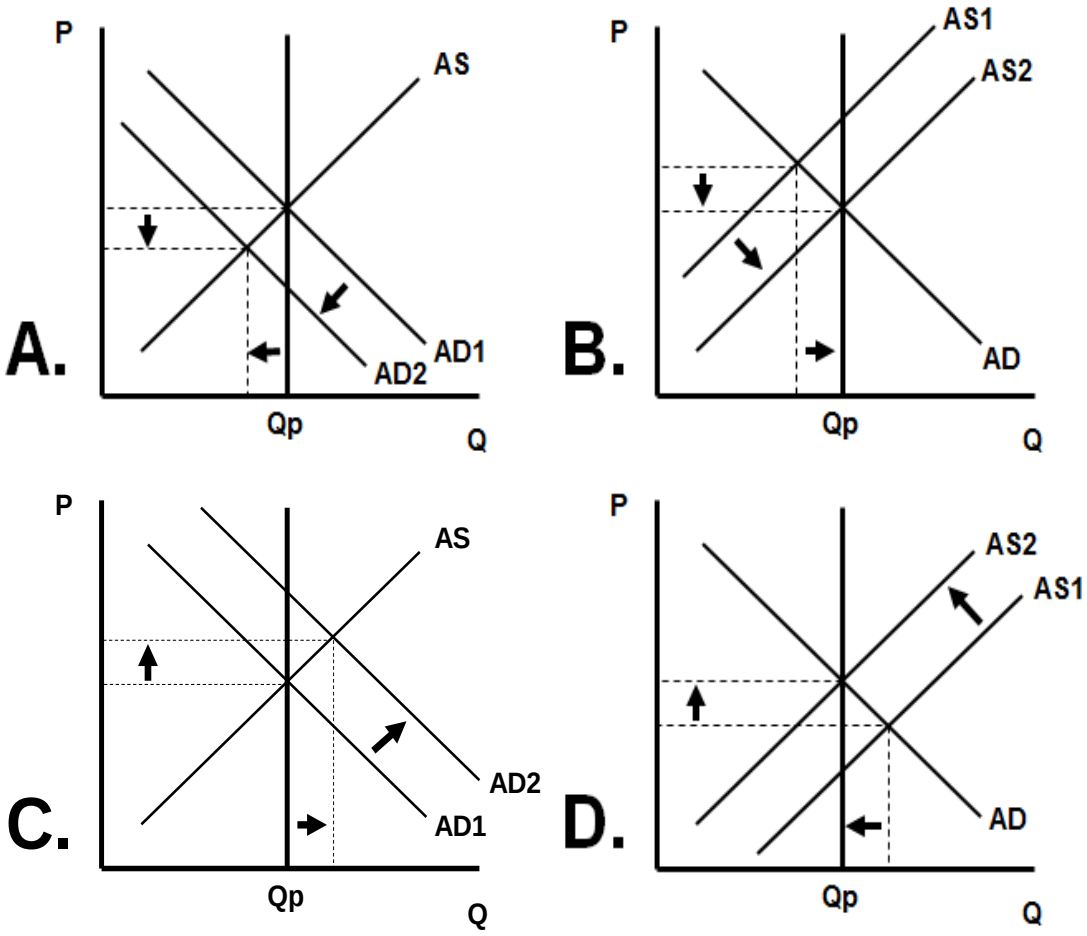
APPENDIX

A. Table 1: Questions used in Analysis

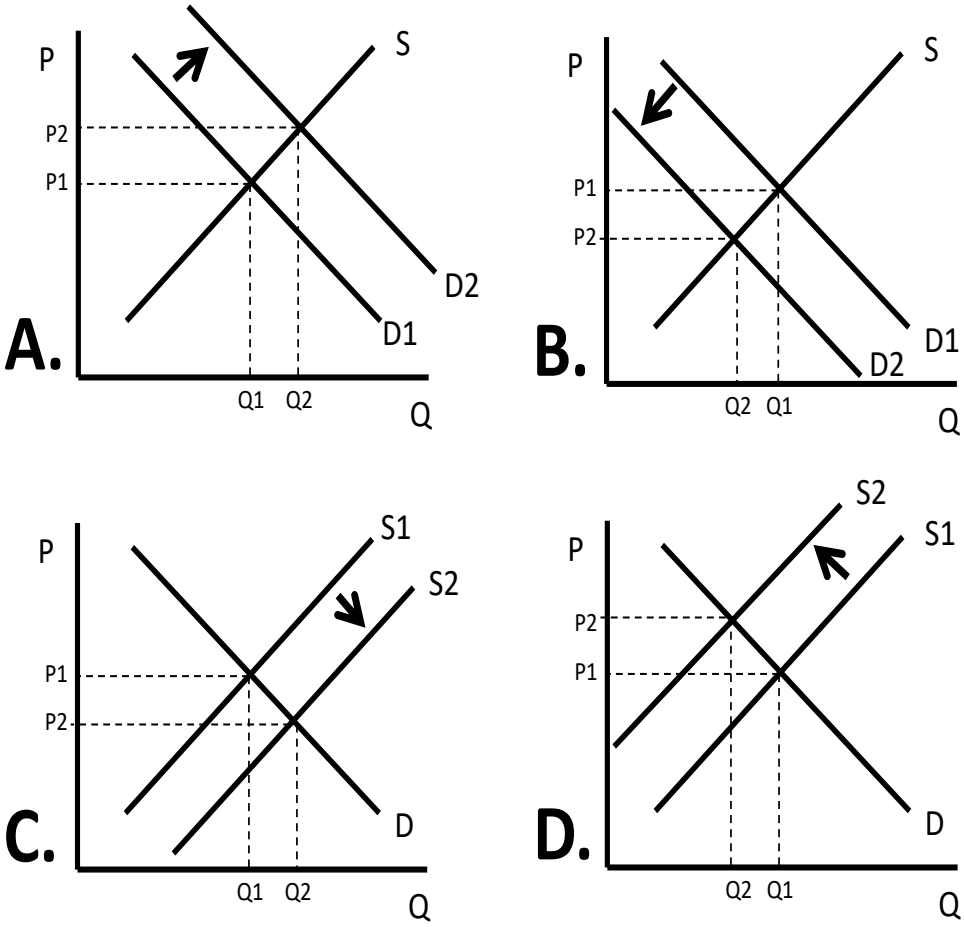
Question	Semester Included	Question Wording
10	F12, F14	After World War II, the U.S. Treasury effectively controlled monetary policy. They did this by: a. setting the interest rates on Treasury bonds, then requiring the Federal Reserve to adjust the money supply to reach those interest rates. b. setting 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	Among the causes of the "Great Moderation" of the 1980's, 1990's and 2000's 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 mini-van, and the daily broadcast of the Mr. Rogers television show. CORRECT ANSWER: C
12	S12, F12, F13, S14, F14	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 U.S. 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
34	F12, F13, F14	During the 1970's 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	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	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	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
100	F12, F13, S14, F14	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	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	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	The "Great Inflation" of the 1960's and 1970's 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 which the Johnson administration had imposed to stop Vietnam-era inflation. CORRECT ANSWER: C
156	F12, F13, S14	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
160	F12, F13, S14, F14	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

TABLE 1: Demographics of Total Sample

	N
Total sample	1,413 (100%)
Demographics not reported	13 (0.9%)
Underrepresented minorities (URM)	132 (9.4%)
International students	88 (6.2%)
Freshman	596 (42.6%)

TABLE 2: Question-level Change in Student Performance After the Re-design

Question	Total sample *N*	Chi-squared (p-value)	t-statistic (p-value)	Order	Student performance
10	532	22.4 (<.00001)	-4.59 (<.00001)	low	Sig. worse (-16.7%)
11	1,192	25.4 (<.00001)	-5.00 (<.00001)	low	Sig. worse (-14.1%)
12	1,413	47.9 (<.00001)	-7.15 (<.00001)	low	Sig. worse (-12.6%)
160	1,047	6.1 (.013)	-2.61 (.009)	low	Sig. worse (-6.7%)
112	587	0.1 (.731)	0.34 (.731)	low	Not sig. (1.4%)
75	570	2.2 (.142)	1.47 (.141)	low	Not sig. (5.9%)
98	936	47.8 (<.00001)	-6.08 (<.00001)	high	Sig. worse (-19.2%)
53	570	0.8 (.359)	-0.91 (.362)	high	NS (-3.0%)
100	1,047	2.3 (.127)	1.51 (.131)	high	NS (5.1%)
106	826	3.11 (.078)	1.74 (.082)	high	NS (5.7%)
34	826	11.5 (.0007)	3.32 (.0009)	high	Sig. better (11.0%)
156	826	11.5 (.0007)	3.32 (.0009)	high	Sig. better (11.1%)
101	1,047	41.0 (<.00001)	5.58 (<.00001)	high	Sig. better (14.7%)

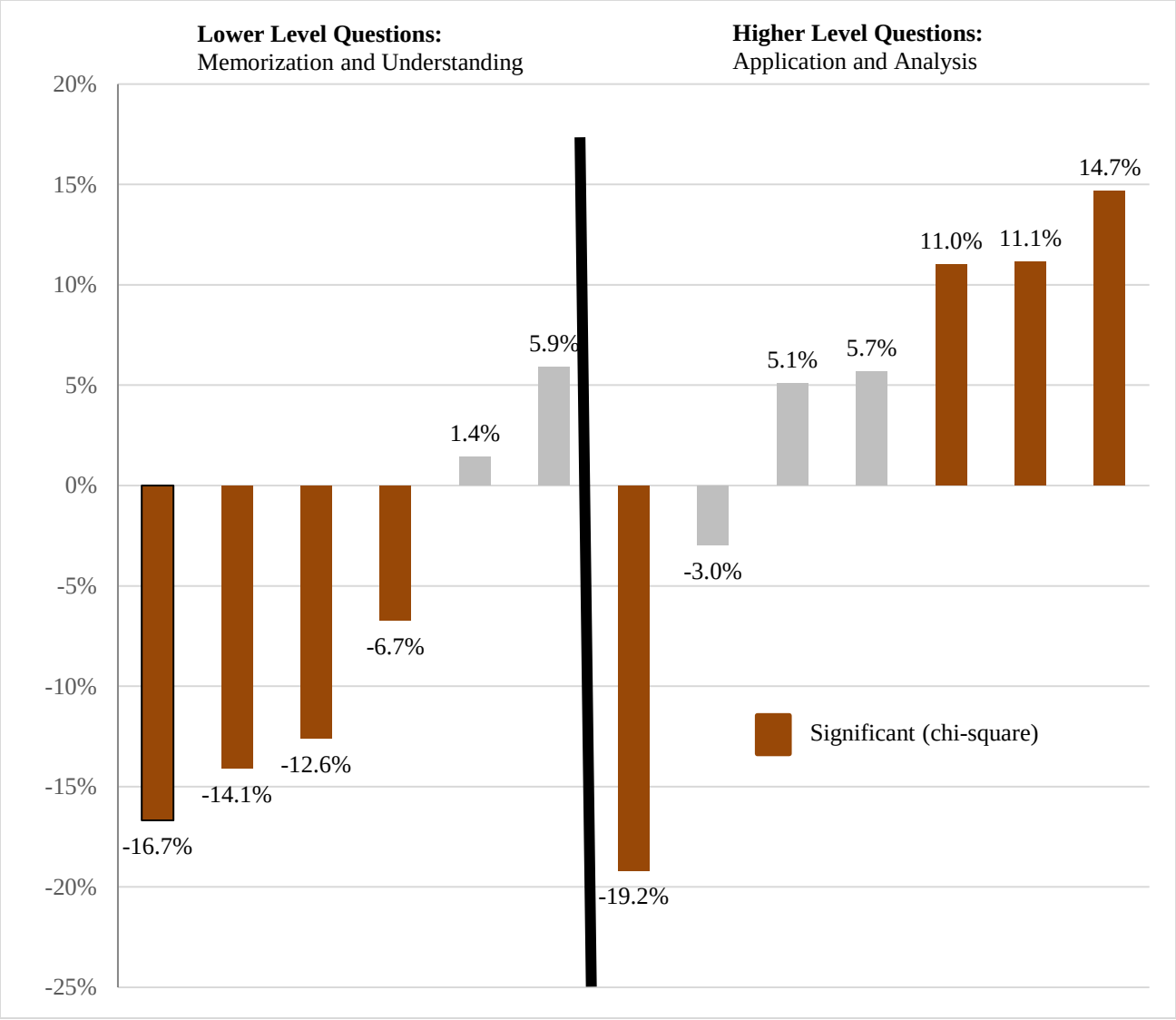


FIGURE 1: Change in Student Performance on Exam Questions Before and After Re-design

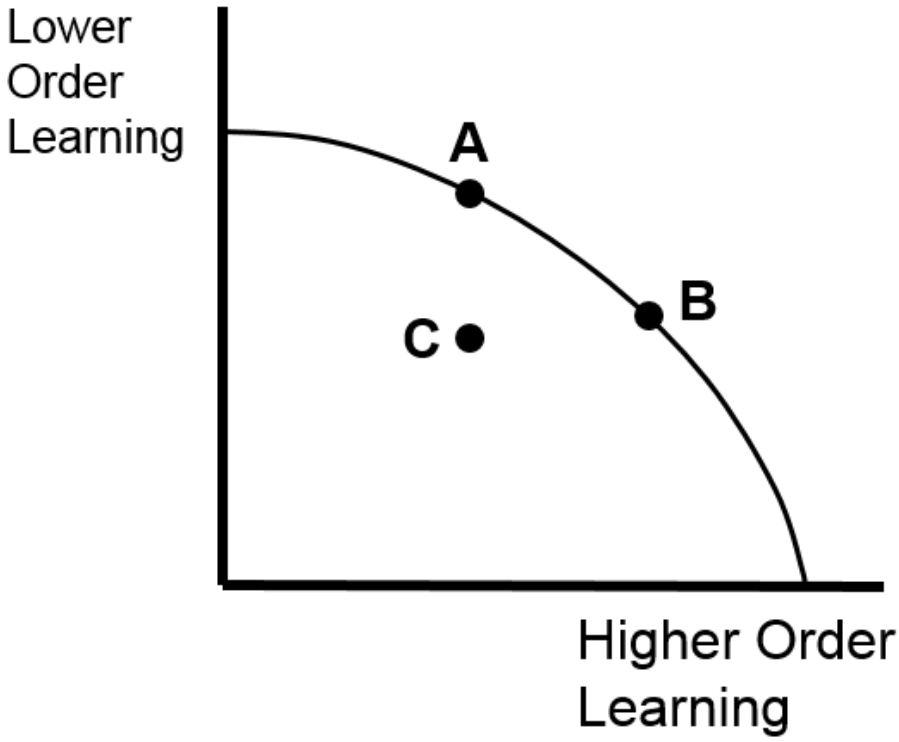


FIGURE 2: Production Possibility Frontier of Taxonomic Achievement