

# **The Challenges of Course Redesign: Lessons learned from coping with disaster<sup>1</sup>**

## **INTRODUCTION**

This is a personal account of the process by which the author redesigned a Principles of Macroeconomic course section and evaluated the effectiveness of those changes. The redesign incorporated modifications that increase the emphasis on active learning and writing. These modifications included written exercises to be completed prior to the in-class discussion of the topics, in-class team activities, and after class essay assignments.

There is some evidence of student learning. Analysis of the final essay indicates that many students performed at or above expectations, comparisons of pre-/post-test performance indicate some value added for the student, and the grade distribution for the course is much better than expected.

However, there is also evidence that there are substantial challenges to be addressed and improvements to be made. There is no evidence that the pre-class writing exercises or the in-class team activities contributed significantly to student learning. There is very little evidence that the various components of the course were well integrated and work together to improve student learning.

## **HISTORY AND BACKGROUND**

### **Early Teaching Experience: seat of the pants course design**

The story begins with my return to the classroom after a three year hiatus. The scene is a Principles of Macroeconomics course, a familiar scene to me and most university faculty teaching economics. The task is to redesign an aging course concept using information and knowledge gained during the hiatus.

In my early life I had a reputation as an enthusiastic and competent teacher. I had never won a teaching award nor was I consistently at the top of the departmental measures of teaching effectiveness. I was used caulk and talk techniques enhanced by typical doses of student/teacher interaction employed by teachers I respected and admired. I searched for techniques and strategies that might grab my students' attention. In short, I was an adequate teacher who taught as I was taught.

As the years passed I was fortunate to participate in several faculty development programs, some formal others informal. During my first full-time appointment at

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<sup>1</sup> As with all research, this project is the result of extensive collaboration and the acknowledgements made here can only recognize a few of those that have supported this project. The author acknowledges the members of *The Fall 2002, Scholarship of Teaching, Assessment & Learning (SoTAL) Symposium*, at The University of Akron, without whom this experiment and this analysis would never have been begun. Special thanks must be extended to Thomas Angelo, not only for his leadership of the SoTAL, but also for his specific support of this project. Other colleagues who have disproportionately contributed to this project include, George Hruby, David McConnell, Steven Myers and Michael Nelson.

Gettysburg College, a young colleague and I visited each others classrooms and met regularly for lunch to discuss our experiences and suggest improvements. These discussions usually centered on delivery issues. Although they were very helpful, they were not very scholarly.

In 1992 I participated in the AEA-JCEE-Lilly Teacher Training Workshop at Northwestern University, sponsored by the AEA, the National Council on Economic Education, and the Lilly Foundation and taught by Michael Salemi, Phillip Saunders and William Walstad. In 1995 I was one member of a team sent to Kentucky by the University of Akron's General Education Advisory Committee for a "Writing across the curriculum" retreat and workshop taught by Barbara E. Walvoord. These events help initiate more scholarly (or pseudoscholarly) modifications to the courses I taught. In particular, I developed a series of writing assignments designed to complement the traditional use of multiple choice exams for the assessment of student learning in the principles courses and was one of the first in our department to begin using computer created slides and integrating the web into the course to enhance delivery. Some of these modifications were born out of necessity, but most were attempts to incorporate the "best practices" I learned in these workshops.

In the fall of 1996, I assumed administrative responsibilities in institutional research. While I continued to teach one course per term until the spring 2000, my administrative duties precluded continued course development; my classes were put into maintenance mode and classroom innovation halted.

### **Administrative Experience and Impetus for Redesign: view from the catbird's seat**

During my stint in institutional research, I learned more about academic and institutional assessment, student success indicators and alternative methodologies for tracking and analyzing learning. My perspective was widened and my interests broadened. It was during this time that I was first exposed to "Scholarship Reconsidered: Priorities of the Professoriate" by Ernest Boyer<sup>2</sup> and "Scholarship Assessed: Evaluation of the Professoriate" by Glassick, Huber, and Maeroff<sup>3</sup>, which introduced me to the ideas of scholarly teaching, classroom research, and the scholarship of teaching.

At the end of my administrative appointment it was my privilege to be nominated for and participate in *The Fall 2002, Scholarship of Teaching, Assessment & Learning (SoTAL) Symposium*, at The University of Akron, led by Thomas A. Angelo. This experience opened my eyes to a literature on learning theory I did not know; exposed me to nationally recognized scholars and practitioners in the field of learning and teaching; and provided a forum to exchange ideas with an exceptional cohort of my peers.

During the *Symposium*, I learned I would be returning to teaching and began the resurrection of the principles of macroeconomics course. I was energized and ready to put much of my newly acquired knowledge, understanding and ideas into practice.

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<sup>2</sup> Boyer, Ernest L. 1990. *Scholarship Reconsidered: Priorities of the Professoriate*. San Francisco, CA: Jossey-Bass, Inc. and the Carnegie Foundation for the Advancement of Teaching.

<sup>3</sup> Glassick, Charles E., Huber, Mary Taylor, and Maeroff, Gene I. 1997. *Scholarship Assessed: Evaluation of the Professoriate*. San Francisco, CA: Jossey-Bass, Inc. and the Carnegie Foundation for the Advancement of Teaching.

Against very sound, articulate, and persistent advice that I begin with small focused changes that would allow for better assessment of their effectiveness, I stormed ahead with a complete overhaul of the course. A few of the ideas I wanted to incorporate into the redesign included: active learning opportunities, trying to assess students' prior knowledge and use that knowledge in the classroom, and to continue development of learning through writing exercises initially begun prior to the hiatus.

This is a personal account of how I, acting independently without coordination with other instructors of the multi-section course, redesigned a course to incorporate concepts and techniques which research indicates improve student learning, how I assessed the effectiveness of the redesign, and the lessons I learned during its first term of implementation. It is a reflection, a retrospective on my experience.

This paper is not a rigorous test of the techniques employed. There is no control group, there is small number of observations, and many design challenges. However, in the paper I recognize the complexity of the learning process and use multiple measures to triangulate evidence of student learning or the lack thereof.

I also believe these are the circumstances under which active teachers often must work to improve student learning and hope my reflections will help others in their struggles to improve their students' economic education.

## **COURSE REDESIGN**

### **The Course and Parameters of the Redesign**

As mentioned above, I selected the Principles of Macroeconomics course as the focus of my efforts. This is the second semester of the two-semester sequence, since in our department Principles of Microeconomics is a prerequisite.

Our department is in the process of modifying the undergraduate program to focus on proficiency in or mastery of specific skills. Our discussions are focused on a list of six proficiencies undergraduate economics majors should possess proposed by W. Lee Hansen<sup>4</sup> in a recent article. So the redesign needed to address these proficiencies.

Research indicates that student learning and retention increases if students are active rather than passive participants in their education.<sup>5</sup> Therefore, the new course design would incorporate an active-learning, peer-to-peer learning, team-oriented format to provide each student with the best opportunity to succeed.

Finally the redesign needed to address a frustration that I share with colleagues: students often see the material for the first time when it is covered in class and thus are unprepared for class discussion. Under the old design, students would wait for the lecture to provide an outline of the important points in a chapter. If the instructor did a "good" job in class

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<sup>4</sup> Hansen, W. Lee. 2001. Expected Proficiencies for Undergraduate Economic Majors. *Journal of Economic Education* 32 (Summer):232-233.

<sup>5</sup> McKeachie, Wilbert J. and colleagues. 2002. *McKeachie's Teaching Tips: Strategies, Research, and Theory for College and University Teachers*. Boston, MA: Houghton Mifflin Co. chapter 15; and Johnson, D.W., Johnson, R.T. and Smith, K.A. 1991. *Active Learning: Cooperation in the College Classroom*. Edina, MN: Interactive Book Co.

(covered the material that would be on the tests) students often found the textbook at best a handy reference and at worst an unnecessary expense. Barbara Walvoord argued at the 1995 workshop that the initial exposure to the material should be during what she calls “the student’s alone time”. She argued that the very limited and therefore valuable classroom time should be devoted to helping student process the material and practice applications. Essentially she argued that students should confront the material initially alone, without instructor interference.

### **The Redesign Plan**

For this course, I adapted five of Hansen’s proficiencies (1 – 5) and added one of my own as the course goals. These goals are: Students who successfully complete this course will demonstrate

1. An ability to access existing knowledge (about macroeconomics)
2. Command of [that] knowledge
3. An ability to interpret existing knowledge [in a variety of situations]
4. An ability to [find and] interpret [existing] economic data
5. [The ability to] apply existing knowledge
6. The ability to apply select analytical and critical thinking tools used by economists

I designed a variety of assessments that would allow students to demonstrate their proficiency in each of the areas. These assessments and the proficiencies they address are discussed below.

To incorporate an active-learning, peer-to-peer learning, team-oriented course format I chose to use what McKeachie<sup>6</sup> calls the syndicate form of teams. During the first week of the course, students completed a “pre-test” instrument developed by colleagues<sup>7</sup> as a measure of general economic knowledge. I assigned students to “permanent” teams using the results of this test, the student’s gender and class (sophomore, junior, etc.) to insure diversity within teams and the comparability of assets across teams. The teams were focused on in-class activities, as a concession to the large percentage of commuting students.

Finally, to address the issue of first exposure to the material, I created at least one worksheet for each chapter covered. Submission of the completed worksheet prior to the class in which the material was to be discussed was a prerequisite for earning participation points in the class. While the form of the worksheets varied, they all were designed to force students to read and struggle with understanding the material in the textbook prior to attending class.

### **Overview of the Structure of the Course**

The design of the course was to create the following sequence for each student. **Prior to class**, students would read the text and complete the worksheet(s). **During class**, students

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<sup>6</sup> McKeachie 2002. 191-192.

<sup>7</sup> Drs. Steven Myers and Michael Nelson

would work both individually and in teams to review the worksheets, process the material, struggle with understanding, practice applications, and explore relationships between concepts. **After class**, students would complete assignments that require them to apply the concepts, reflect on relationships, and/or demonstrate ability to solve a problem. Four times during the term, students took multiple choice exams to demonstrate their ability to accurately recognize, describe or use the material. For a full description of the course, see the course syllabus.

### **Course Components**

There are three graded course components: student participation (both individual and within teams), multiple-choice tests and written assignments.

#### **Prior to Class: the worksheets**

The worksheets varied. Some were designed specifically to guide the student's reading of the chapter. Others were designed to require the student to apply the chapter material. For example, for the chapter that discusses the creation of money, the students are asked to work through a different example of cash deposits, member bank T-accounts and calculations of the money supply. For the chapter on national income accounts, the students were asked to find current data on specific income measures.

Other worksheets required students to organize the material and think about relationships and concepts. Worksheets requiring the student to create a concept map or Venn diagram of the chapter would be examples of this type of worksheet. During the semester many worksheets were modified in response to student feedback on previous assignments.

Worksheets provide students with the opportunity to demonstrate the ability to access existing knowledge about macroeconomics (course goal #1) and to find and interpret existing economic data (course goal #4).

#### **During class: team work**

During the second week of class, I reviewed the results of the pre-test. Quartiles were established and students assigned to one of three categories: highest quartile, lowest quartile, or middle half of performers. Teams of four (or in one case three) students were created by selecting one student from the highest quartile, one from the lowest and two from the middle half. Teams were then adjusted to minimize the homogeneity of each team with respect to gender and class rank.

At the beginning of each class, students deposited one copy of the assigned worksheet into an envelope and retrieved another envelope containing previously submitted assignments and materials needed for that class. Students would then sit with their teammates.

Class would usually begin with some review of the previous material. The class then progressed in 10 – 20 minute segments in which individuals ponder questions posed about the worksheet assignment, teams actively worked on responses, and teams (or team representatives) shared their work with the class. Teams responsible for the presentation were chosen at random (sometimes with, sometimes without replacement). Teams were encouraged to question the presenters and most class sessions were lively.

At the end of most sessions one team or individual was asked to summarize the important points for the day. Several different classroom assessments were also conducted at the end of class periodically during the term.

### **During class: participation**

Each student could earn a maximum of 15 points per week for participation (5 for individual effort, 10 for team effort). Individual points were earned by a good faith effort to complete the worksheets (graded from a low of 0, if the worksheet showed no effort was made to complete it, to a high of 3 if it demonstrated an attempt to understand the material). Team points were earned by participation in the classroom discussions and activities. Participation accounted for 20% of the course grade.

Through team work and participation students could demonstrate a command of existing macroeconomic knowledge (course goal #2), an ability to interpret existing knowledge in a variety of situations (course goal #3), an ability to apply existing knowledge (course goal #5) and an ability to apply select analytical and critical thinking tools used by economists (course goal #6).

### **After class: essays**

In reviewing the goals for this course, it was clear that their assessment would involve writing assignments. I began the development of this part of the course by focusing on a single objective as stated in the syllabus, that by the end of the course

each student will write a well-structured, enlightened critical essay, about current economic conditions that demonstrates command of existing economic knowledge appropriate interpretation and application of that knowledge, and demonstrates appropriate use of data and argumentation to support a well reasoned policy recommendation.

Starting with an assignment from my former life, which was optional at the time, I developed an assignment that would allow students to demonstrate most of the skills listed in the course goals. I also developed a rubric for grading the assignment. The assignment and the rubric were shared with students the first week of class. This assignment, the “Final Essay”, was worth 10% of the course grade. This assignment was intended to be the “capstone” and allow students to incorporate all of their learning.

Writing assignments were also developed to follow each topic to be covered in the course that allowed students to demonstrate the proficiencies listed in the course goals. These assignments were also designed to aid the development of the final essay. For example, the final essay requires the student to explain how their chosen policy would impact on the economy in both the short and long run. One assignment, relatively late in the course, asks students to explain the impact of a specific monetary policy on the money market in both the short and long run. Rubrics were developed for each assignment and shared with students. These preliminary assignments combined are worth 40% of the course grade. Combined they also demonstrate a student’s ability to access existing knowledge about macroeconomics (course goal #1), command of that knowledge (course goal #2), ability to interpret existing knowledge in a variety of situations (course goal #3), ability to find and interpret existing economic data (course goal #4), ability to apply existing knowledge

(course goal #5) and ability to apply select analytical and critical thinking tools used by economists (course goal #6).

### **After Class: multiple-choice exams**

Points were also earned by completion of a series of multiple-choice exams. Performance on in-class multiple choice exams were traditionally the main measure I had for student learning. While I supplemented these test results with other measures, usually optional writing assignments, the tests would count for over 85% of the course grade. While well-constructed multiple choice questions can be effective measures of some learning, they are inappropriate to measure some of the proficiencies stated in the course goals. Therefore the use of multiple choice tests were modified in three ways. First their weight in the overall course grade was reduced to 30%. Second they were moved out of the classroom to a computer-based testing facility. Third, students were allowed two attempts for each test and the higher grade was retained.

The multiple choice tests primarily address the student's ability to access existing knowledge about macroeconomics (course goal #1) and command of that knowledge (course goal #2). They also can contribute to course goals #3 (ability to interpret existing knowledge) and #5 (ability to apply existing knowledge). The reduction in the weight given to multiple choice exams reflects the limited role they play in assessing student attainment of the course goals.

The test bank for each exam contains about five times as many questions as the exam. Questions were assigned to topics and divided into two groups: 1) definitions and simple recall questions and 2) questions that require students to use a definition or apply a model to a given situation. The tests were a random sample of questions in the test bank, stratified by topic and question type. The question distracters were also scrambled. Therefore, each student received an individually generated exam that had the same number of questions from each topic and the same number of each type of question.

I provided an outline of each exam, indicating the number of questions in the test bank and the number of questions for each topic on the exam. Students knew the sampling stratification and could allocate their valuable study time accordingly.

Utilizing the services of the Computer Based Testing and Assessment Center accomplished several tasks. One, it allows for immediate feedback to students. Wiggins defines feedback as information on how the student is doing and how they can improve their performance.<sup>8</sup> Immediately upon completion of the exam students are given information on the number of questions missed by topic. They can then concentrate study on those specific sections in which they need the most improvement.

Two, it accommodates students' busy schedules, allowing them to schedule the tests for times most convenient for them and/or when they are most attuned to academic tasks.

Three, it frees about four to six class periods that can be used for more productive learning. It eased the tension between the perceived need to cover material and the time required to allow active learning techniques to be employed in the class.

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<sup>8</sup> Wiggins, Grant P. 1999. *Assessing Student Performance: Exploring the Purpose and Limits of Testing*. San Francisco, CA: Jossey-Bass, Inc. Chapter 6.

Four, it allows students the opportunity for multiple attempts, the third modification, at relatively low cost.

Allowing students multiple attempts allows the exams to be used as a learning opportunities as well as assessment instruments. As noted above, immediately upon completion of the exam students are given information on how they performed on each topic covered by the test. Each student has the opportunity to analyze the feedback on their performance, determine those topics in which they need improvement, study the sections in which they deem most important and then retest their understanding of the material. This opportunity to improve can be an important motivation for learning.

### **THE EXPERIENCE**

The class was both a delight and a challenge. The delight was that during most class sessions students were engaged, usually talking with teammates on task. They often asked challenging questions and argued over the interpretation of comments and explanations. Communications with students (both face-to-face and electronic) were frequent and showed signs of engagement and inquisitiveness in the material.

The challenges were many. The withdrawal rate was far higher than I had expected. Students had problems interpreting written directions for both worksheets and essays. Many student comments were discouraging, at least on their face. In particular they were less than enthusiastic in the workload and the responsibility of active learning. And there was the challenge of the time and energy required to create the assignments and rubrics, to grade the assignments, and prepare for a class sessions over which I had minimal control.

**Table 1: Course attrition**

Starting enrollment	First day of classes	48
	Beginning of week 2	42
Official enrollment	Beginning of week 3	37
Enrolled for grade at end of term		24
Students submitting final essay		22

As the semester progressed, I became more certain that the experiment was a disaster. I made numerous adjustments in response to the classroom assessments responses and other student comments. I rewrote assignments, rubrics, and outlines for classroom activities. And yet the feeling of progress eluded me.

It was not until the end of the term that a hint of some progress emerged. While the scores on the multiple-choice test continued to be disappointing, the scores on the final essays were much better than those for the preliminary essays. In calculating the final course grades I was astonished at the final course grade distribution. In the past I would usually have a mean score in the “D” range, more “Fs” than “Cs”, and relatively few

students in the “A” to “B” range. The current distribution was quite a surprise. I have to remind myself that this is the distribution for the survivors. The high withdrawal rate at the beginning of the course may reflect a process by which students who would have fallen into the “D” range self-selected out of the course. Even so, it was a hint of sunshine. It provided the incentive needed to continue analyzing this course and learn how it might be improved. The results of that analysis follow.

**Table 2: Course grade distribution**

Grades	Number	Percentage	Comments
A	3	8%	
B	12	32%	
C	3	8%	
D	1	3%	
F	6	16%	3 of 6 stopped attending 1 additional student failed to complete all assignments
WD	12	32%	

## RESULTS OF ANALYSIS<sup>9</sup>

The analysis proceeds on two main tracks. First I address the question of whether the course contributed to student learning. That is, to what extent did students meet the objectives of the course and how much did they learn? The second question is how did the various components of the course contribute to the final outcome? Table 3 contains the definitions of the variables available for analysis.

### MEASURING STUDENT LEARNING

I begin with an analysis of students’ performance. As mentioned above, the grade distribution provided me with the first clues that the course was at least partially successful and that student learning had occurred. After all, each assignment, except the multiple choice tests, were tied to performance rubrics. Therefore the grades had some usefulness as measures of student learning. But grade distributions are very hard for an outside objective observer to interpret. So I use two other measures to assess student learning: performance on the final essay relative to the rubric and performance on the post-test relative to the pre-test.

<sup>9</sup> For most of the analysis, the observations of the 22 students submitting the final essay are used. For the analysis including the pre-test scores, there are 21 observations since one student did not complete the pre-test.

**Table 3: Variable Definitions**

<b>Worksheets</b>	percentage of worksheet points earned during		
wks_prt2	the period covered by exam 2.	wks_prt5	the period covered by exam 5.
wks_prt3	the period covered by exam 3.	wks_tot	the entire term.
wks_prt4	the period covered by exam 4.		
<b>Participation</b>	individual participation points earned during the period covered by		
part2_in	exam 2.	part4_in	exam 4.
part3_in	exam 3.	part5_in	exam 5.
	team points earned during the period covered by		
part2_tm	exam 2.	part4_tm	exam 4.
part3_tm	exam 3.	part5_tm	exam 5.
	total points earned during the period covered by		
part2_T	exam 2.	part4_T	exam 4.
part3_T	exam 3.	part5_T	exam 5.
part_ind	individual participation points earned during the entire term.		
part_tm	team points earned during the entire term.		
part_tot	total points earned during the entire term.		
<b>Essays</b>	sum of the points earned on		
es_grp1	essays 3 and 4.	es_fin	the final essay.
es_grp2	essays 5, 6, and 8.	es_1-4	essays 2 - 12.
es_grp3	essays 2, 7 and 10.	es_tot	essays 2 - 12 and the final essay.
es_grp4	essays 9, 11, and 12.		
<b>Tests</b>			
test 1	score on the pre-test.		
	score on exam covering material covered during weeks		
test 2	1 to 5.	test 4	10 to 12.
test 3	6 to 9.	test 5	13 to 15.
test 6	score on the post-test.	test 2-5	sum of scores on tests 2 - 5.
<b>Course grade</b>			
fin_pts	total points earned during the semester		
fin_gpa	numeric value of letter grade earned (A = 4.0, A- = 3.8, B+ = 3.3, B = 3.0, etc.)		
<b>Education gain</b>			
Gain1	test 6 - test 1		
Gain2	normalized gain - (test 1 - test 6) / (40 - test 1)		

***Analysis of the Final Essay***

The final essay assignment essentially asks students to describe our current macroeconomic situation, forecast where the economy is headed if no policy changes are made, suggest an appropriate policy change and explain how it would impact the economy. This analysis provides insight into the extent to which this primary course objective was accomplished.

The rubric for the final essay lists eleven aspects of the essay that need to be addressed, along with descriptions of various levels of performance. What follows is an analysis of how students performed as measured by the rubric.<sup>10</sup>

The eleven aspects of the essay graded by the rubric are:

1. Statement of purpose (maximum 3; acceptable 2)
2. Target audience (maximum 2; acceptable 2)
3. Description of the current macroeconomic situation (maximum 5; acceptable 3)
4. Explanation of short-term implications for economic activity (maximum 5; acceptable 3)
5. Statement of your goal for improved economic performance (maximum 3; acceptable 2)
6. Statement of the desired changes in the policy variables (maximum 3; acceptable 2)
7. Analysis of the impact the proposed policy – Real Goods market (maximum 5; acceptable 3)
8. Analysis of the impact the proposed policy – Money market (maximum 5; acceptable 3)
9. Discussion of alternative policies (maximum 3; acceptable 2)
10. Definition of the criteria (maximum 3; acceptable 2)
11. Original thought (maximum 3; acceptable 2)

Of the 24 students who were officially enrolled at the end of the term, 22 submitted the required essay. One of those essays was submitted very early and only the final point total was recorded; the detail data by dimension is missing. Therefore the analysis by dimension is based on 21 observations.

For each dimension, the maximum possible level of performance and a minimum acceptable level are reported above. Performance at the minimum acceptable level, for me, indicates that the student has demonstrated a solid understanding of that dimension of the assignment, but has not demonstrated understanding of some nuances. Under a traditional letter grade system, such a performance might earn a high “C” or low “B” grade. The total minimum acceptable level of performance (the sum of the minimum for each dimension) is 26 points out of 40 points.

Eleven (11 of 21, more than half) of the students performed acceptably on all dimensions; fourteen (14 of 21) performed acceptably on 9 dimensions; and thirteen (13) of 22 students submitting the final essay earned total scores above the minimum acceptable total. Fifteen (15) students scored acceptable levels on seven (7) of the eleven (11) dimensions. Thus, one can conclude that the course goal was achieved for over half of the students who completed the course.

For seven (7) of the eleven (11) dimensions, the average score for the 21 students in the analysis is above the minimum acceptable performance. Students had the most difficulty

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<sup>10</sup> See the appendix for a copy of the assignment and the rubric.

analyzing the impact their policy proposal would have in the money market and clearly defining criteria by which objective observers could judge the effectiveness of the proposed policy. The failure of many students to analyze the impact their proposal in the money market may be attributable to the fact that the vast majority of student proposals focused on tax policy. To discuss the impact of such policies on the money market requires students to look beyond the immediate impact of the policy. They must be able to follow a line of reasoning through the relationships of several concepts. This may require a depth of understanding that has not been fully developed.

The ability to clearly define assessment criteria is a meta-cognitive skill that many students did not develop during the course. This may be one of those goals that stretch students. One that we may not expect many to achieve, yet one we should not abandon.

### *Analysis of Learning Gain*

Analysis of differences in pre-test and post-test scores is often cited as some of the strongest evidence of student learning. This approach is often described as analysis of educational gain. Our question is do student scores on the pre-test and post-test in this course provide evidence of the course adding to students' knowledge of economics?

The Paired-Samples T Test procedure compares the means of two variables for a single group. It computes the differences between values of the two variables for each case and tests whether the average differs from zero. This procedure can determine if the differences between PRE (test 1) and POST (test 6) test scores is statistically significant. The results of the paired-sample T test indicates that the correlation coefficient between the PRE and POST scores is .54 and a 2-tailed t-test indicates that difference is significant at the 5% level.

**Table 4: Paired Sample Analysis**

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Test 1	20.52	21	3.628	.792
	Test 6	23.19	21	4.589	1.001

		N	Correlation	Sig.
Pair 1	Test 1 & Test 6	21	.540	.011

	Paired Differences				t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			

					Lower	Upper			
Pair 1	Test 6 - Test 1	2.67	4.029	.879	8.3	4.50	3.033	20	.007

An alternative to the Paired-Samples T Test procedure is to test if the educational gain is significantly different from zero. There are at least two widely used measures of educational gain in the literature. One uses the difference between the post-test and pre-test scores.<sup>11</sup> I call this Gain1 or absolute gain. It is the score on post-test (test 6) minus the score on pre-test (test 1). The second is what Hake<sup>12</sup> calls the normalized gain and I call Gain2. It is the score on post-test (test 6) minus the score on pre-test (test 1) divided by the potential gain. The potential gain is the difference between the maximum possible score on the pre-test and the actual score on the pre-test. It is calculated as the score on the post-test (test 6) minus the score on the pre-test (test 1) all divided by 40 minus the score on the pre-test (test 1). Formally,

$$(POST - PRE)/(40 - PRE) \quad (1)$$

where POST = test 6 score and PRE = test 1 score.

Caution must be used in the interpretation of this measure of added value in the context of this course. First, many important goals of the course are not easily measured using a multiple choice test and the design of the course was not focused on using multiple choice tests as a primary component of the course. Thus students might rationally put their efforts elsewhere and the gains measured by the pre and post-test may understate their learning. Second, due to time constraints the test used for the pre and post-test was designed by colleagues for use in a one semester principles course. It covered both micro and macroeconomic topics. While students have practice in applying many microeconomic topics in this course, most of their gain is most likely to be on the macroeconomic topics.

Therefore, analysis of the gain should not be the sole evidence of student learning. However, it should not be ignored in the triangulation of measures used to support evidence of student learning during the term.

The pre-test (also used as the post-test) is a forty-item multiple-choice instrument created by colleagues for use in a one semester principles course. Five economists active in the teaching field validated the pre-test. The items matched to the twenty national voluntary content standards published by the Foundation of Teaching Economics (Seigfried (1996)). Additionally each question is rated as to level of complexity in three categories: Recall and recognition, Simple Application, and Complex reasoning.<sup>13</sup>

<sup>11</sup> For example see Allgood, Sam and Walstad, William B. 1999. The Longitudinal Effects of Economic Education on Teachers and Their Students. *Journal of Economic Education* 30 (2):108.

<sup>12</sup> Hake, Richard R. 2002. Assessment of Student Learning in Introductory Science Presentation at PKAL Roundtable on the Future: Assessment in the Service of Student Learning. Duke University, March 1-3; an updated version of 1 June 2002 is online at <[http://www.pkal.org/template2.cfm?c\\_id=354](http://www.pkal.org/template2.cfm?c_id=354)>

<sup>13</sup> Myers, Steven C. 2002. Instructional Design And The Online Student: Do On-Line Students Learn More Than Face-To-Face Students? Some Suggestive Evidence. Presentation at Syllabus. Boston, MA  
C:\Documents and Settings\myers\My Documents\websites\econ\_www3\MidwestConference\2003\2003Presentations\Stratton\_The Challenges of Course Redesign\_d031016.doc

To calculate either measure of value added (Gain1 or Gain2); a student must have a score for both the pre- and post-test. One student did not take the pre-test, thus there are 21 valid observations for this analysis.

Six students scored within one point on both tests, while 12 students scored at least two points higher and three students scored at least two points lower on the post-test than on the pre-test. The maximum gain for Gain1 is 10 points (0.41 for Gain2), while the minimum gain is -6 (-0.32 for Gain2). The mean is 2.67 points higher on the post-test for Gain1, a 10% gain from the pre-test mean of 20.5. Alternatively for Gain2, students gained on average 13% (0.13 points) of the possible improvement (the difference between the pre-test score and the maximum attainable score). For seven students Gain1 is greater than one standard deviation greater than zero (8 for Gain2). For 13 students (12 for Gain2) Gain1 is within one standard deviation of zero. One student scored more than one standard deviation below zero for both Gain1 and Gain2.

Thus there is evidence of educational gain for at least seven (7) students.

**Table 5: General Descriptive Statistics**

	N	Minimum	Maximum	Mean	Std. Deviation
Gain (t6-t1)	21	-6.00	10.00	2.6667	4.02906
Normalize Gain (t6 - t1)/(40-t1)	21	-.32	.41	.1329	.20074
Valid N (listwise)	21				

### MEASURING COURSE COMPONENT CONTRIBUTIONS

Given the findings above that some student learning occurred, how did each component of the course contribute to student learning and how this course might be modified to increase the amount of student learning? To answer these questions, I first investigate the students' assessment of how well the components of the course (the worksheets, essay and the in-class time) contributed to their learning. This provides some insight into the students' subjective evaluation of their experience.

I then investigate, using correlation and regression analysis, the extent to which the course components worked together to accomplish the course goals using more objective data.

In this analysis I address the following questions:

Using the variables on which I have data,

1. Can I explain students' final course scores?
2. Can I explain students' final essay performance?
3. Did the worksheets and/or classroom participation contribute to higher test scores?
4. Did worksheets and/or classroom participation contribute to higher essay scores?
5. Are the essay scores correlated with test scores?

### *Student Assessment of Effectiveness of Class*

Twice during the term (at about the fifth and twelfth weeks) I asked students to evaluate three major components of the course, the worksheets, the essays, and the classroom time on a 5-point scale.<sup>14</sup> The results are shown in Table 6.

While there is some evidence that students saw improvement in the effectiveness of the course components, students clearly see substantial room for improvement in each component. At the end of the term, students rated the classroom time only marginally more than “adequately effective” and the essays as only marginally better than “slightly effective”. The ranking of the three components remained the same at the end of the term as at the beginning, with the classroom time being ranked most effective and the essays least effective. Only the increase in the mean score for the worksheets is statistically significant.

**Table 6a: Results of students’ assessment of the course components: worksheets**

**1. Overall, how effective are the worksheets for helping you learn in this course?**

	Not at all	Slightly	Adequate	Effective	Very Effective	Mean*
Frequency	1	2	3	4	5	
Administration						
First	2	9	8	2	0	2.48
Second	0	7	6	3	1	2.88

First administration		Second administration
2	Number of students who rank this component highest	8
7	Number of students who rank this component second	7
6	Number of students who rank this component third	2

\* The difference in the mean score is statistically significant at the 1% level.

<sup>14</sup> In response to the results of the first assessment, I modified the treatment of the essays and reworked many later worksheets to respond to concerns expressed. Students were often unsure what I expected in the worksheets, so changes were made to their wording and focus. Students found that workload of about one short essay per week excessive. So I modified the format of the essays, grouping them into categories that addressed the different parts of the final essay assignment and asked students to submit 5 essays, covering at least 3 of the 4 parts designated in the final essay.

**Table 6b: Results of students' assessment of the course components: essays****2. Overall, how effective are the essays for helping you learn in this course?**

	Not at all	Slightly	Adequate	Effective	Very Effective	Mean*
Frequency	1	2	3	4	5	
Administration						
First	5	8	6	1	1	2.29
Second	3	7	5	2	0	2.35

First administration		Second administration
1	Number of students who rank this component highest	5
4	Number of students who rank this component second	7
10	Number of students who rank this component third	5

\* The difference in the mean score is not statistically significant.

**Table 6c: Results of students' assessment of the course components: class time****3. Overall, how effective is the classroom time used for helping you learn in this course?**

	Not at all	Slightly	Adequate	Effective	Very Effective	Mean*
Frequency	1	2	3	4	5	
Administration						
First	3	4	5	3	6	3.24
Second	1	4	2	8	2	3.35

First administration		Second administration
8	Number of students who rank this component highest	11
5	Number of students who rank this component second	6
2	Number of students who rank this component third	0

\* The difference in the mean score is not statistically significant.

➤ ***Can I explain students' final course scores?***

There are two related variables available to measure student course performance, the total number of points earned and the numerical value of the letter grade earned. Care must be

taken in this analysis, since one measure of student course performance (total number of points earned) is defined as the sum of points earned for participation, essays, and tests. Therefore, by definition, there must be a very tight relationship between the final course score and its components. I address this by comparing results of two the two definitions of final course score: 1) the total number of points earned and 2) the numeric value of the letter grade earned and by correlations on the separate pieces of each component of the course. That is on each test, each group of worksheets or essays and on participation for separate sections of the course. While this does not eliminate the problems, it does reduce their impact.

**Model 1:** We assume a student's final course score is a function of her (his) participation and performance on the essays, worksheets, and tests.

$$\text{Formally,} \quad S = f(E, P, W, T) \quad (2)$$

where  $S$  measures the student course performance,  $E$  measures performance on the essays,  $P$  measures student participation,  $W$  measures student worksheet performance, and  $T$  measures test scores.

If the course is working as an integrated whole, there will be positive and significant correlations between the students' final course performance and their performance on the essays and worksheets, their course participation, and the scores earned on tests 2 – 6. I hypothesize that course performance will be uncorrelated with the score on the pre-test.

#### **RESULTS USING TOTAL COURSE POINTS**

Simple correlation analysis indicates:

- Positive correlations with all essay sets, except group 3;
- Positive correlations with total essay points and with the score on the final essay;
- Positive correlations with individual participation during the first period and with team participation in the first and second periods;
- Positive correlation with only the worksheets completed during the first period of the course;
- Positive correlations with tests 2, 3, 4, and 5;
- And no statistically significant correlation with either the pre- or post-test.

Regression models:

$$\text{Model 1a: } S_1 = f_1(E_1, P_1, W_1, T_1)$$

Where  $S_1$  is the total number of points earned for the course,  $E_1$  is the total essay points earned (exclusive of the final essay),  $P_1$  is the total participation points earned,  $W_1$  is the points earned on the worksheets for the first period, and  $T_1$  is the total points earned on tests 2 through 5.

**Table 7: Results Model 1a: Adjusted  $R^2 = 0.99$** **Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	41.193	26.122		1.577	.131
	Total points for T2 - T5	2.694	.278	.396	9.699	.000
	Worksheet percentage period 2	-67.049	56.817	-.049	-1.180	.253
	Total participation	1.003	.184	.221	5.444	.000
	Essay points, excl final	1.084	.078	.530	13.900	.000

a Dependent Variable: Total course points

As expected, there is high correlation among these components and the four components combine to explain virtually all of the variance in total points earned. The positive correlation with the pre-test and the lack of correlation with the worksheets is unexpected.

**RESULTS USING FINAL COURSE GPA**

Simple correlation analysis indicates:

- Positive correlations with all essay sets, except group 3;
- Positive correlations with total essay points and with the score on the final essay;
- Positive correlations with individual and team participation only during the first period;
- Positive correlation with only the worksheets completed during the first period of the course;
- Positive correlations with tests 2, 3, 4, 5, and 6;
- And no statistically significant correlation with the pre-test.

Regression models:

$$\text{Model 1b: } S_2 = f_2(E_1, P_1, W_1, T_1)$$

Where  $S_2$  is the numeric value of the letter grade earned for the course and  $E_1$ ,  $P_1$ ,  $W_1$ , and  $T_1$  are defined as in Model 1a.

**Table 8: Results Model 1b: Adjusted  $R^2 = 0.76$** **Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.056	.701		-1.507	.148
	Total points for T2 - T5	.001	.007	.033	.176	.862
	Worksheet percentage period 2	.395	1.524	.049	.259	.798
	Total participation	.003	.005	.095	.511	.615
	Essay points, excl final	.009	.002	.774	4.444	.000

a Dependent Variable: Final course gpa

Again as expected, there is high correlation among these components and the four components combine to explain most of the variance in total points earned. There is also the expected lack of correlation with the pre-test. However, in the regression analysis the lack of significance for all but the essays is unexpected.

➤ **Can any of the variables on which I have data explain students' final essay performance?**

**Model 2:** We assume a student's final essay scores is a function of her (his) course participation and performance on the "preliminary" essays, worksheets, and tests.

Formally, 
$$FE = f(E, P, W, T)$$

where FE is the final essay score, and E, P, W, and T are defined as in Model 1.

If the course is working as any integrated whole, the students' final essay scores should be positively correlated with their performance on the "preliminary" essays and worksheets, their course participation, and scores earned on tests 2 – 6. I hypothesize that that the final essay performance will be uncorrelated with the score on the pre-test.

Simple correlation analysis indicates that the final essay score is:

- Not significantly correlated to individual sets of essays, but positively correlated with total essay points earned on the "preliminary" essays;
- Not correlated to any measure of participation;
- Not correlated to any worksheets;
- Positively correlated with tests 2, 3, and 5;
- And positively correlated with total course points and final course GPA.

Regression model:

$$\text{Model 2: } FE = f_3(E_1, P_1, W_2, T_1)$$

Where FE is the final essay score,  $W_2$  is the percentage of total worksheet points earned and  $E_1$ ,  $P_1$ , and  $T_1$  are defined as in Model 1a.

**Table 9: Results Model 2: Adjusted  $R^2 = 0.70$**

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.987	11.781		-.169	.868
	Total points for T2 - T5	.353	.167	.451	2.114	.048
	Percent of total worksheet points	37.309	64.127	.339	.582	.568
	Total participation	-.176	.325	-.338	-.541	.595
	Essay points, excl final	.114	.042	.485	2.712	.014

a Dependent Variable: Final Essay

According to this analysis performance on the tests and the cumulative performance on the “preliminary” essays explains most of the variation in the final essay scores. The lack of correlation with most other variables is unexpected. Apparently, the worksheets and class participation did not contribute significantly to student performance on the final essay.

➤ **Can any of the variables on which I have data explain students’ post-test scores?**

**Model 3:** We assume a student’s post-test score is a function of her (his) course participation and performance on the essays, worksheets and tests.

Formally, 
$$POST = f(E, P, W, T)$$

where POST is the post-test score and E, P, W, and T are defined as in Model 1.

If the post-test is a measure of course performance and the course is working as any integrated whole, the students’ post-test scores should be positively correlated with their performance on the essays and worksheets, their course participation, and scores earned on tests 2 – 5. I hypothesize that that it will be uncorrelated with the score on the pre-test.

Simple correlation analysis indicates that the post-test score is:

- Positively correlated with only group 3 essays;
- Not correlated with any measure of participation;
- Not correlated to any worksheets;
- Positively correlated with tests 2, 3, 4, and 5;
- And not correlated to the pre-test.

Regression models:

$$\text{Model 3a: } \text{POST} = f_4 (E_1, P_1, W_2, T_1, \text{PRE})$$

Where POST is the post-test (test6) score,  $W_2$  is defined as in Model 2, PRE is the pre-test score (test1), and  $E_1$ ,  $P_1$ , and  $T_1$  are defined as in Model 1a.

$$\text{Model 3b: } \text{POST} = f_5 (E_1, P_1, W_2, T_1)$$

Where POST is the post-test (test6) score,  $W_2$  is defined as in Model 2, and  $E_1$ ,  $P_1$ , and  $T_1$  are defined as in Model 1a.

**Table 10: Results Model 3a: Adjusted  $R^2 = 0.88$**

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.407	2.330		1.033	.315
	Total points for T2 - T5	.293	.034	1.201	8.575	.000
	Percent of total worksheet points	-18.483	14.205	-.539	-1.301	.210
	Total participation	.048	.073	.295	.658	.519
	Essay points, excl final	-.005	.008	-.069	-.600	.556
	PRE	-.207	.119	-.168	-1.734	.100

a Dependent Variable: test 6

**Table 11: Results Model 3b: Adjusted R<sup>2</sup> = 0.87****Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.769	2.419		.731	.474
	Total points for T2 - T5	.275	.034	1.129	8.026	.000
	Percent of total worksheet points	-6.858	13.167	-.200	-.521	.608
	Total participation	-.014	.067	-.085	-.206	.839
	Essay points, excl final	-.002	.009	-.024	-.205	.840

a Dependent Variable: test 6

According to this analysis performance on tests 2-5 explains most of the variation in the post-test scores. Pre-test scores do not contribute significantly to that explanation. The lack of correlation with most other variables is unexpected. Apparently, the worksheets and class participation and essays did not contribute significantly to student performance on the post-test.

Analyses were also conducted to determine if the gain is correlated with prior knowledge, as measured by the score on the pre-test, or with measures of student activity in the course.

**Model 4:** I assume the gain score is a function of each course component (the essays and worksheets, course participation and test scores).

Formally,  $\text{Gain} = f(E, P, W, T)$

where Gain is the measure of educational gain and E, P, W, and T are defined as in Model 1. From the preceding analysis, one would not expect the coefficients on E, P, and W to be statistically significant.

If gain is a measure of learning and the course is working as any integrated whole, then each course component should be correlated with the gain score and contribute to the explanation of the variation in the gain scores. Thus, the students' gain scores should be positively correlated with their performance on the "preliminary" essays and worksheets, their course participation, and scores on tests 2 – 5. Gain1 should be inversely correlated with the score on the pre-test, since students that score low on the pre-test have the most room for improvement. The normalized gain (Gain2) adjusts for this phenomenon and therefore should be uncorrelated with the pre-test.

Simple correlation analysis indicates that Gain1 and Gain2 are:

- Positively correlated with the total test points earned;

- Not significantly correlated with pre-test scores;
- And not significantly correlated with the points earned from worksheets, participation or the essays.

Regression models:

$$\text{Model 4a: } G_1 = f_7 (\text{PRE}, E_1, P_1, W_1, T_1)$$

Where  $G_1$  is the Gain1, PRE is the score on the pre-test (test1) and  $E_1, P_1, W_1,$  and  $T_1$  are defined as in Model 1a.

$$\text{Model 4b: } G_2 = f_8 (\text{PRE}, E_1, P_1, W_1, T_1)$$

Where  $G_2$  is the Gain2, PRE is the score on the pre-test (test1) and  $E_1, P_1, W_1,$  and  $T_1$  are defined as in Model 1a.

**Table 12: Results Model 4a: Adjusted  $R^2 = 0.51$   
Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.312	6.545		.048	.963
	PRE	-.926	.253	-.834	-3.657	.002
	Total participation	-.017	.108	-.148	-.155	.879
	Percent of total worksheet points	-3.472	19.569	-.166	-.177	.862
	Total points for T2 - T5	.258	.064	1.001	4.018	.001
	Essay points, excl final	-.004	.009	-.073	-.414	.685

a Dependent Variable: Gain (t6-t1)

**Table 13: Results Model 4b: Adjusted  $R^2 = 0.42$   
Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.197	.355		-.556	.586
	PRE	-.037	.014	-.662	-2.667	.018
	Total participation	3.207E-05	.006	.006	.005	.996
	Percent of total worksheet points	-.347	1.061	-.332	-.327	.748
	Total points for T2 - T5	.013	.003	.976	3.601	.003
	Essay points, excl final	-8.667E-05	.000	-.036	-.186	.855

a Dependent Variable: Normalize Gain (t6 - t1)/(40-t1)

According to this analysis educational gain is explained primarily by the performance on the pre-test and tests. The lack of correlation with other variables is unexpected. Apparently, the worksheets and class participation did not contribute significantly to educational gain.

- **Did the worksheets contribute to higher test scores?**
- **Did classroom participation contribute to higher test scores?**

The expected correlation between worksheets and classroom participation during the weeks just prior to each exam and the exam scores is not found. There is no correlation found between scores on the pre-test and scores on other tests. However, performance on early exams is correlated to performance on later exams (T2 with 3, 4, 5, 6; T3 with 4, 5, 6; T4 with T 5, 6; and T5 with 6).

- **Did worksheets contribute to higher essay scores?**
- **Did classroom participation contribute to higher essay scores?**
- **Are the essay scores correlated with test scores?**

The expected correlation between worksheets and classroom participation and essay scores is not found. In general, essay scores are not correlated with participation, either individual or team, nor are they correlated with worksheet scores. Also early essay scores are not correlated with later essay scores.

In general, essay scores are not correlated with tests scores. The exceptions are a correlation between performance on group 4 essays and on test 2 and between performance on group 3 essays and the post-test.

## **SUMMARY AND LESSONS LEARNED**

For students who persisted, there is evidence of achievement of primary goal. That is most students were able to write a well-reasoned essay on the current state of the economy. There is also some evidence of educational gain, though this evidence is tentative.

No evidence is found of benefit from the use of teams or from student participation in class. This lack of evidence is not surprising. The implementation of teams in this course lacks several important elements that have been shown to affect their effectiveness. I conclude that either I redesign the use of teams in the course or consider if there are other modifications that might be more beneficial to students.

The initial student attrition from the course is problematic, since one of the goals of redesigning the course was to improve the reputation of the course. There may be several reasons for the attrition. It is possible that the attrition is the result of rational choice caused by poor prior information about the course. Since I had not taught the course in some time and the course was drastically redesigned, student expectations about the course at the time they registered may have been substantially different from the

description they faced during the first week of class. Students (even those that persisted) perceived that the workload was much higher than in alternative sections. Student perceptions of any additional benefits that might derive from the increased work were uncertain. Therefore, rational students might have reevaluated their choice and transferred to other sections where the workload was more consistent with their expectations.

The impact of this cause of student attrition may weaken as a history for the course is developed and students become better informed about the costs and benefits of this course design.

This attrition also highlights the difficulty of redesigning a single section of a multi-section course. Many students are likely to opt for more familiar format, in which the benefits and costs are less uncertain, until they are convinced that the new design is superior.

Less synergy between the various components of the course was found than expected. In particular, there is little evidence that the worksheets or participation contributed to performance on the tests or essays. While it appears that performance on early tests may contribute to performance on later tests and the total performance on “preliminary” essays may contribute to the performance on the final essay, there is no evidence that performance on the tests contributed to essay performance or that performance on the essays contributed to test performance.

The course has fallen short of the ideal in which the worksheets, classroom activities, tests, and essays build on each other and all contribute to student learning and understanding. The quality of each course component and the interactions between the course components must be improved to aid student learning.

Finally, I must acknowledge the wisdom of the advice I received early in this project from Tom Angelo and others. The impact and effectiveness of course redesign or pedagogical change is easier to assess if the redesign or change is made in small incremental steps. I am now left with the choice of which of the many deficiencies of the course I should change first to see if student learning will improve.

Do I rewrite the essays to build on one another better?

Do I improve the rubrics for the essays?

Do I modify the worksheets and their use during class time?

Do I change the way in which class time is used? Perhaps class time should focus on the critique of essays.

Do I find ways to improve the use of teams? Modify the creation of the teams? Eliminate teams?

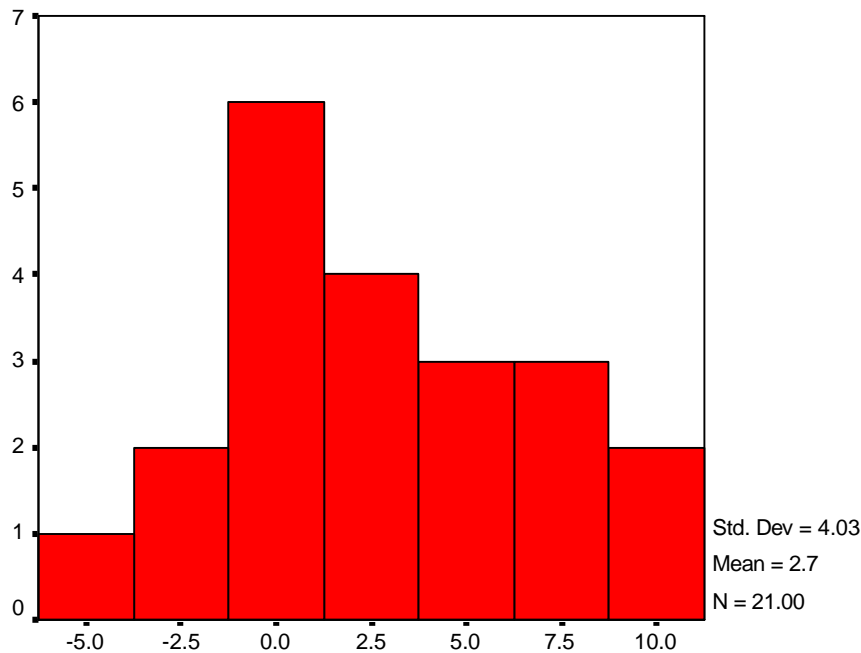
Do I find a better pre/post test?

## APPENDIX

Table A1: Frequency Distribution Gain1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-6.00	1	4.8	4.8	4.8
	-2.00	2	9.5	9.5	14.3
	-1.00	2	9.5	9.5	23.8
	.00	1	4.8	4.8	28.6
	1.00	3	14.3	14.3	42.9
	2.00	1	4.8	4.8	47.6
	3.00	3	14.3	14.3	61.9
	4.00	1	4.8	4.8	66.7
	5.00	2	9.5	9.5	76.2
	7.00	3	14.3	14.3	90.5
	9.00	1	4.8	4.8	95.2
	10.00	1	4.8	4.8	100.0
	Total	21	100.0	100.0	

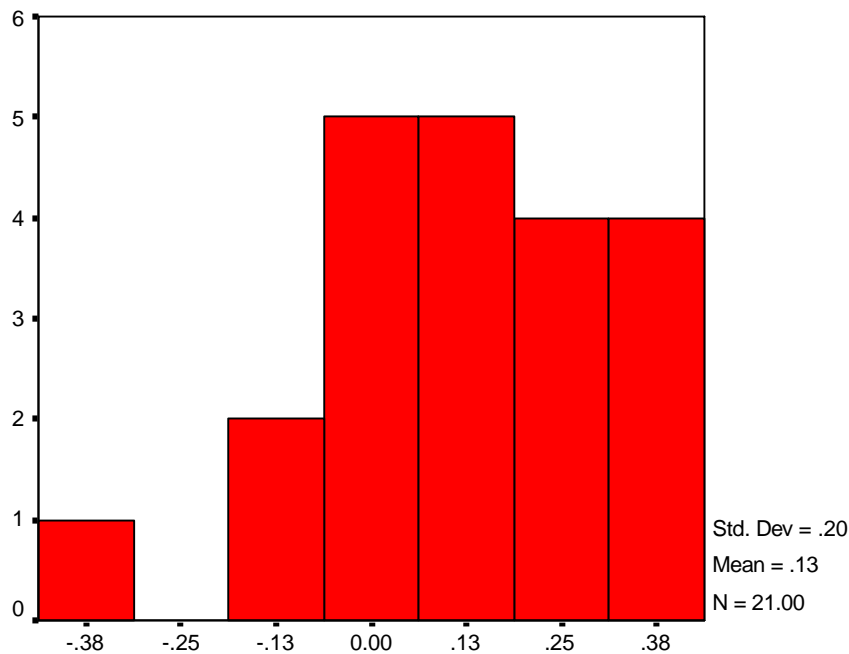
Chart A1: Histogram of Gain1



Post - Pre Test

**Table A2: Frequency Distribution Gain2**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-.32	1	4.8	4.8	4.8
	-.13	1	4.8	4.8	9.5
	-.11	1	4.8	4.8	14.3
	-.05	1	4.8	4.8	19.0
	-.05	1	4.8	4.8	23.8
	.00	1	4.8	4.8	28.6
	.06	1	4.8	4.8	33.3
	.06	1	4.8	4.8	38.1
	.07	1	4.8	4.8	42.9
	.09	1	4.8	4.8	47.6
	.13	1	4.8	4.8	52.4
	.15	1	4.8	4.8	57.1
	.18	1	4.8	4.8	61.9
	.25	2	9.5	9.5	71.4
	.28	1	4.8	4.8	76.2
	.29	1	4.8	4.8	81.0
	.40	1	4.8	4.8	85.7
	.41	1	4.8	4.8	90.5
	.41	2	9.5	9.5	100.0
Total		21	100.0	100.0	

**Chart A2: Histogram of Gain2**

Normalize Gain (t6 - t1)/(40-t1)