A comparison between online and traditional delivery models for an undergraduate course in elementary linear algebra

Joint Mathematics Meetings #1086-G5-20
Innovative and Effective Ways to Teach Linear Algebra
Friday, January 11, 2013, 9:00 a.m.
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Today's Talk Agenda I

- Introduction
- Operational Definitions and Related Existing Research
- Types of Mathematics Course Delivery at ASU
- The Experiment
  - Hypothesis
  - Data Collection
  - Procedures
  - Analysis
  - Results

Today's Talk Agenda II

- Characteristics of a good distance learning mathematics course (Instructor's perspective)
- Students' perspectives on blended delivery of mathematics at ASU
- Future adjustments to blended delivery of Linear Algebra and Discrete Mathematics at ASU
- Cited sources
- The End

Introduction

- Athens State University offers MA 310 Linear Algebra and Matrices during the fall semester as a traditionally delivered course and 10-week summer term as a distance delivered course.
- Required of students majoring in
  - Mathematics
  - Mathematics Secondary Licensure
- Computer Science Elective

Course Content

- Content
  - Systems of Linear Equations and Applications
  - Matrices
    - Operations and Properties
    - Inverses, Elementary Matrices and Applications
    - Eigenvalues and Eigenvectors
  - Determinants
  - Vector Spaces and Applications
  - Inner Product Spaces
  - Introduction to Linear Transformations

Rationale—why give the talk?

- To add to the body of research regarding the impact of distance learning on students studying transitional level mathematics

Operational Definitions I

DL-Online LPE Course

(Distance Learning—Online Live Proctored Examinations)

A course in which

- at least some, if not all, of the content is presented over an Internet Delivery System (such as Blackboard, Tegrity, Wimba Collaborate, etc.)
- Attendance is required at the main campus or approved satellite campus to take major tests and final exams.

Operational Definitions II

Traditional Course

A course in which

- At least ninety percent of delivery of instructional content takes place in real time inside a classroom either on the main campus or a satellite campus.

Operational Definitions III

Transitional Mathematics Course (TMC)

A course that

- "bridges the gap between lower level, computationally focused math classes and upper level, proof based math classes"
  - Pyzdek & Dumitrascu (2008)

Brief Research on the Topic

- Athens State University (Merritt, 2011)—MA 308 Discrete Mathematics
  - Making no assumptions about the distribution of scores being normal, the results of the Kruskal-Wallis test finds H = 1.695 (p-value = 0.4285), indicating no statistical significance among the population medians for blended, traditional day and traditional night.

Brief Research on the Topic II

- Athens State University (Merritt, 2011)—MA 308 Discrete Mathematics

	Median	Skewness	Kurtosis
Blended	75.370	-1.378	1.826
Traditional Day	74.480	-0.629	0,132
Traditional Night	71.515	-1.060	0.616

Brief Research on the Topic III

- College of Southern Nevada (Yates & Beaudrie, 2009)—Basic Math, Prealgebra, Beginning Algebra, Intermediate Algebra, Liberal Arts Math
  - No statistical difference between overall performance—proctored vs. non-proctored testing
  - Assessing students completely online might cause weaker students to advance and fail in the future.

Brief Research on the Topic IV

- Smith, et. al. (2003) study revealed
  - that there was actually considerably more preparation involved
  - distance education forced instructors to think about instruction and content in new ways
  - “More room for ambiguity and students to be confused” (p. 62)

Two Instructional Delivery Options at ASU

- Distance Learning
  - Online—Full or Live-Proctored Examinations
  - Blended
- Traditional

DL-Online LPE Option

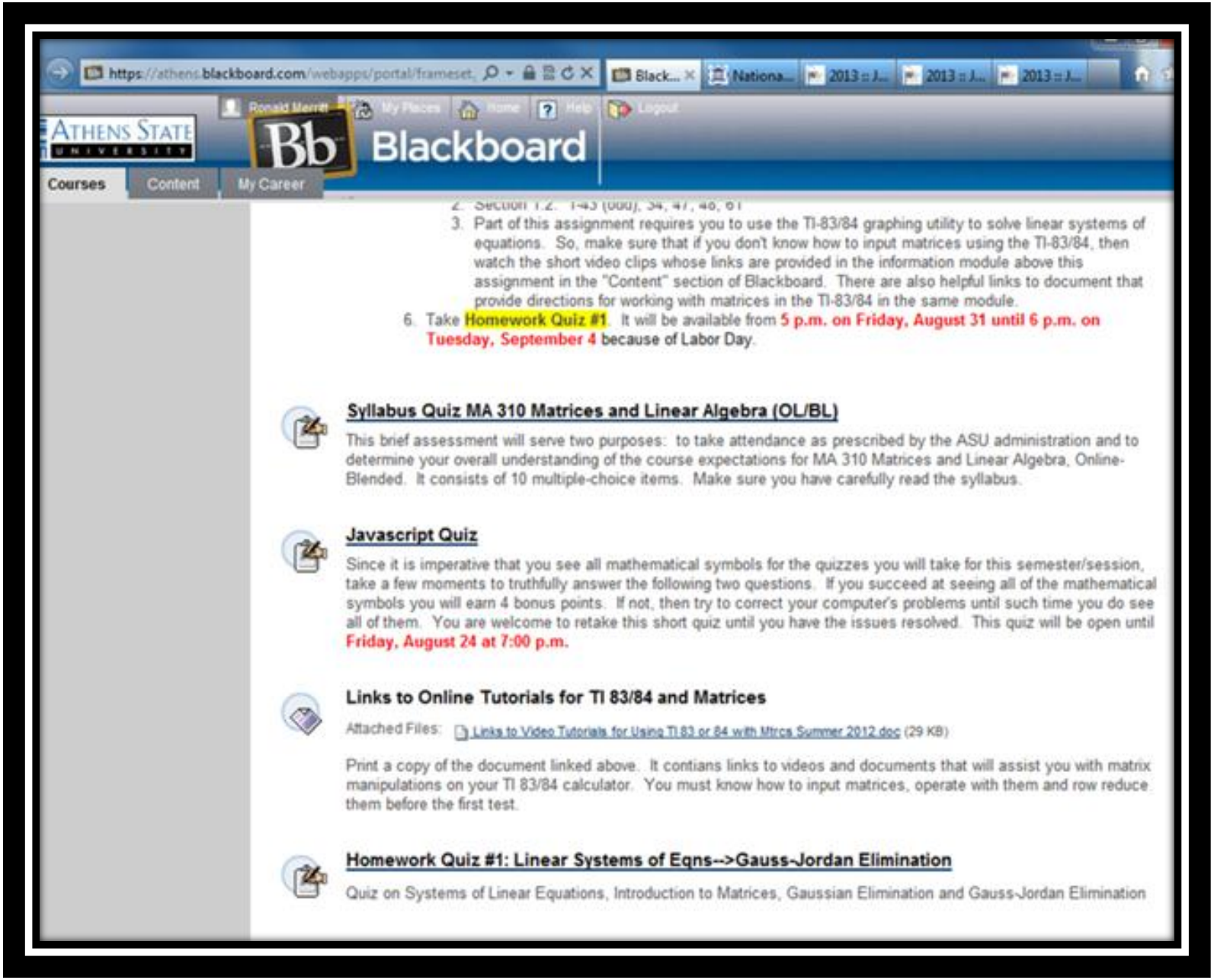
- Offered Every Summer
  - Required on-campus meetings
    - Unit tests taken on campus or administered by an approved proctor at a satellite campus—nearly 50% of course grade
    - Final Exam—approximately 25% of course grade
  - Localized Assessment
    - Approximately 25% of course grade
    - Online discussion of syllabus, course management system navigation, etc. and syllabus quiz
    - Online homework quizzes via Blackboard using the Acxiom Verification System
    - Beginning Summer 2013—Weekly Discussion Board Problems

DL-Online LPE Option

- Asynchronous delivery
- At least 35 hours of digitized Tegrity video
  - homemade video lecture
  - some theory
  - MANY examples related to homework problems
  - review of certain missed quiz and unit test items
  - old tests and sample final exam questions
  - mainly "Chalk & Talk"

Online Homework Quizzes

- Each week for when there is no unit test, break or final examination, students take an online quiz
- There are normally 10 items per weekly topic or section counting either 2 or 3 points each on a scale of 600-700 total course points.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Ronald Merrell
My Places
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ATHENS STATE UNIVERSITY
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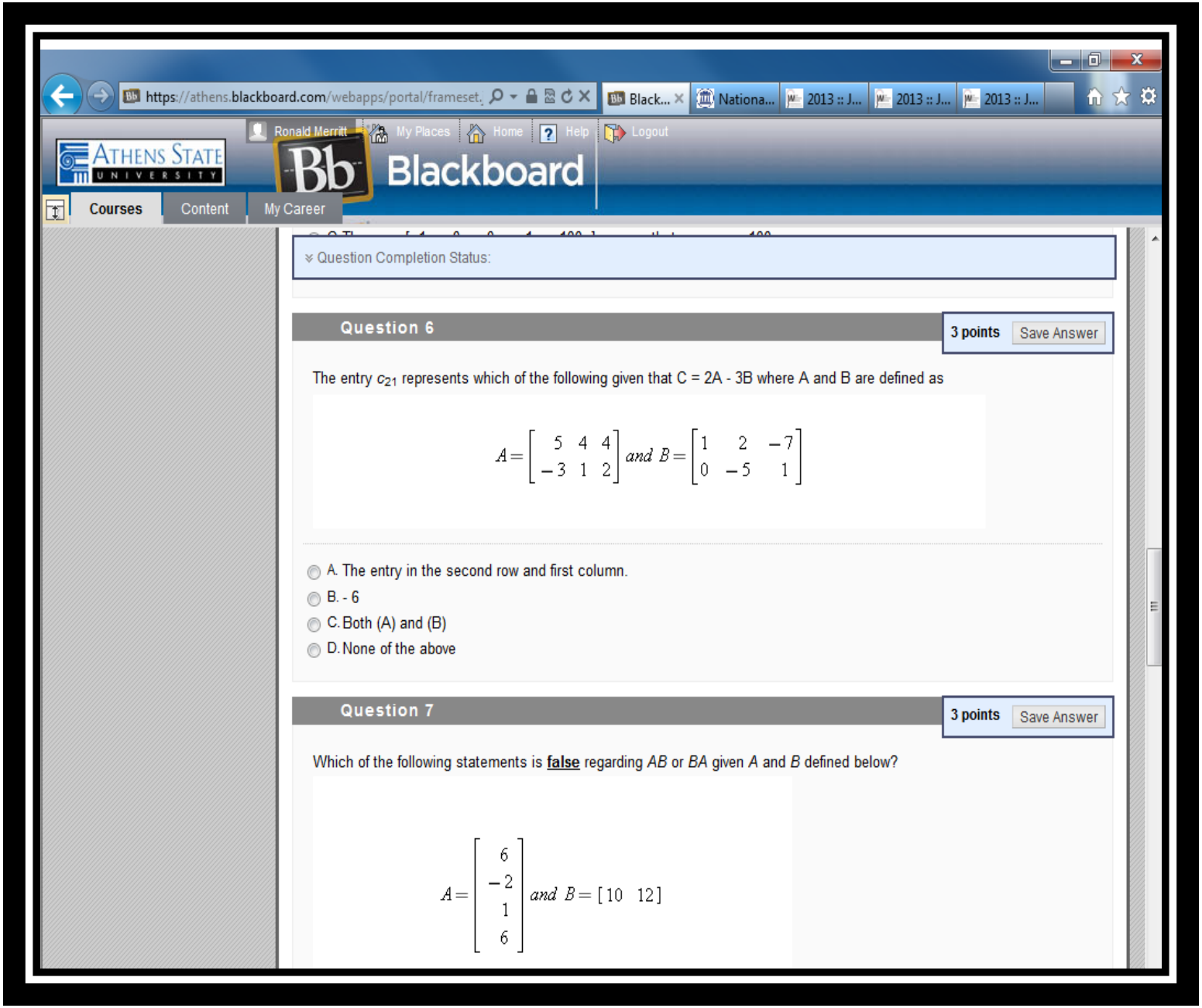
Content
My Career
3. Part of this assignment requires you to use the TI-83/84 graphing utility to solve linear systems of equations. So, make sure that if you don't know how to input matrices using the TI-83/84, then watch the short video clips whose links are provided in the information module above this assignment in the "Content" section of Blackboard. There are also helpful links to document that provide directions for working with matrices in the TI-83/84 in the same module.
6. Take Homework Quiz #1. It will be available from 5 p.m. on Friday, August 31 until 6 p.m. on Tuesday, September 4 because of Labor Day.
Syllabus Quiz MA 310 Matrices and Linear Algebra (OL/BL)
This brief assessment will serve two purposes: to take attendance as prescribed by the ASU administration and to determine your overall understanding of the course expectations for MA 310 Matrices and Linear Algebra, Online-Blended. It consists of 10 multiple-choice items. Make sure you have carefully read the syllabus.
Javascript Quiz
Since it is imperative that you see all mathematical symbols for the quizzes you will take for this semester/session, take a few moments to truthfully answer the following two questions. If you succeed at seeing all of the mathematical symbols you will earn 4 bonus points. If not, then try to correct your computer's problems until such time you do see all of them. You are welcome to retake this short quiz until you have the issues resolved. This quiz will be open until Friday, August 24 at 7:00 p.m.
Links to Online Tutorials for TI 83/84 and Matrices
Attached Files: Links to Video Tutorials for Using TI 83 or 84 with Mtrcs Summer 2012.doc (29 KB)
Print a copy of the document linked above. It contians links to videos and documents that will assist you with matrix manipulations on your TI 83/84 calculator. You must know how to input matrices, operate with them and row reduce them before the first test.
Homework Quiz #1: Linear Systems of Eqns-->Gauss-Jordan Elimination
Quiz on Systems of Linear Equations, Introduction to Matrices, Gaussian Elimination and Gauss-Jordan Elimination

Online Homework Quizzes

- The instructor constructs the quiz items based on specific items assigned from the textbook for weekly homework. Thought processes are targeted not simply answers, since some of the items used to assess the students' homework performance are odd-numbered problems for which full solutions may be provided "in the back of the book."

Online Homework Quizzes

- All the items are multiple-choice with four possible answers; one of which is the "best" answer.
- Due to a variety of computer errors that may take place, the instructor allows as much as an hour to take the quiz.
- Option for instructor to implement Acxiom Identity Authentication for any or all of the quizzes
- Students have access to the homework quizzes from Friday afternoon until early Monday evening.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My Places
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Question Completion Status:
Question 6
3 points
Save Answer
The entry c_{21} represents which of the following given that C = 2A - 3B where A and B are defined as
$$A=\begin{bmatrix} 5 & 4 & 4 \\ -3 & 1 & 2 \end{bmatrix} \text{ and } B=\begin{bmatrix} 1 & 2 & -7 \\ 0 & -5 & 1 \end{bmatrix}$$
A. The entry in the second row and first column.
B. - 6
C. Both (A) and (B)
D. None of the above
Question 7
3 points
Save Answer
Which of the following statements is **false** regarding *AB* or *BA* given *A* and *B* defined below?
$$A=\begin{bmatrix} 6 \\ -2 \\ 1 \\ 6 \end{bmatrix} \text{ and } B=\begin{bmatrix} 10 & 12 \end{bmatrix}$$

Online Homework Quizzes

- Feedback on the electronic quizzes is somewhat more limited than for pencil-and-paper homework quizzes. Although electronic feedback is almost instantaneous.

Hypothesis

- There is no difference in the distribution of performance between students who completed the traditional MA 310 course and students who completed the DL-PLE course.

VS

- There is a difference.

Data Collection

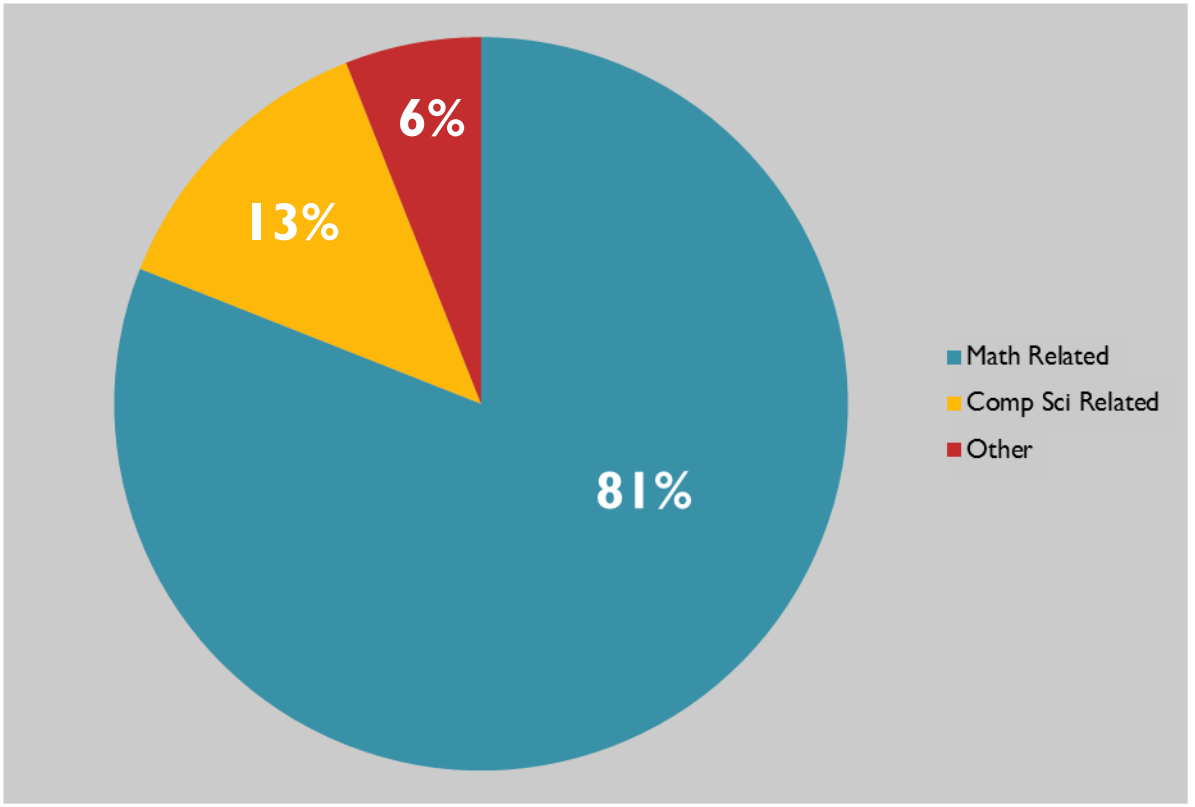
- Data was collected from classroom records for both traditional and blended courses every semester/session
  - Grades for Fall 2008-Fall 2012
    - Unit Test Scores (Fall) or Midterm Scores (Summer)
    - Final Exam Scores
    - Final Grades (Numerical and Ordinal)
  - Data on majors if available on Banner for Fall 2008-Fall 2012

Procedures

- DL—PLE option first available to students Summer 2010.
- Two different instructors taught the traditional version of the course, and one of these instructors solely taught the DL-PLE version.
- The instructors essentially taught the same content at the same level of rigor. Weekly or biweekly discussions took place between the two linear algebra instructors to ensure the overall content delivery and assessment were commensurate.

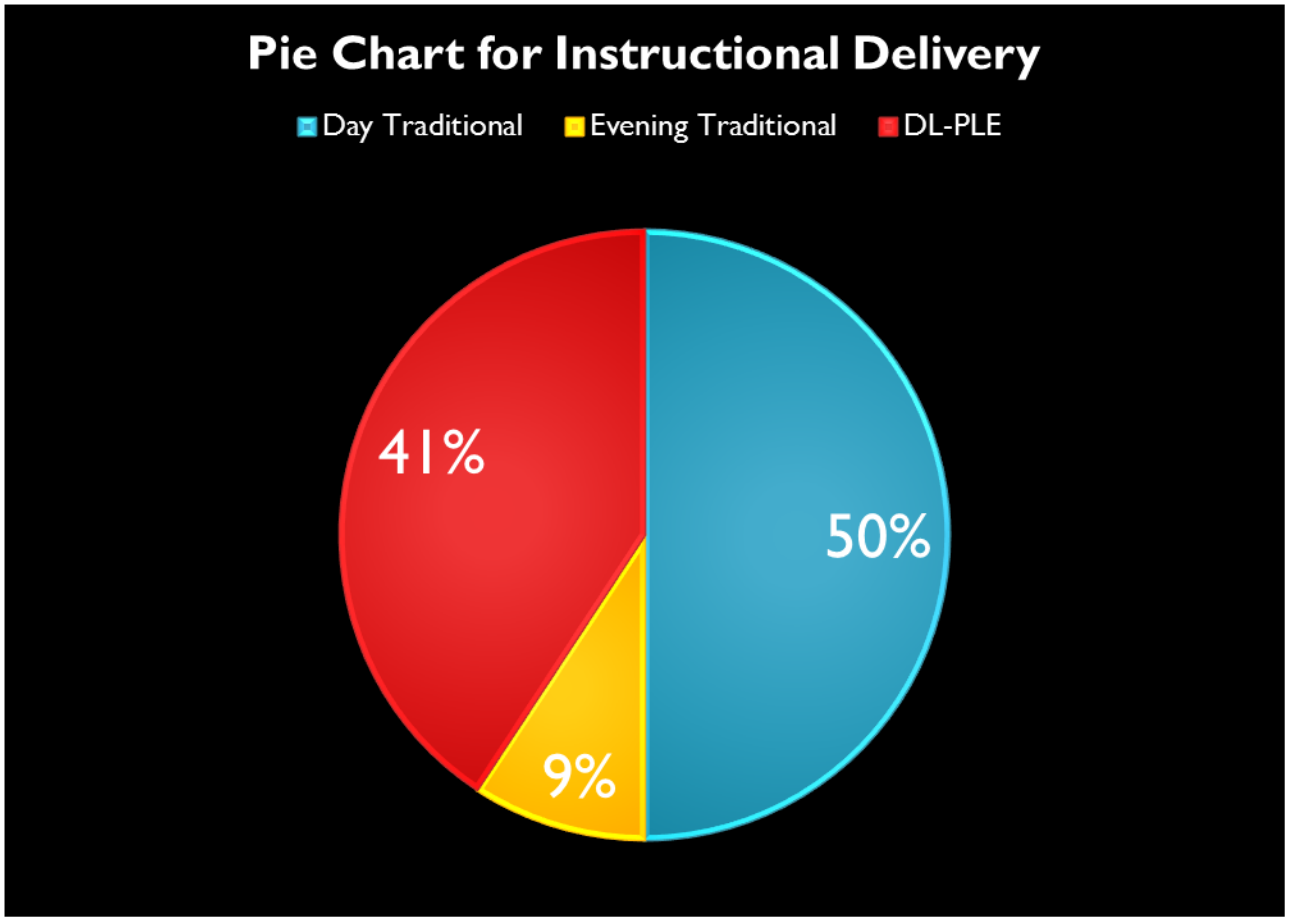
ANALYSIS I

Distribution by Major
All Classes FA 2008-FA 2012



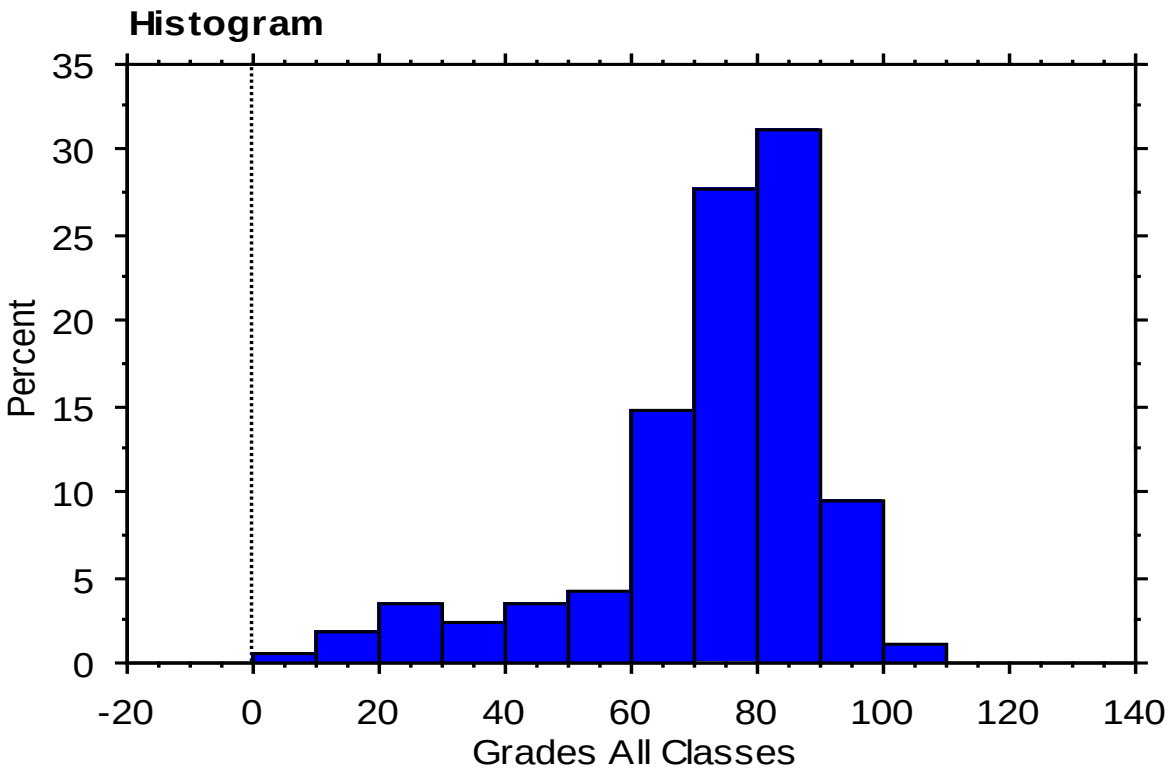
ANALYSIS II

Distribution by Instructional Delivery



ANALYSIS III

Results for n = 170 students (non withdrawals)
Percent Histogram of All Final Numerical Scores



ANALYSIS IV

Results for n = 170 students (non withdrawals)
Variable = Final Weighted Average Score

Parameter	Value
Mean	72.188
Standard Deviation	18.755
Standard Error	1.438
Range	94
Skewness	-1.472
Kurtosis	2.100
Median	76
Mode	76
Trimmed Mean (10%)	75.007

ANALYSIS V

Results for n = 170 students (non withdrawals)
Variable = Final Weighted Average Score
Question of Normality of the Distribution

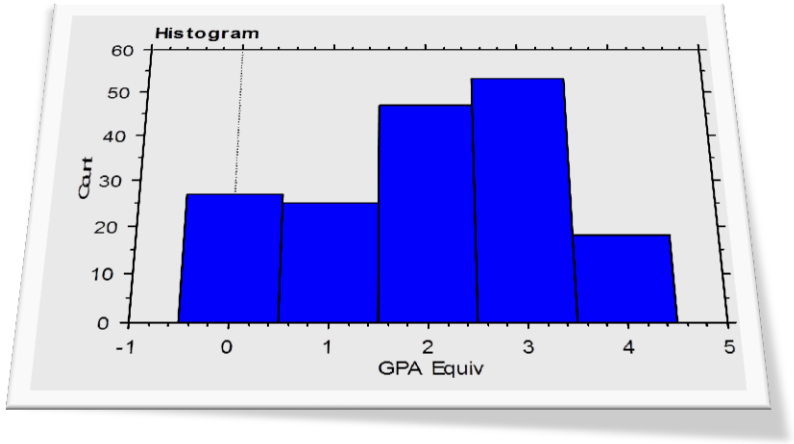
- Skewed to the left of the mean—population might not be normally distributed
- Skew value might be significant, but not strong
- Leptokurtic—grades grouped more around the mean than the normal distribution

Skewness	-1.472
Kurtosis	2.100

ANALYSIS VI

Results for n = 170 students (non withdrawals)
Variable = Final Weighted Average Score
Question of Normality of the Distribution

- Evidence is rather strong to warrant non-parametric tests, but NP's probably should be used. If the "F" grades were limited to the range of 50-59, then the distribution for all grades might possibly have come from a normal population. Consider the descriptive statistics below.



Parameter	Value
Mean	2.059
Standard Deviation	1.234
Skewness	-0.282
Kurtosis	-0.912
Median	2.000
Mode	3.000
Trimmed Mean (10%)	2.074

ANALYSIS VII

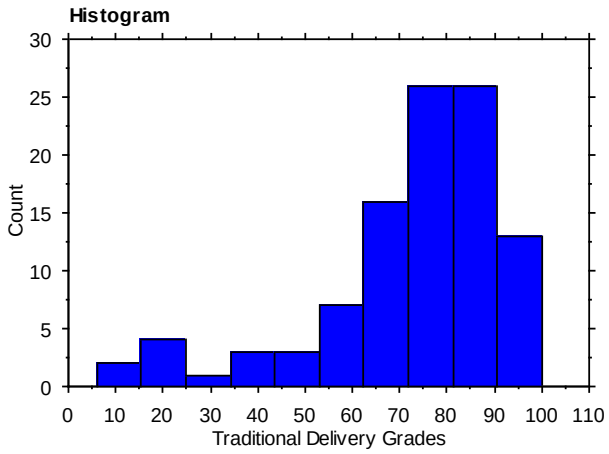
Results for n = 170 students (non withdrawals)
Mann-Whitney Test for Equal Distributions
Traditional versus DL

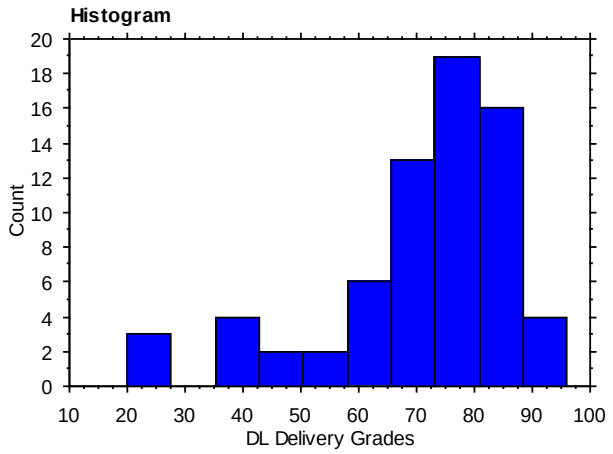
Delivery Type	U-Statistic	z-value	*p*-value
Real Grades	3077.5	-1.292	0.1965
Ordinal Grades	3069.5	-1.317	0.1875

ANALYSIS VIII

Results for n = 170 students (non withdrawals)
Means/Meadians for All Final Grades

	Count	Mean	Median	Std. Dev.
Traditional	101	72.624	79	20.543
Distance Learning	69	70.957	76	16.452





RESULTS I

Decision—Normality Not Assumed

- According to the Mann-Whitney results, since the *p*-value for the U-statistic is 0.1965 (and 0.1875 for ordinal grades), which is bordering on statistical significance, there ***may*** not be enough evidence to suggest a difference between the overall population distributions, and in particular, their medians.

RESULTS II

Decision with Respect to Distributions

- No reason to reject the null hypothesis for traditional vs. DL

Characteristics of a Good Distance Learning Mathematics Course

A teacher's perspective

Immediate Suggestions for Improvement

- After having experience with teaching an online liberal arts mathematics course for two semesters and more than four years teaching discrete mathematics and linear algebra online, it is absolutely essential that classroom discussion needs to be a part of a transitions mathematics DL course, or for any mathematics course being offered electronically.

Characteristics of a Good Distance Learning Mathematics Course

I. Provide sufficient feedback—try to respond to students electronically, in person or by phone within a reasonable amount of time to resolve any issues, including, but not limited to
   A. Homework questions
   B. Online assessment questions (following the quiz)—especially when there are claims the online assessments are not fully accessible
   C. General and routine feedback on the class' overall performance

Characteristics of a Good Distance Learning Mathematics Course

II. Inform students of technical expectation and provide adequate direction for IT assistance.

III. Provide adequate support services, such as tutoring for students within reasonable driving distance, assistance by phone or on-line tutoring if available.

Characteristics of a Good Distance Learning Mathematics Course

IV. Make goals, objectives, assessment due dates and examination dates very clear on the syllabus provided at an on-campus or web orientation.

V. Provide feedback on scores—preferably electronically through learning delivery systems, such as Blackboard.

Characteristics of a Good Distance Learning Mathematics Course

VI. Online Assessments

A. Provide enough online assessment so that students understand the impact with respect to their overall grade. Once per week for a normal semester is preferred.

B. Make the assessments relevant to their homework assignments as one would do in a traditional math class.

C. Be very clear and redundant about assessment due dates

Characteristics of a Good Distance Learning Mathematics Course

VII. Content: Ensure the delivery of the course content is as close to that which is delivered in a traditional course.

A. Provide the same amount of lecture time, if not more.

B. Provide an abundance of examples that are similar to those broached in the companion textual reading and exercises.

Characteristics of a Good Distance Learning Mathematics Course

VII. Content: Ensure the delivery of the course content is as close to that which is delivered in a traditional course.

C. Think about the questions that are asked by students routinely in the traditional course and try to address the answers in the chosen content delivery apparatus.

D. PowerPoint slides alone won't cut it—relate to your students by some type of audio-visual instruction. Try to reach different types of learners.

Characteristics of a Good Distance Learning Mathematics Course

VIII. Teach the course in a traditional format at least twice before attempting to teach it via a distance format.

IX. Make a physical notebook and an electronic file of everything you use.

X. Electronic Verification—not perfect, but helpful.

TAKEN FROM 2011 ONLINE SURVEY ITEM #3—SHORT ANSWER

If you have taken a blended or online course either at Athens State University or some other institution of higher learning, what makes this course better than other blended/online courses, if anything? If you have not taken a blended or online course prior to this one, just respond with "First blended class."

- Seven students answered "First blended class."
- Students wrote:
  - "…not a fan of online or blended math courses…"
  - "This course has a lot more video instruction, which is helpful. When I've taken online courses in the past, sometimes I felt as though I'm just reading the textbook and then being tested on what I've read, instead of being taught by the professor."

ITEM #4—SHORT ANSWER CONTINUED

How are the online lectures useful? If they are not useful, then record, "Not very useful," or "Not useful at all," or "I have not used them."

- Students wrote:
  - "The lectures feel like you are in a class lecture."
  - "I would be completely lost without the lectures."
  - Can take notes easily
  - Examples are good
  - "…comprehensive, easy to follow and understand"
  - "…like to see more examples…"

ITEM #5—ADVANTAGES

List what you think are the advantages of this blended course are.

- Students wrote:
  - Significant drive time is eliminated (45 minutes to 2 hours reported)
  - Weather
  - Flexibility for work (e.g., swing shift)
  - Saving money with gas prices rising and "ware and tare" on vehicles
  - Don't have to sit in a classroom for 3 hours

ITEM #5—ADVANTAGES CONTINUED

List what you think are the advantages of this blended course are.

- Students wrote:
  - Learning to manage time better
  - "…quizzes help people to stay on track…"
  - Review lecture at one's own pace for better understanding
  - Would never be able to attend class otherwise
  - "My biggest problem with classes is attendance and tardiness, this class makes those problems virtually obsolete."

ITEM #5—ADVANTAGES CONTINUED

List what you think are the advantages of this blended course are.

- Students wrote:
  - Convenient for parents with small children at home

ITEM #6—DISADVANTAGES

List what you think are the disadvantages of this blended course are.

- Students wrote:
  - "…the material sounds the same. The videos are not very engaging."
  - Requirement of on-campus visits [tests, final exam]
  - Minimal feedback on quizzes—what was missed and still not understood
  - Students lack the ability to ask questions of the instructor immediately

ITEM #6—DISADVANTAGES CONTINUED

List what you think are the disadvantages of this blended course are.

- Students wrote:
  - Videos are rather lengthy.
  - Lack of immediate response by professor when students ask questions.
  - "Less hands on"
  - Lack of face-to-face interaction
  - "I tend to learn better in an actual classroom…"
  - One person—lack of "student-to-student" interaction

ITEM #6—DISADVANTAGES CONTINUED

List what you think are the disadvantages of this blended course are.

- Students wrote:
  - "I have no complaints…"
  - "…you have to take time to watch the videos."
  - "…real disconnect with the class and the instructor."
  - Would like to see distance "live sessions"

BRIEF COMMENTARY I

- Many of these comments could possibly have come from a set of students under traditional on-campus instruction [Merritt—completely anecdotal]
- Providing synchronous instruction or tutoring (on Wimba) is difficult at best.
- Group work is possible but difficult to assign without knowing when students are available to work cooperatively or collaboratively.

BRIEF COMMENTARY II

- There are mechanisms available for student interaction online, and students are encouraged to take advantage of these. Most do not.
- No auxiliary assistance for the professor and increased workload for same course over the traditionally offered course

Cited Sources

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Questions, Comments, Complaints? And Thanks for Attending this Session

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