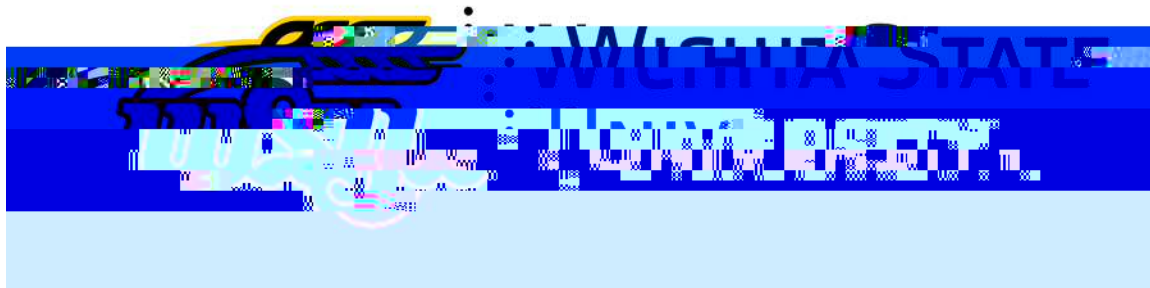


Prerequisite Testing as a Tool to Gauge Incoming Student Capability & Knowledge in Engineering Statics



Roy Myose, Syed Raza, Elizabeth Rollins,
Brandon Buerge, and **Nicholas Smith**

Department of Aerospace Engineering
Wichita State University

Motivation for Obtaining Baseline Information

New generation of college-age students have *both* capabilities and needs that are quite different than previous generation*

Consequently, teaching techniques may have to be adjusted to meet their needs

Question: if there are changes in performance, is it due to a change in teaching method or change in student capability?

- o Need to know the baseline capability & knowledge level of students entering the course

*Reference: Moore *et al*

Background on Student Performance in First Author's Statics Course

Over the course of 25+ years, the first author has changed the exam structure in Statics several times

Current 50-minute class regular exams: three calculation-based working problems similar to class and textbook examples

Current 75-minute class exams: four working problems of same type as 50-min class plus four multiple choice concept questions

Performance difference found: grade point average (GPA) of 75-minute classes is 16.5% higher than GPA of 50-minute classes

Hypothesis / possible reasons:

- 1) Concept questions are too easy and inflates GPA of 75-minute classes *OR*
- 2) There is a difference in student capability between class sections

Methodology

Investigate whether, pedagogically speaking, concept questions are easier than multi-step calculation-based working problems

- o Examine whether the junior-year Propulsion course final exam, which utilizes both types of questions, correlates with semester grade

Determine how the Statics final exam, which has concept questions and short answer calculation-based problems, correlate against the semester grade for both 50- and 75-minute classes

Investigate whether class GPA correlates with prerequisite testing, which measures incoming student capability and knowledge

- o Determine what conclusions can be drawn about the capability of 50- and 75- minute classes based on prerequisite testing

Junior-year Propulsion Course Final Exam Format

Junior-year Propulsion course has a 110-minute comprehensive final exam weighted as 30% of the semester grade

Final consists of two parts, each worth 50% of the final exam:

- o 1st part – concept questions (2/3 of the points) plus single step calculation-based short answer questions (1/3 of the points)
- o 2nd part – four multi-step calculation-based working problems

Determine the correlation of the two parts with the semester grade

Pearson correlation coefficient ranges between +1 and -1

- o It is +1 when it is perfectly correlated
- o It is 0 when there is no correlation at all
- o It is -1 when increase in one variable leads to a decrease in other
- o Less scattered when the correlation coefficient approaches +/-1

Propulsion Final Exam Results

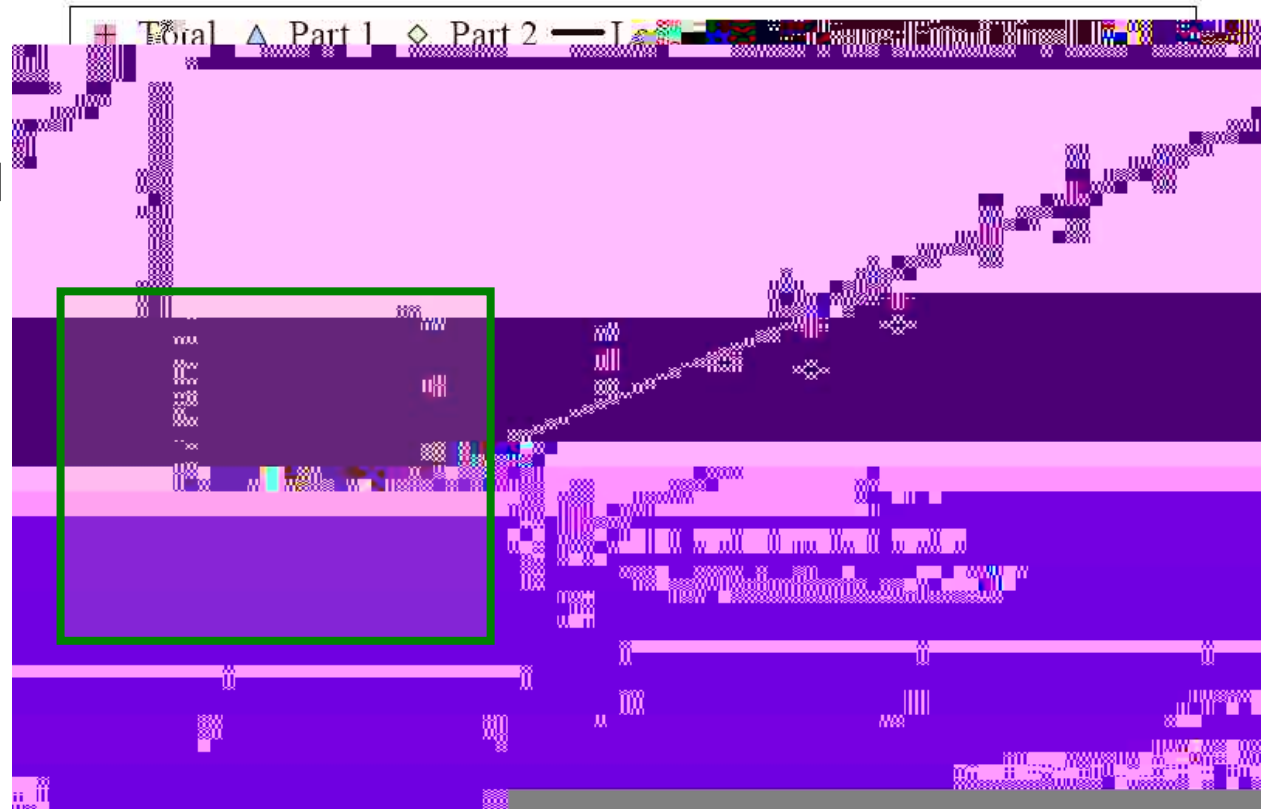
Pearson correlation coefficient of +0.805

- o Highly correlated

Graph of Propulsion final exam score correlated against semester grade (N=350 students)

Generally limited scatter with the exception of D's

- o Arises due to limited data (N<20 students)



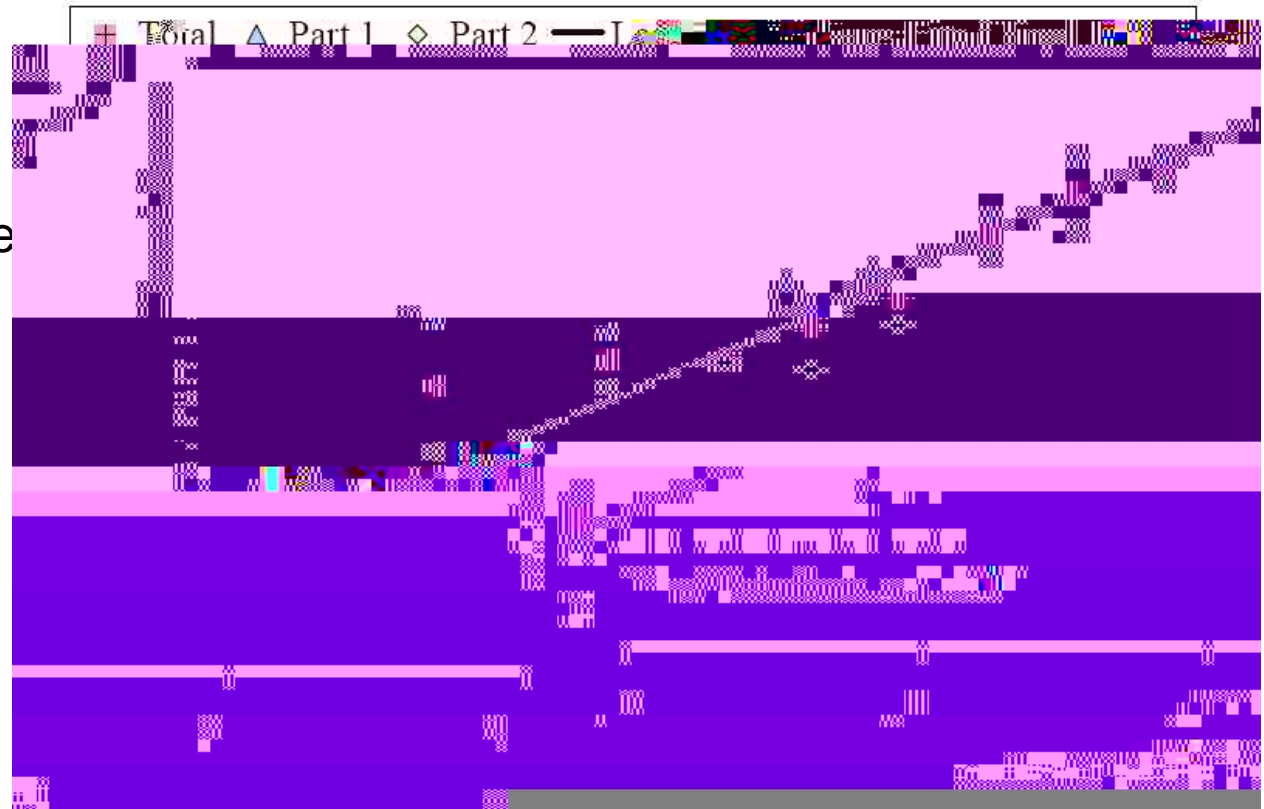
Propulsion Final Exam Results

Least squares fit to total of 1st & 2nd parts (data and line –)

1st part () lies above least squares fit line
® slightly harder

2nd part () lies below least squares fit line
® slightly easier

Conclusion: concept questions are of comparable difficulty level, so **unlikely** to cause increased GPA



Examine Student Performance in Common Format Statics Final Exam

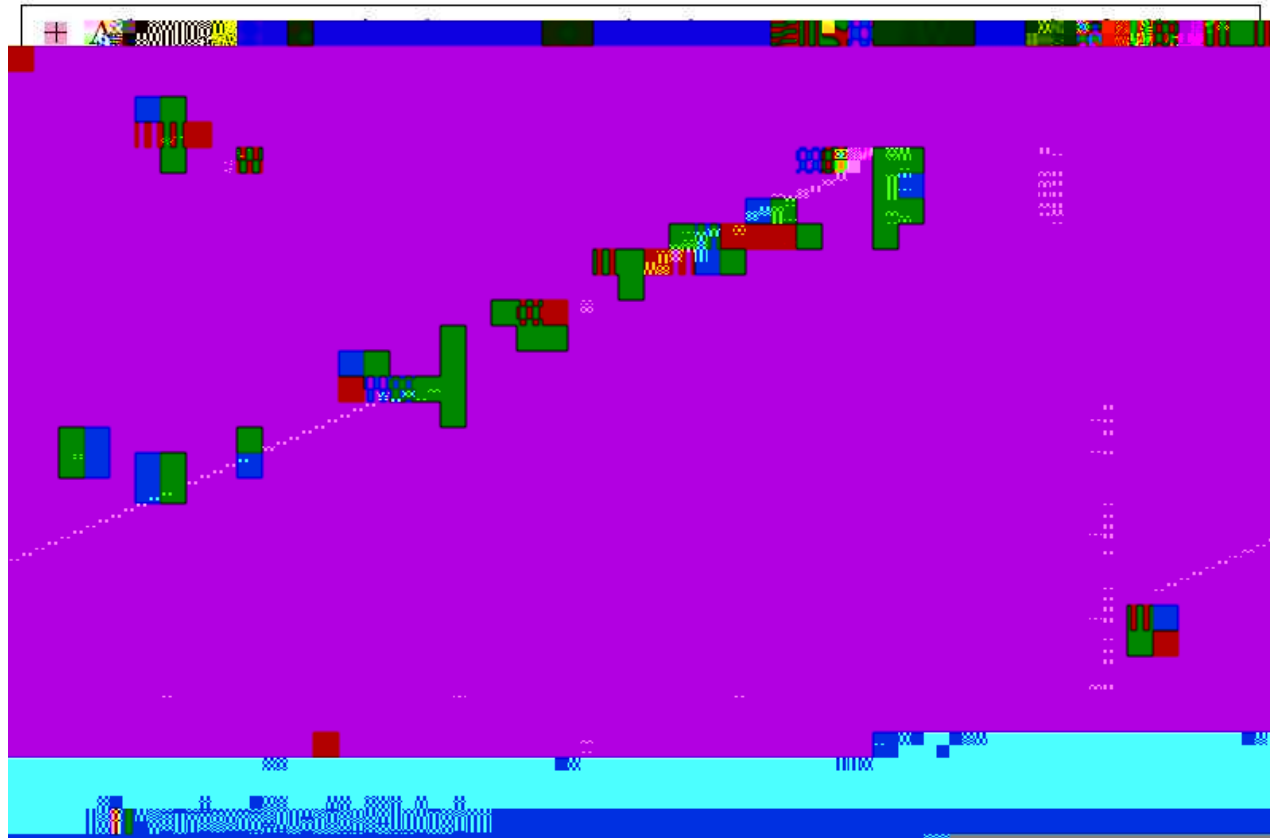
Graph of Statics final correlated against semester grade (N=241 students)

Pearson correlation coefficient of 0.861

- o Highly correlated

Pearson=0.858 for 75-min class (, N=109)

Pearson=0.856 for 50-min class (, N=132)

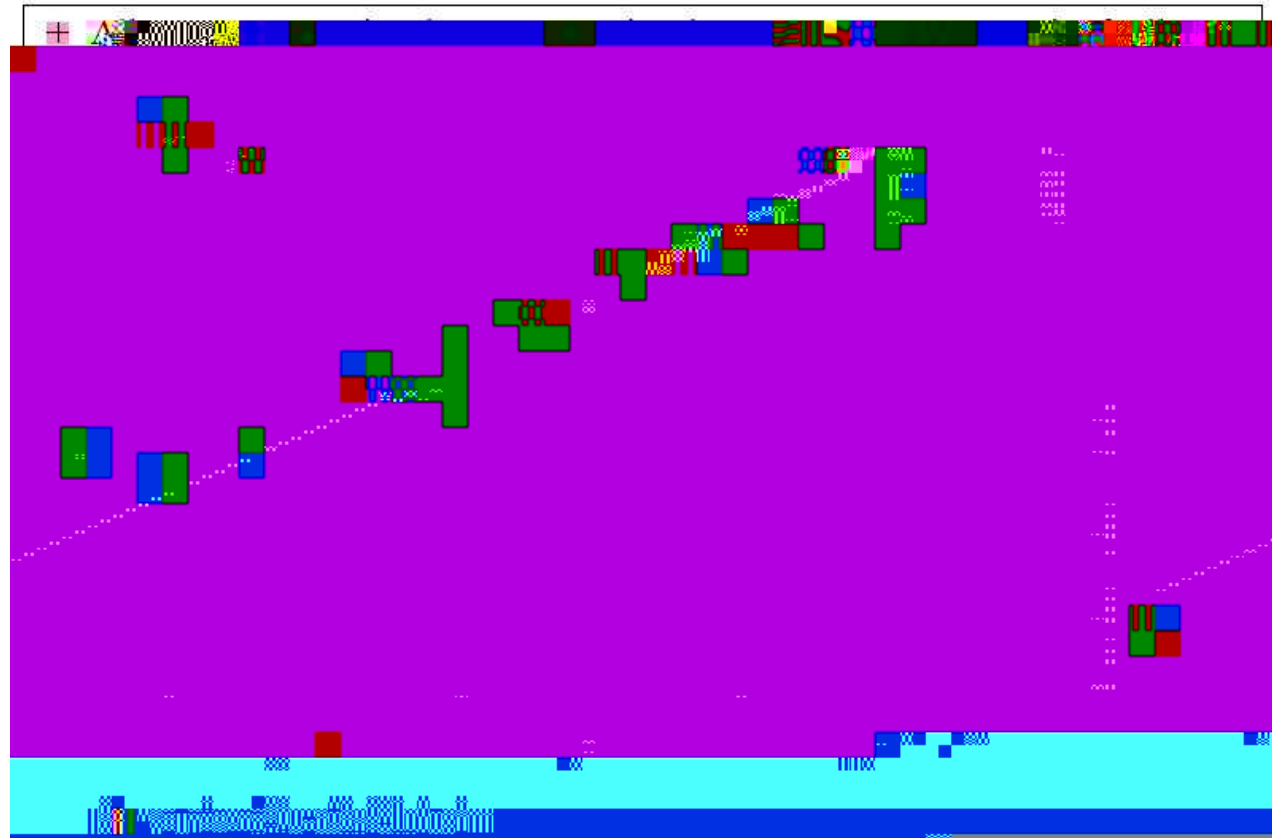


Examine Student Performance in Common Format Statics Final Exam

Students perform similarly irrespective of 50- or 75-min class for the same type of final exam

Graph does not show how many students are at each grade ® this is main affecter of class GPA

Thus, this graph cannot answer the question about student capability



Statics Prerequisite Test to Measure Student Capability and Knowledge

Prerequisite test at **start of semester** covers Physics and Math topics: 1) vector magnitude, 2) vector resultant, 3) friction, 4) dot product, 5) torque (i.e., moment), and 6) force equilibrium

Question types: multiple choice concept questions and single-step calculation-based short answer problems

Prerequisite testing began at WSU in 2012 – preliminary results were reported in 2014* with ~750 students in database

- o Prerequisite testing & database expansion has continued – today ~1760 students
- o No substantive difference in results with increased database size

*Reference: Myose *et al.*, “Correlating Engineering Statics Student Performance with Scores of a Test over Pre-requisite Material...,” *2014 ASEE Midwest Conference*

Statics Prerequisite Knowledge Test Score vs. End of Semester Grade Point

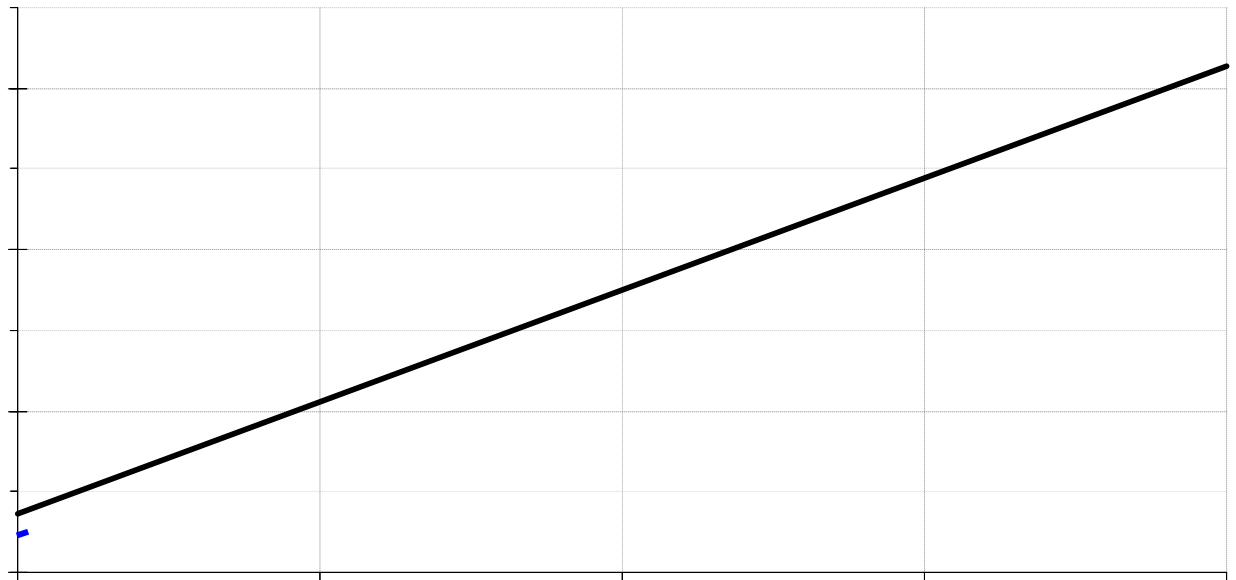
Results shown for grade vs. pre-test score

Data set () of 1760 students taught by six instructors with least squares fit line (— —)

Also shown is least squares fit (solid) line for 1st author's (50-, 60-, & 75-min) classes

16 September 2019

Statics Prerequisite Knowledge Test Score vs. End of Semester Grade Point



Statics Prerequisite Knowledge Test Score vs. End of Semester Grade Point

Two prediction versions:

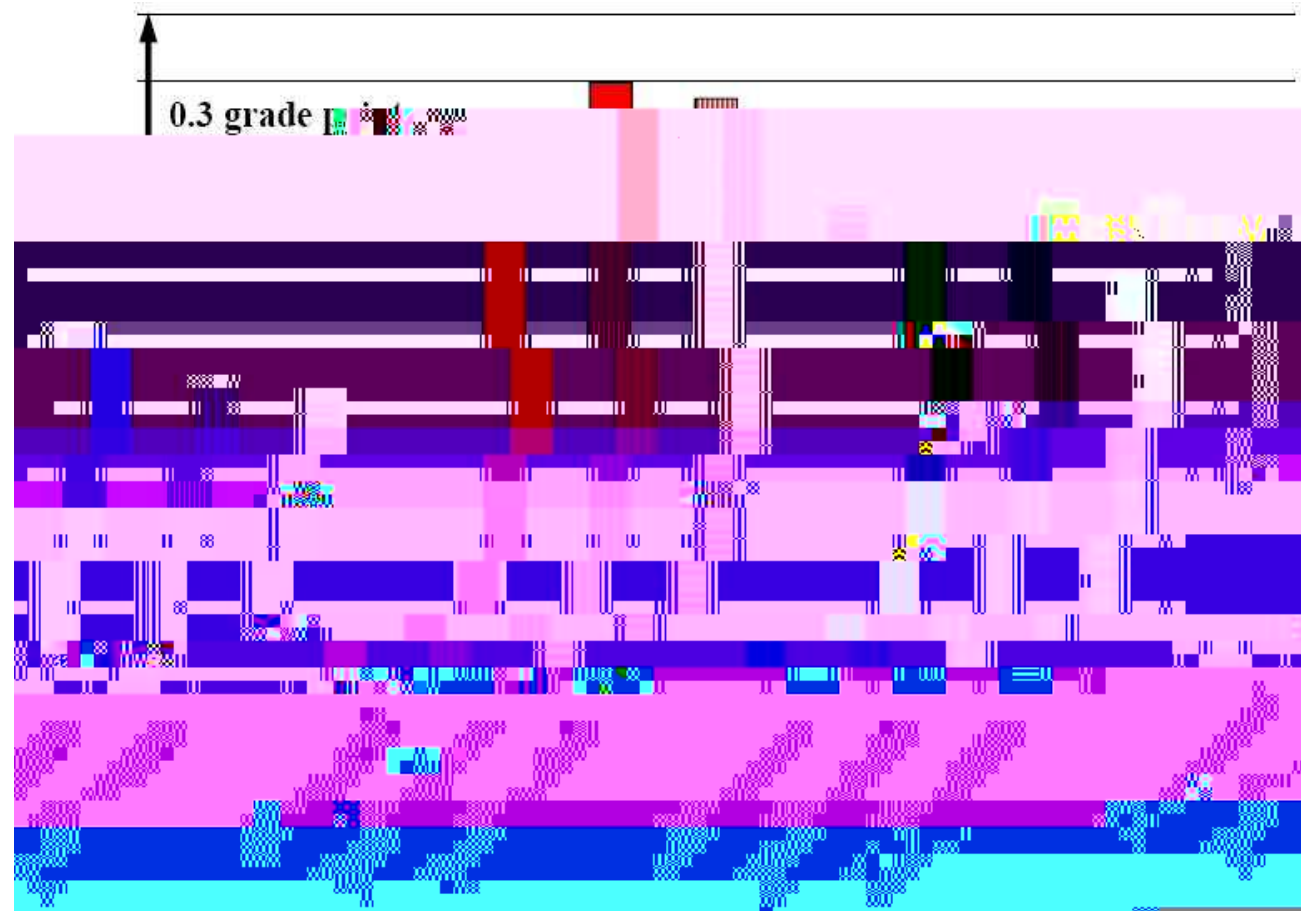
A = use average pre-test score in the eq

B = use individual pre-test scores in the eq, then average predicted grades

Results for class GPA:

A predicted class GPAs to within 0.1 grade points

B underestimated class GPA by 0.1 to 0.2 grade points



Statics Prerequisite Knowledge Test Score vs. End of Semester Grade Point

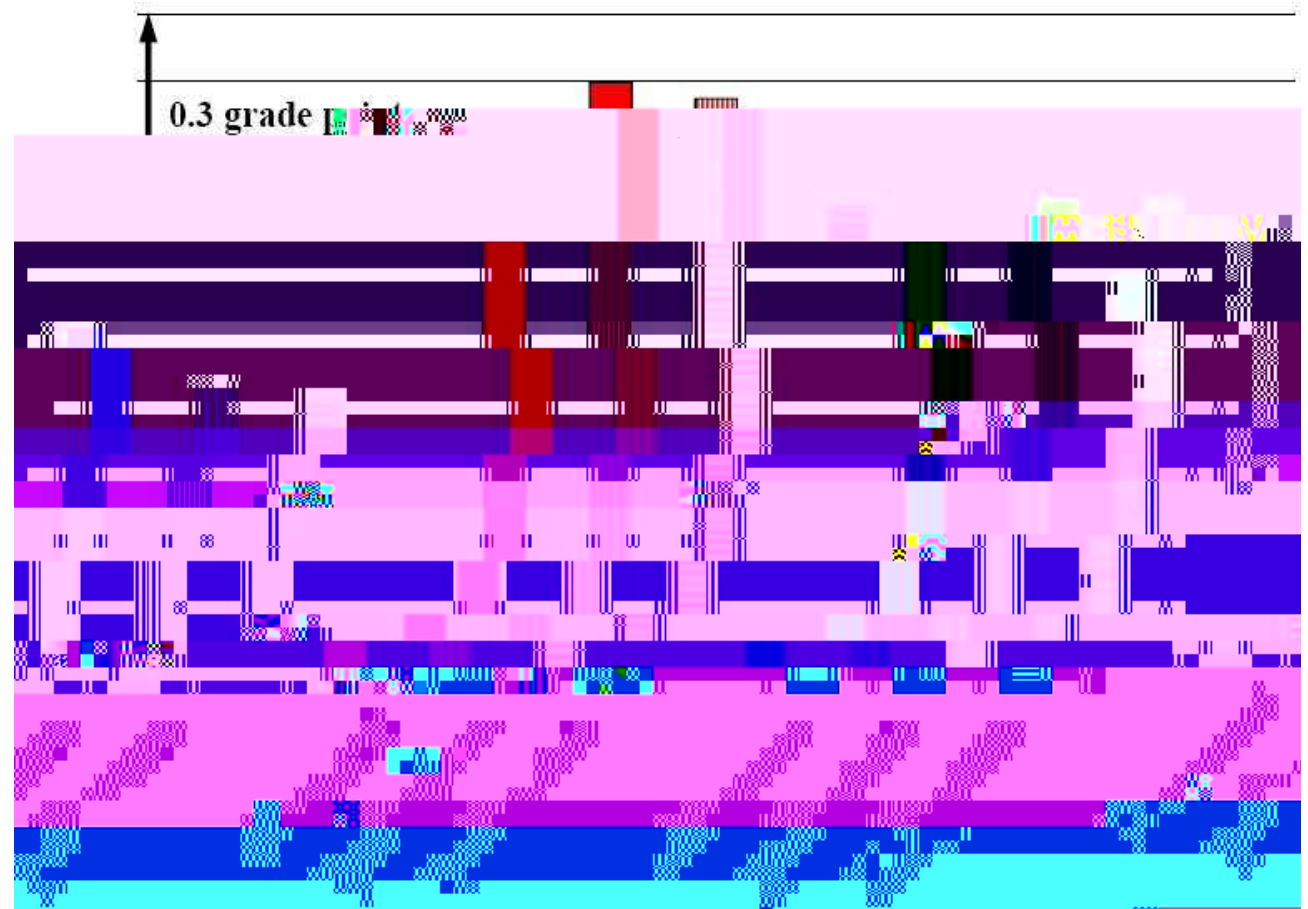
3.2% higher pre-test score for **75-minute** class compared to **50-minute** class

0.37 higher GPA for **75-minute** class than **50-min** class

Version A predicted **0.43** higher GPA

Version B predicted **0.29** higher GPA

Conclusion: GPA difference caused by difference in student capability



Summary

A prerequisite test given at the start of the semester was used to gauge incoming student capability and knowledge

Pre-test is moderately well-correlated with grade even though it is given before any substantive teaching of new material occurs