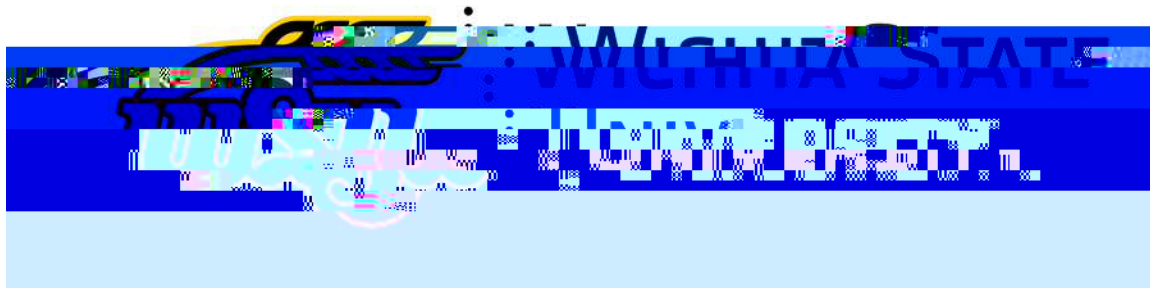


# Prerequisite Testing as a Tool to Gauge Incoming Student Capability & Knowledge in Engineering Statics



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# Motivation for Obtaining Baseline Information

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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

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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

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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

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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 1<sup>st</sup> part – concept questions (2/3 of the points) plus single step calculation-based short answer questions (1/3 of the points)
- o 2<sup>nd</sup> 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

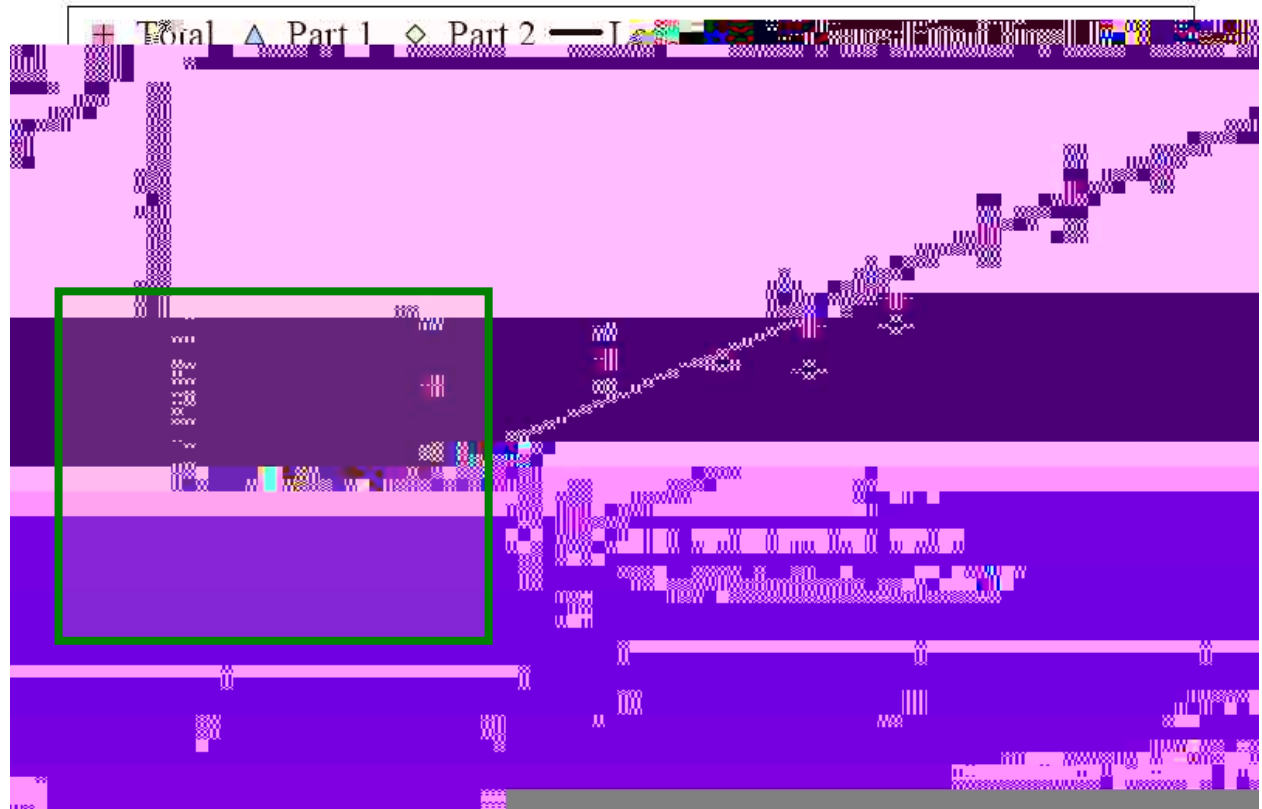
Pearson correlation coefficient of +0.805

- 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)



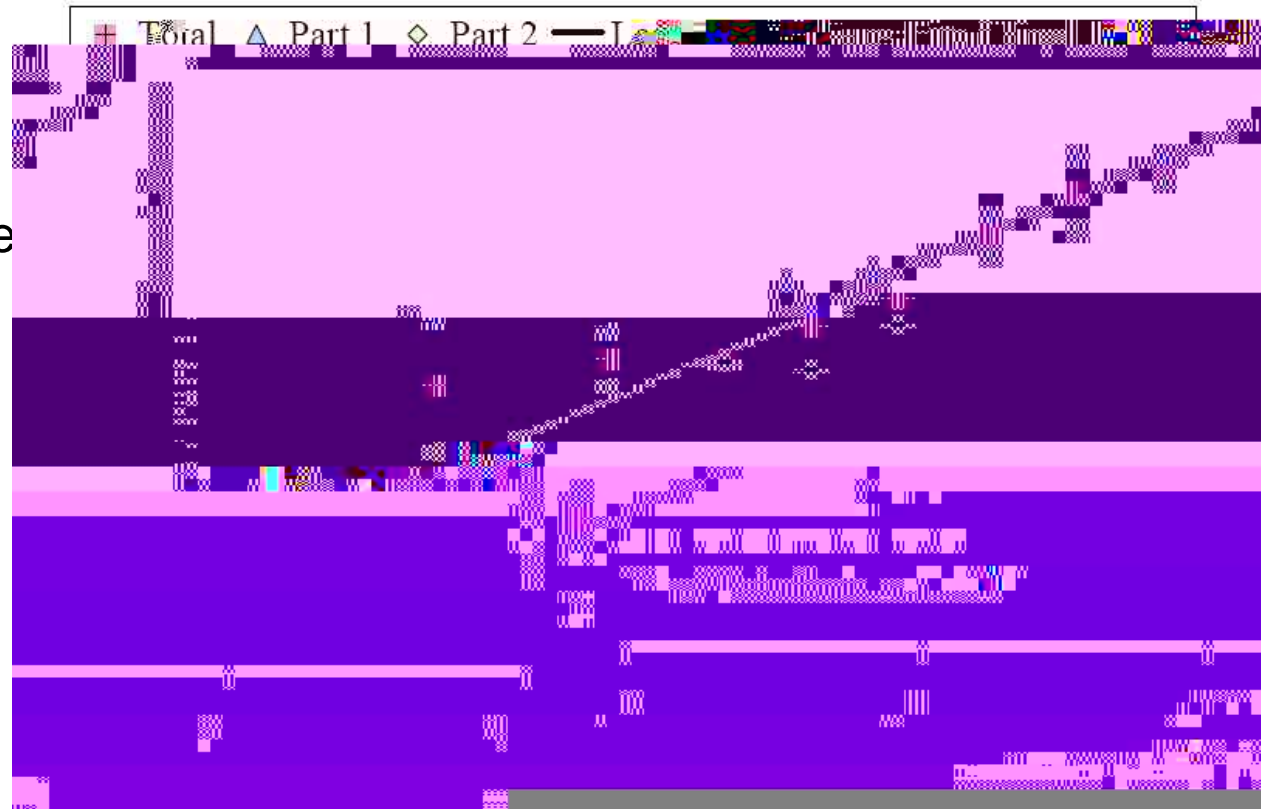
# Propulsion Final Exam Results

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

1<sup>st</sup> part ( ) lies above least squares fit line  
® slightly harder

2<sup>nd</sup> 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

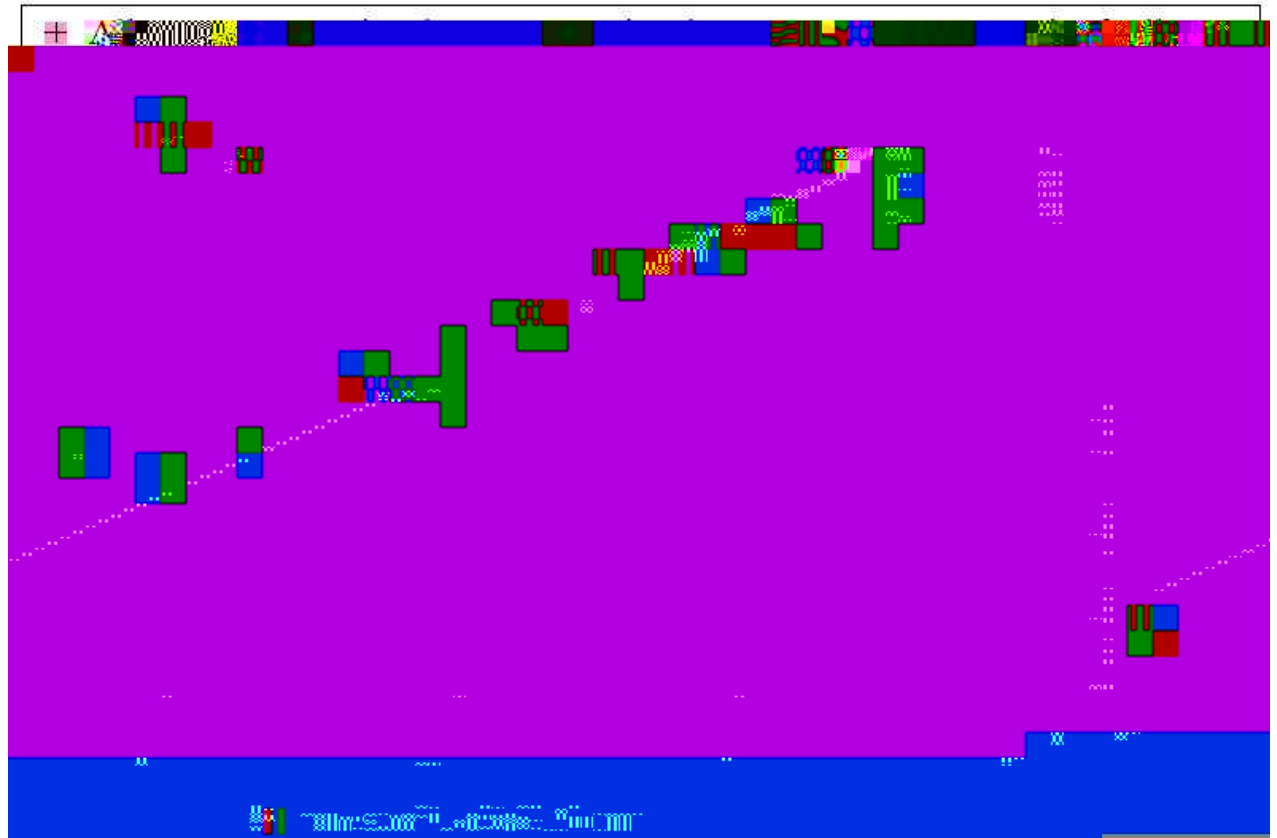
Graph of Statics final correlated against semester grade (N=241 students)

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)



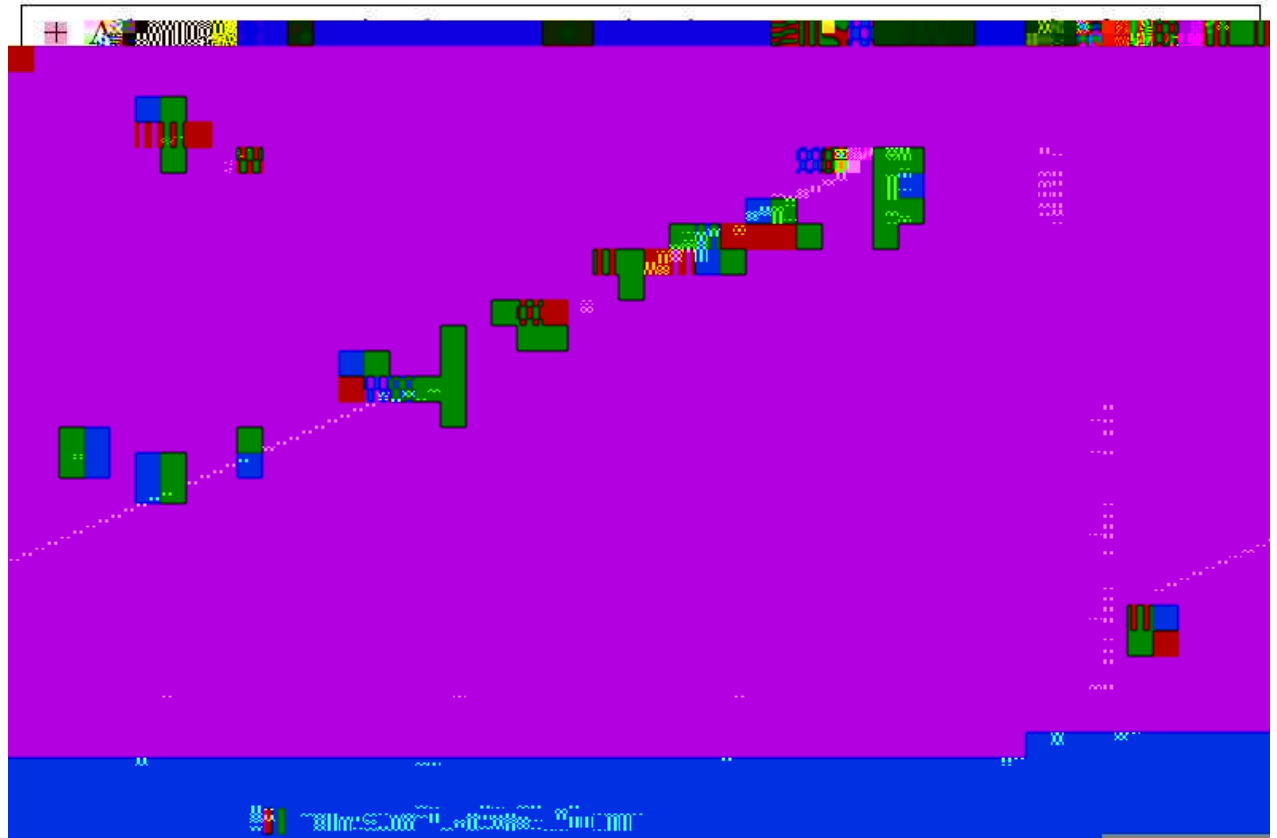


# Examine Student Performance in Common Format Statics Final Exam

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

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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

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Results shown  
for grade vs.  
pre-test score

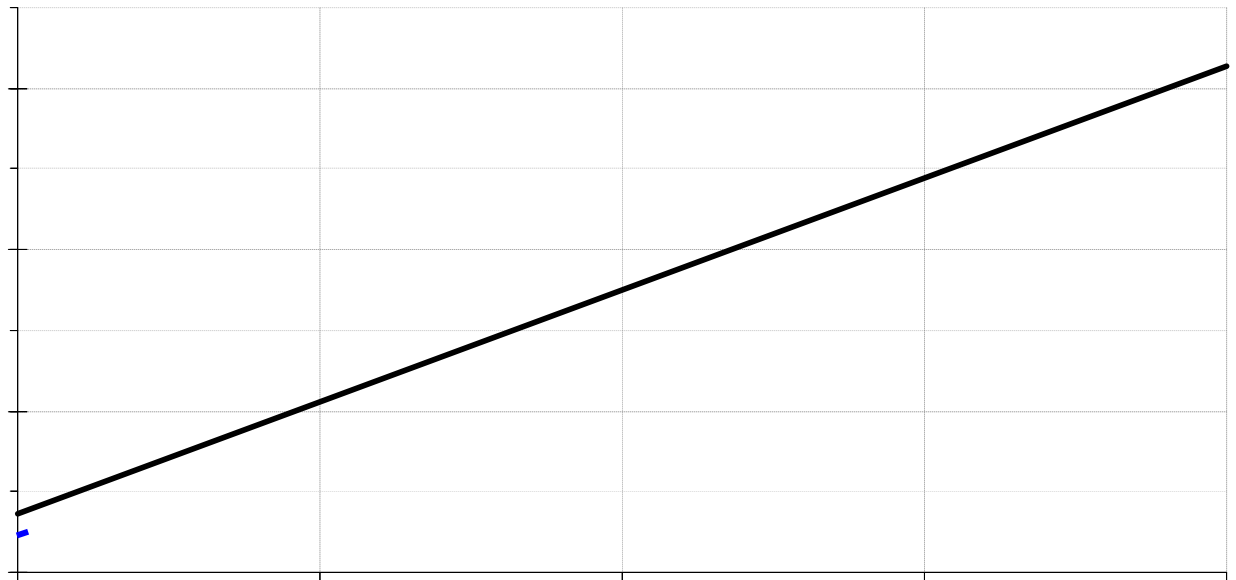
Data set ( ) of  
1760 students  
taught by six  
instructors with  
least squares fit  
line (— —)

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

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

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

Two prediction versions:

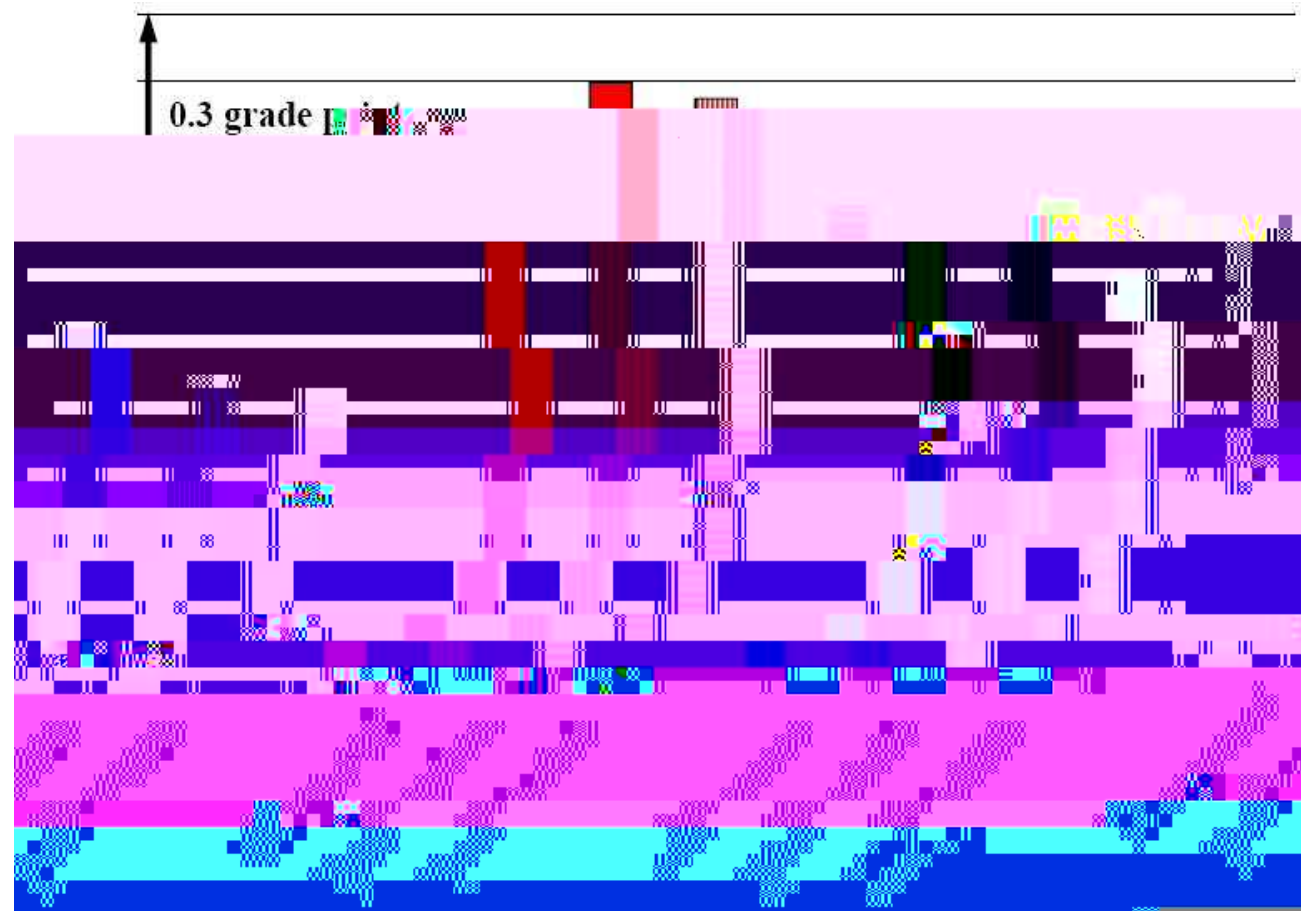
A = use average pre-test score in the eq

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

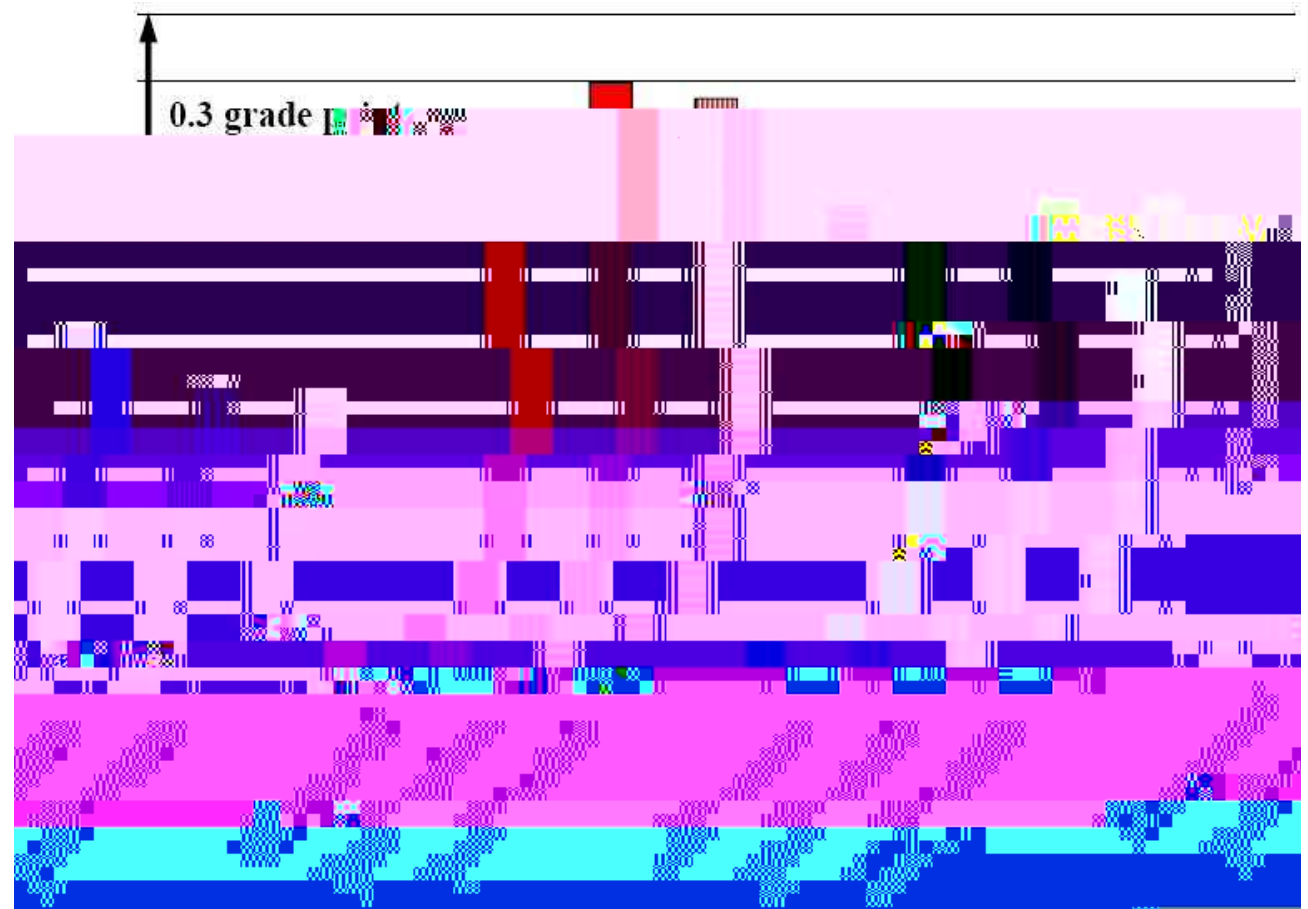
3.2% higher pre-test score for **75-minute** class compared to **50-minute** class

**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

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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