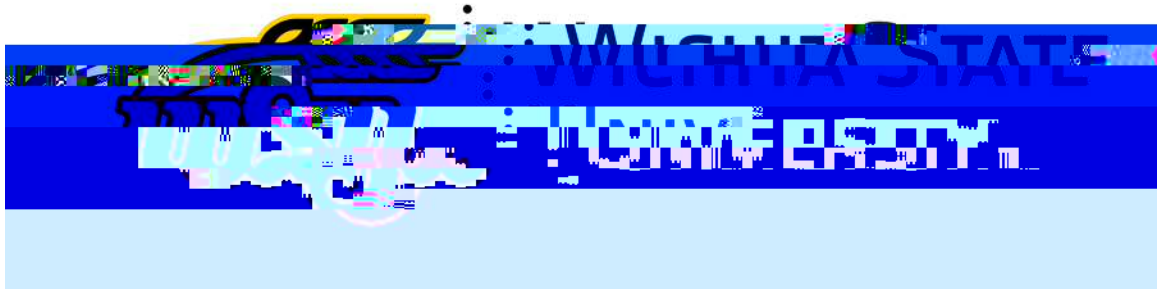
Prerequisite Testing as a Tool to Gauge Incoming Student Capability & Knowledge in Engineering Statics



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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?

- 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

- 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

- 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:

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

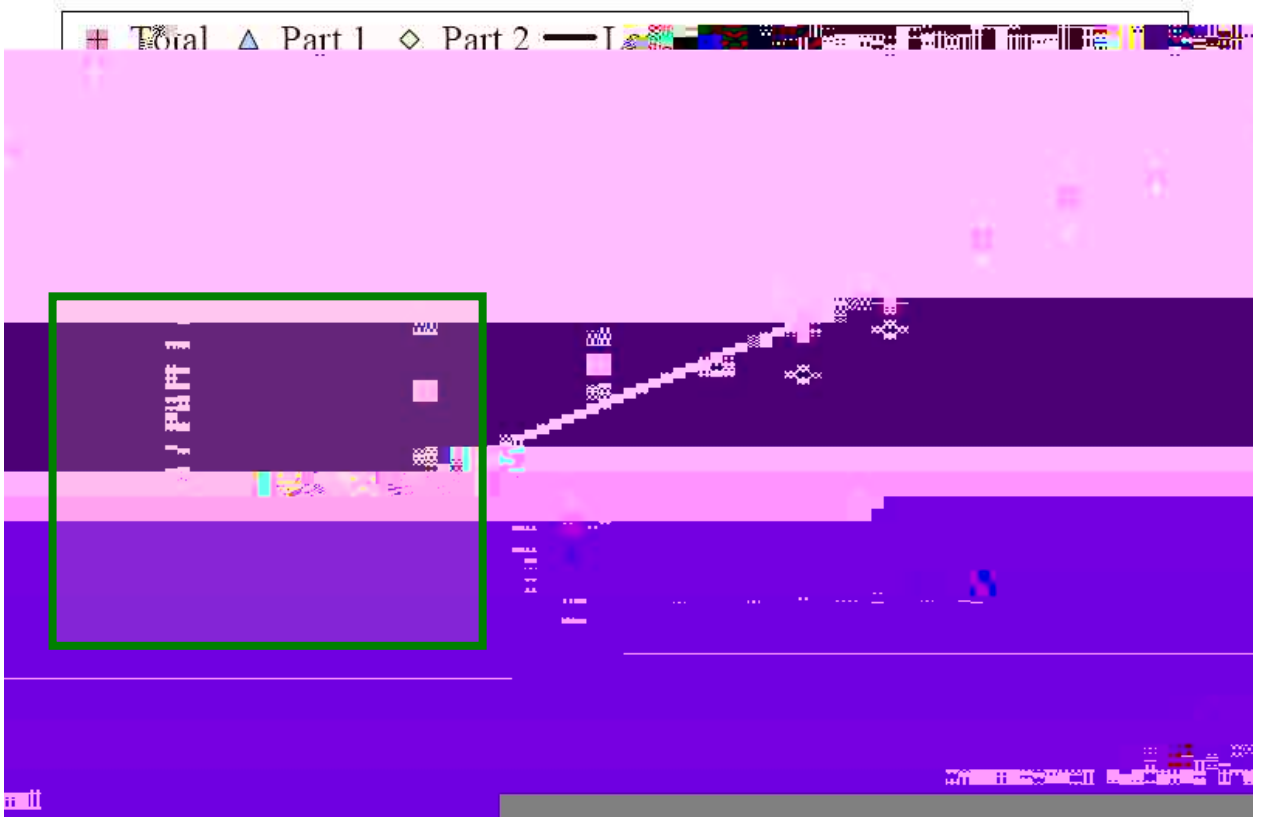
Determine the correlation of the two parts with the semester grade

Pearson correlation coefficient ranges between +1 and -1

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

Propulsion Final Exam Results

- Pearson correlation coefficient of +0.805
  - Highly correlated
- Graph of Propulsion final exam score correlated against semester grade (N=350 students)
- Generally limited scatter with the exception of D's
  - Arises due to limited data (N<20 students)



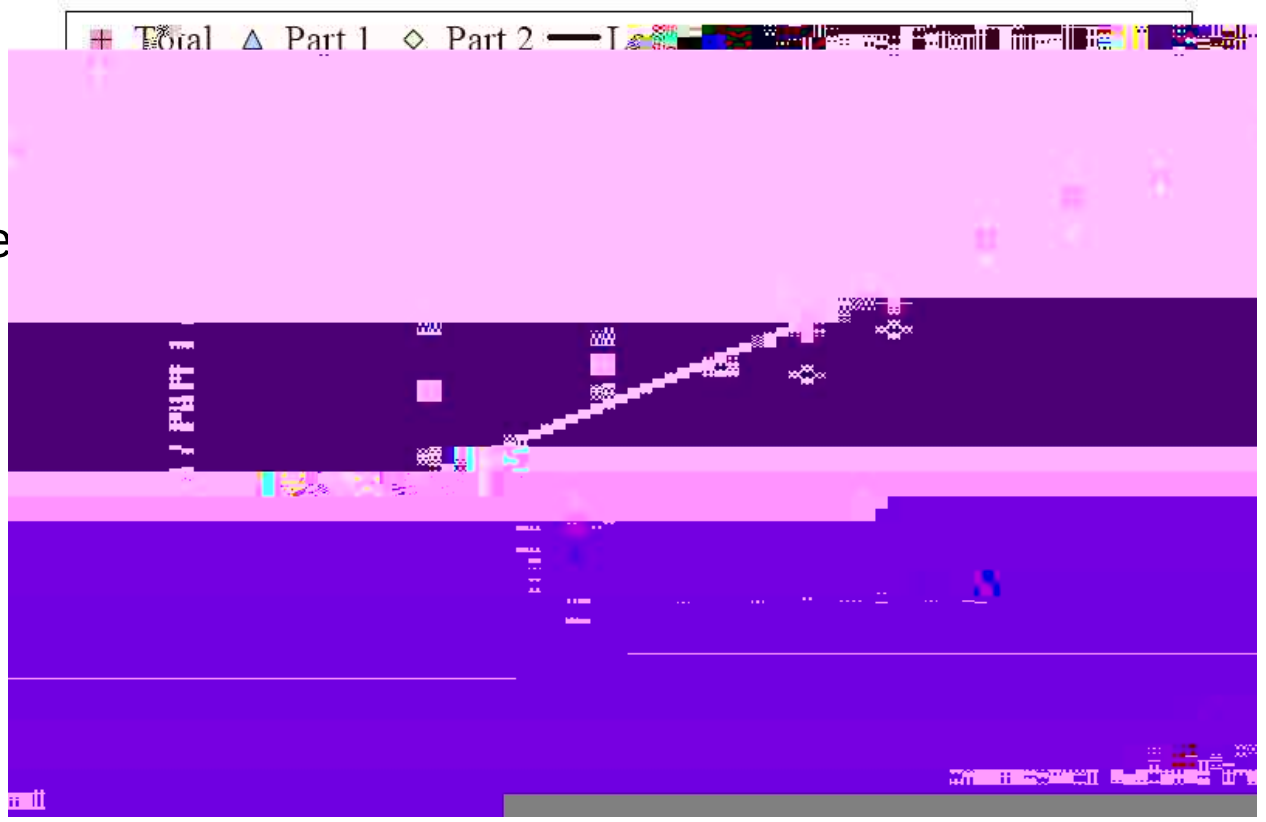
Propulsion Final Exam Results

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

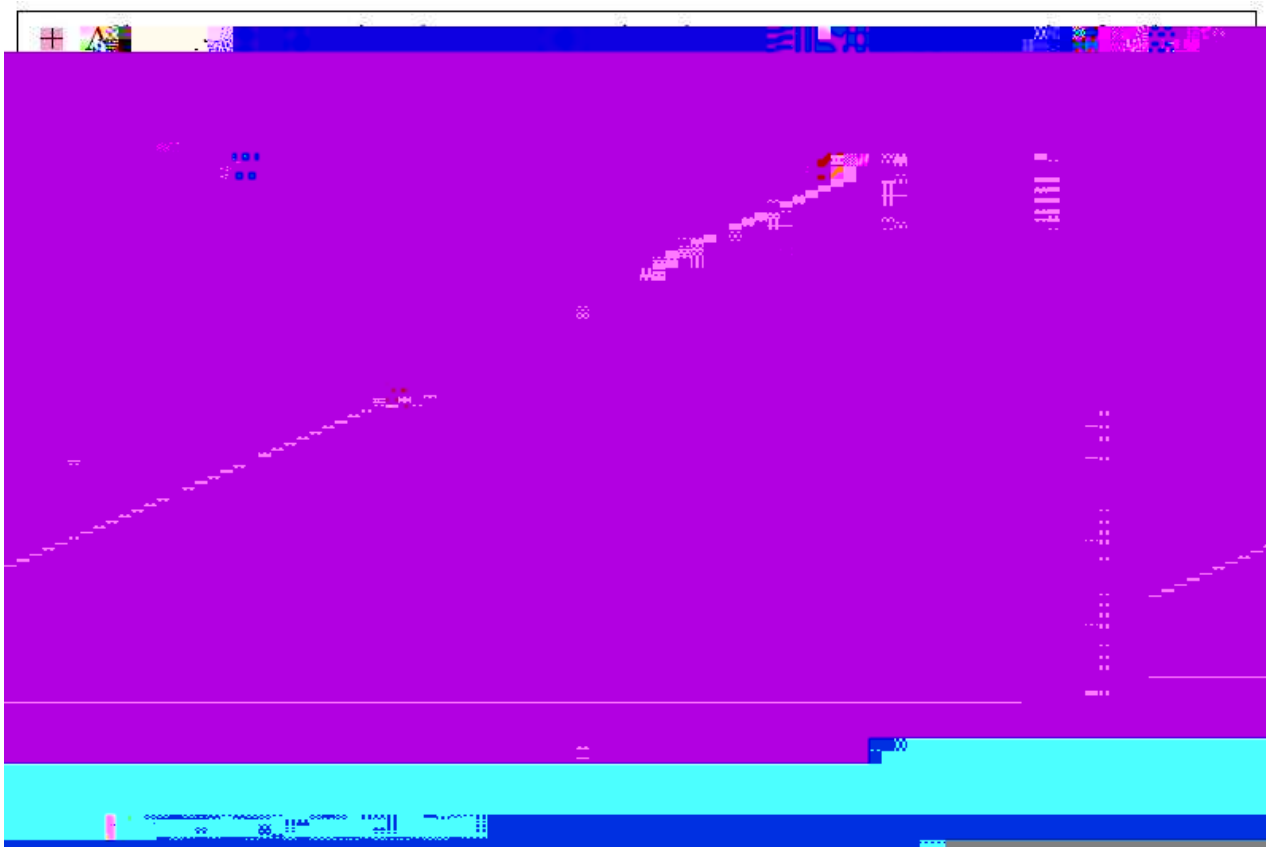
Graph of Statics final correlated against semester grade (N=241 students)

Pearson correlation coefficient of 0.861

- Highly correlated

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

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

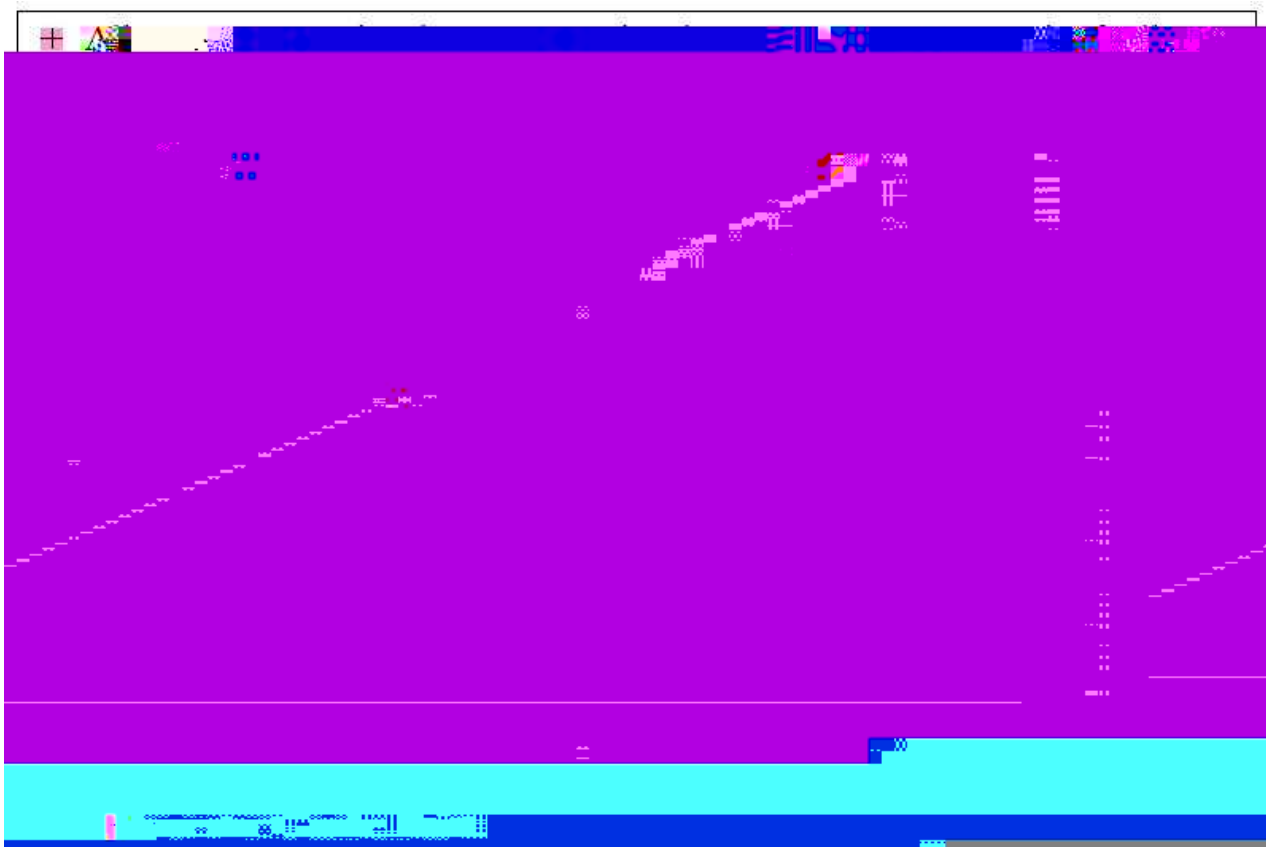


Examine Student Performance in Common Format Statics Final Exam

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

- Prerequisite testing & database expansion has continued – today ~1760 students
- 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

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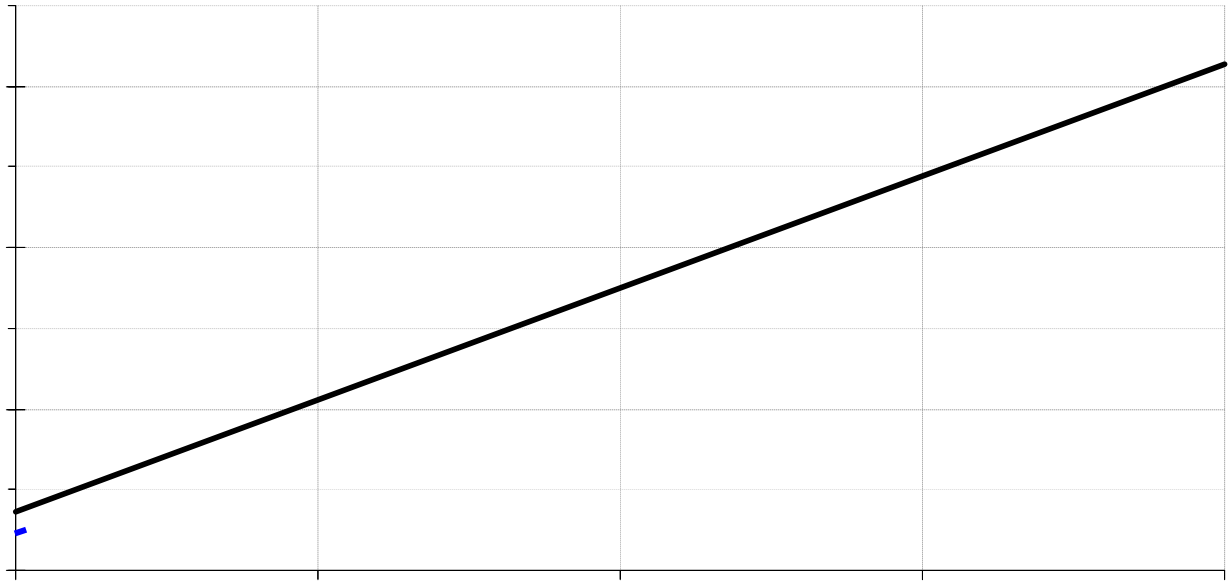
Statics Prerequisite Knowledge Test Score vs. End of Semester Grade Point



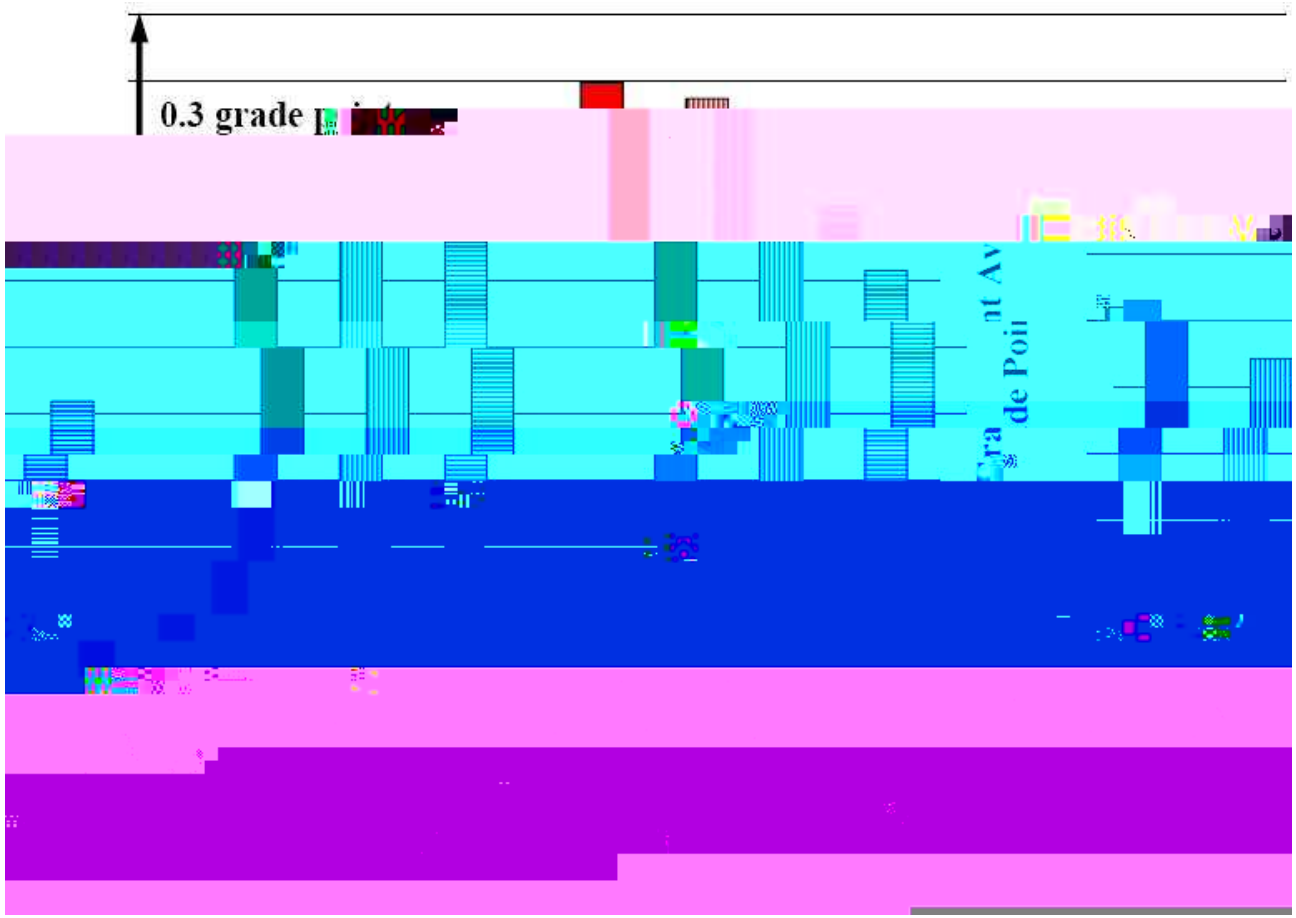
Statics Prerequisite Knowledge Test Score vs. End of Semester Grade Point

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

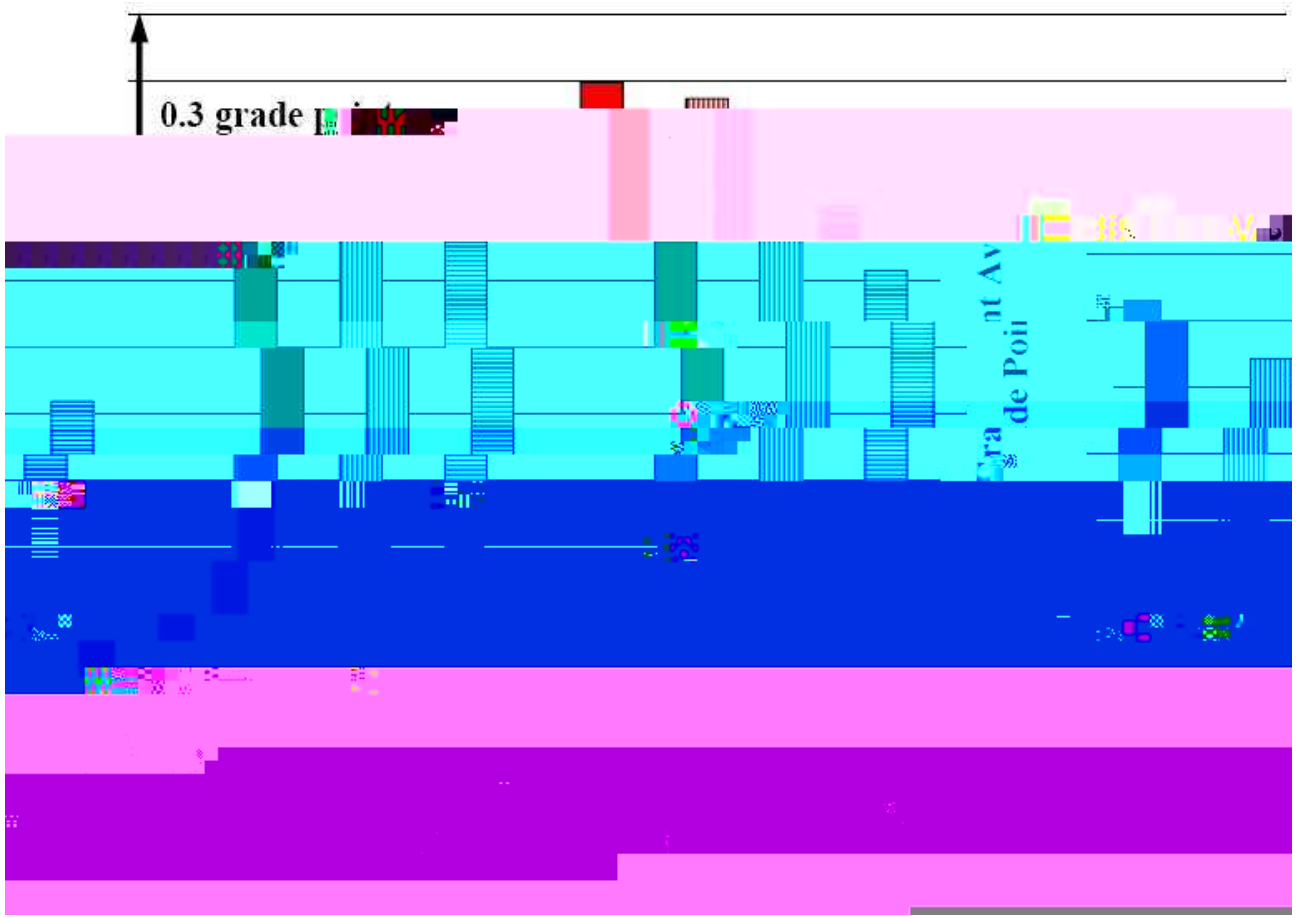
Results for class GPA:

- 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