Gender Differences in both Force Concept Inventory and Introductory Physics Performance

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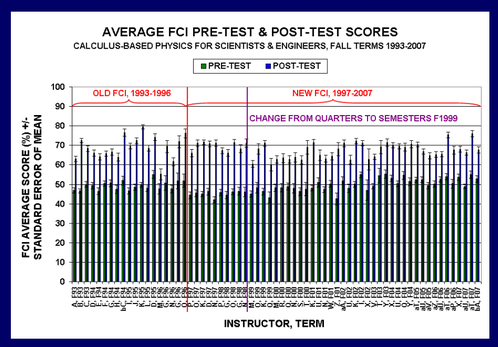
INTRODUCTION

The first-semester of calculus-based physics for scientists & engineers (mechanics) at the University of Minnesota has an average fall term enrollment of 800 students with an average class size of 185. The course meets three hours per week in lecture, two hours in lab, and one hour discussion session. The lab and discussion sessions average 16 students per class (3-4 students per group) and are taught by teaching assistants using Cooperative Problem Solving [1,2] with closed-ended problems (Context-rich) appropriate for group work.

The Force Concept Inventory (FCI) Exam is routinely given in laboratory during the first and last week of the fall term. It does not count in the grade. From 1993-1996 the old version of the FCI was given, and from 1997-2007 the new FCI was administered. Only the latter will be included in this analysis. The final sample includes 5,636 students (1,261 females, 4,375 males) from 40 classes with 22 different instructors. On average, females make up 22% of these classes. The average dropout rate for these classes is 7%.

Students working on a problem-solving lab

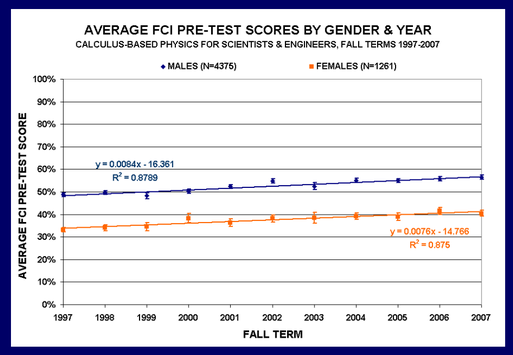
PRE & POST FCI BY CLASS 1993-2007



SELECTION CRITERIA

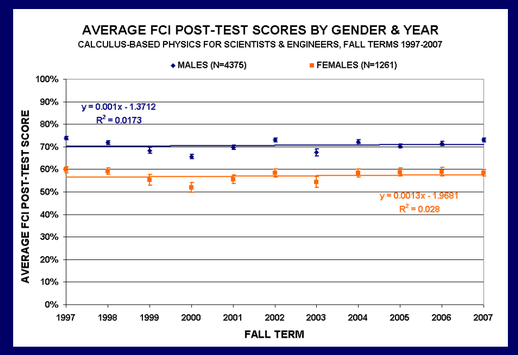
- Total enrollment for 1997-2007 is 7,408
- Match pre-post scores on the FCI Exam *[762 thrown out; post-test scores but no pre-test because fall term begins on a Tuesday]*
- Exclude classes for which matched FCI data is less than half the final enrollment *[10 classes cut from 50 total for 1997-2007]*
- Exclude a student's score if no gender reported *[14 students thrown out]*
- Exclude a student's score if >3 questions blank *[60 students thrown out]*
- Exclude a student's score if abnormally high negative gain (higher than - 5 points) indicating they were not serious about the test *[42 students thrown out]*

PRE-TEST BY YEAR



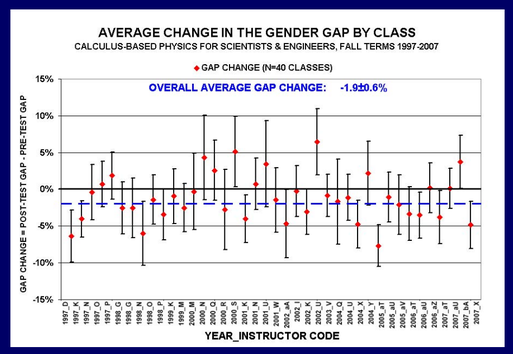
PRE-TEST SCORES ARE INCREASING

POST-TEST BY YEAR

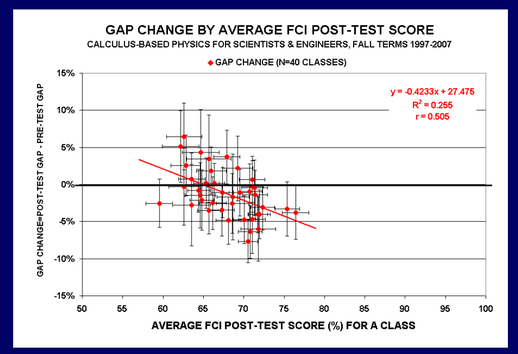


POST-TEST SCORES ARE CONSTANT

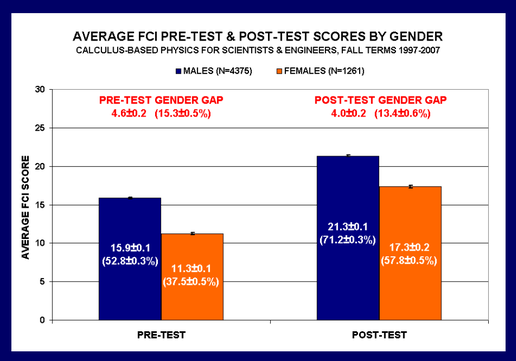
GAP CHANGE BY CLASS



GAP CHANGE BY POST

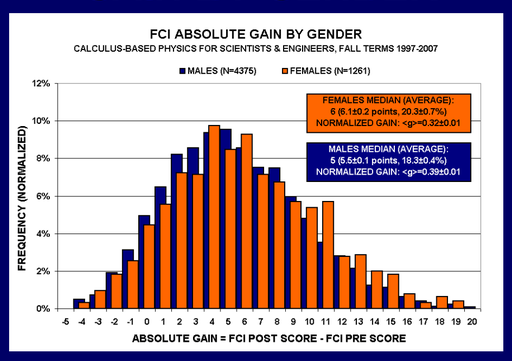


AVERAGE FCI SCORES BY GENDER



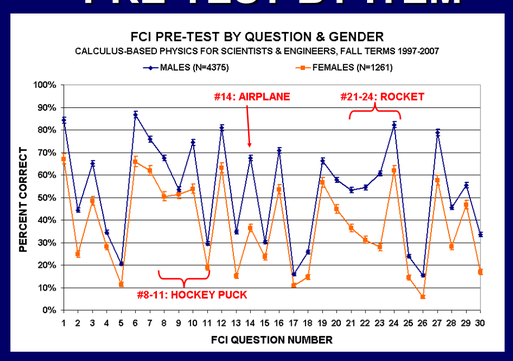
GENDER GAP PERSISTS AFTER INSTRUCTION

GAIN BY GENDER



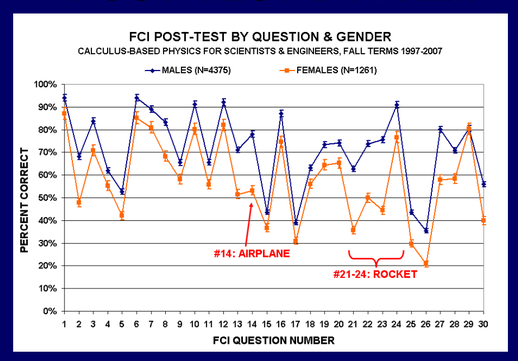
DISTRIBUTIONS OF ABSOLUTE GAIN LOOK SIMILAR

PRE-TEST BY ITEM

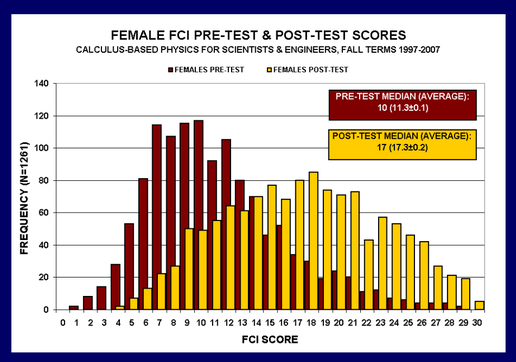


LARGEST "GAP" FOR QUESTIONS 14 & 23

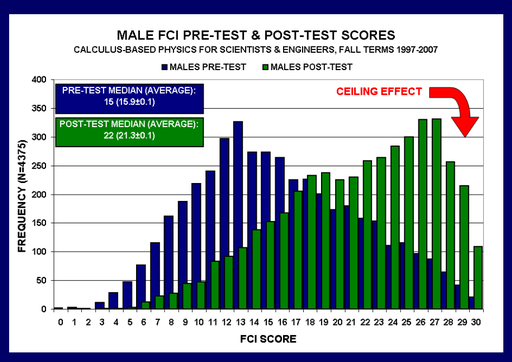
POST-TEST BY ITEM



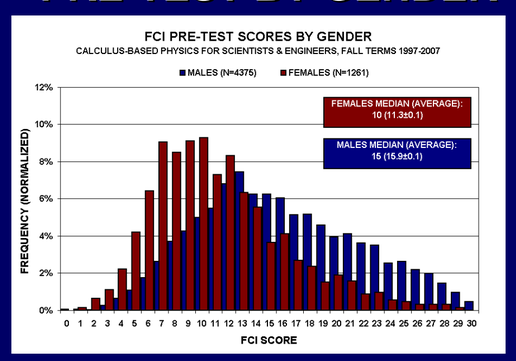
FEMALES PRE & POST



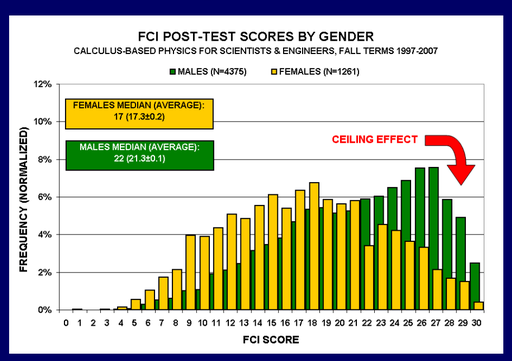
MALES PRE & POST



PRE-TEST BY GENDER



POST-TEST BY GENDER



FINDINGS: FORCE CONCEPT INVENTORY

- Over the past decade, there is a significant [p<0.0001] gender gap in FCI pre-test scores (15.3±0.5%) that persists after instruction (13.4±0.6%)
- The distributions of absolute gain for males and females are very similar even through the male post test score exhibits a clear ceiling effect.
- Pre-test FCI scores are increasing for both genders whereas post-test scores are constant.
- The gender gap decreases with increasing post test score.
  - *Lorenzo, Crouch, & Mazur (2006) observed a reduction or elimination of the gender gap with interactive engagement methods. This is consistent with our data for their higher post test (and pre test) scores.*
  - *Pollock, Finkelstein, and Kost (2007) observed no significant reduction of the gender gap with interactive engagement methods. This is consistent with our data for their lower post test (and pre test) scores.*
- The change in the gender gap for a class ranges from – 8%±3% to +7%±5% with an average of – 1.9±0.6%. The differences by class and instructor are consistent with statistical fluctuations. Even though different instructors implement cooperative group problem solving differently, no instructor dependent gender gap change was observed.
  - *Pollock, Finkelstein, and Kost (2007) also observed such variations which were consistent with statistical fluctuations.*
- The largest gender gap is observed for FCI items number 14 (airliner / bowling ball) and number 23 (rocket). This is true for both the pre-test and post-test.

REFERENCES

[1] P. Heller, R. Keith, and S. Anderson, "Teaching problem solving through cooperative grouping. Part 1: Group versus individual problem solving," Am. J. Phys. 60(7), 627-636 (1992).

[2] P. Heller and M. Hollabaugh, "Teaching problem solving through cooperative grouping. Part 2: Designing problems and structuring groups," Am. J. Phys. 60(7), 637-644 (1992).

[3] M. Lorenzo, C.H. Crouch, and E. Mazur, "Reducing the gender gap in the physics classroom," Am. J. Phys. 74(2), 118-122 (2006).

[4] S.J. Pollock, N.D. Finkelstein, and L. E. Kost, "Reducing the gender gap in the physics classroom: How sufficient is interactive engagement?" Phys. Rev. ST Phys. Educ. Res. 3, 010107 (2007).

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