Students' Learning in First Year Physics Classes

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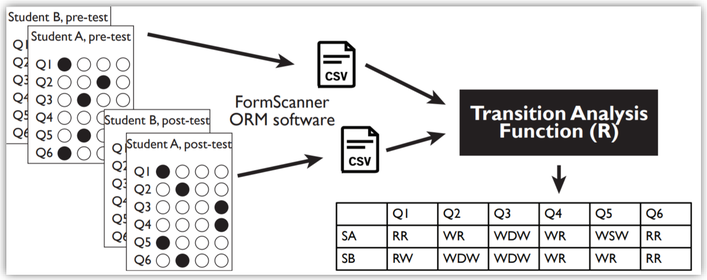
Introduction

In introductory physics classes, students are given a conceptual evaluation prior to instruction and then again after. Researchers currently use "normalized gain" and "normalized change" to evaluate learning in these studies. Moreover, the quality of data collected due to these studies is not always clear.

We propose new metrics that assess how students' paired responses change from pre-test to post-test. These are an improvement on current practices as we get to characterize how students confront their own misconceptions. We can also use these metrics to ascertain the "seriousness" of participants while taking the assessment, and thus we learn of the quality of the data.

How Do Students Answers Change?

We compare students' pre-test and post-test responses and characterize them according to the type of transition that occurred:



Pre-test Answer	Post-test Answer	Type of Transition
Right	Right	Right to Right (RR)
Right	Wrong	Right to Wrong (RW)
Wrong	Right	Wrong to Right (WR)
Wrong	Wrong (same as pre-test)	Wrong to Same Wrong (WSW)
	Wrong (different from pre-test)	Wrong to Different Wrong (WDW)

What is "Seriousness"?

Serious participants "chose answers with consideration, including educated and/or thoughtful guesses, throughout their entire assessment"[3]

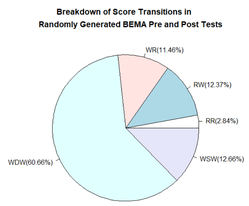
- Low Q indicates seriousness
- High Q and a combination of other cutoffs using metrics indicates nonserious

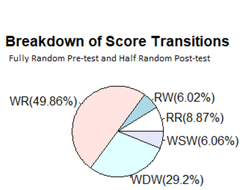
Transition Metrics

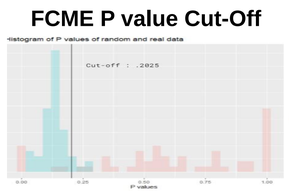
We characterize change at the whole class, individual student, or individual question level using metrics derived from these transitions:

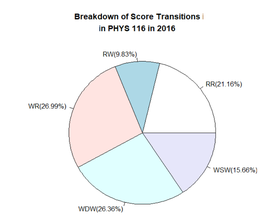
Normalized Gain $G = \frac{WR - RW}{WDW + WSW + WR}$	Gain in final score normalized by maximum possible gain	**Counterproductive Change** $C = \frac{RW}{WDW + RW + WR}$	Fraction of all changed answers that changed from right to wrong
Productive Change $P = \frac{WR}{WDW + RW + WR}$	Fraction of all changed answers that changed from wrong to right	**Shuffling** $S = \frac{WDW}{WDW + RW + WR}$	Fraction of all changed answers that remained incorrect
Change Quotient $Q = \frac{RW + WR + WDW}{RR + WSW + RW + WR + WDW}$	Fraction of answers that changed from the pre−test to the post−test.		

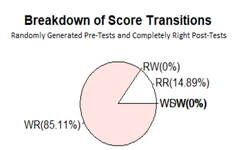
Determining the Thresholds

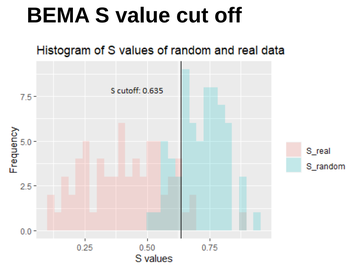




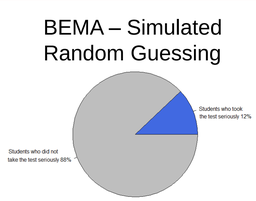


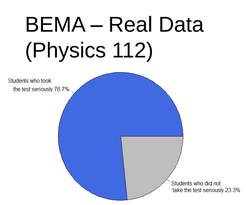


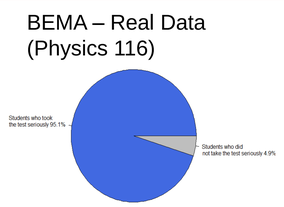


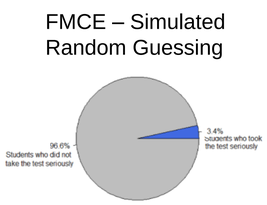


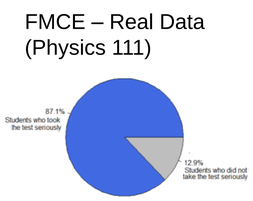
Seriousness Pie Charts

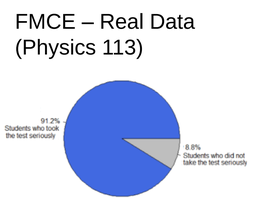






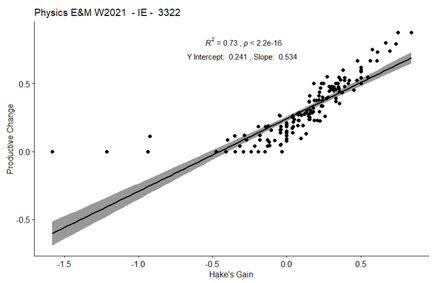


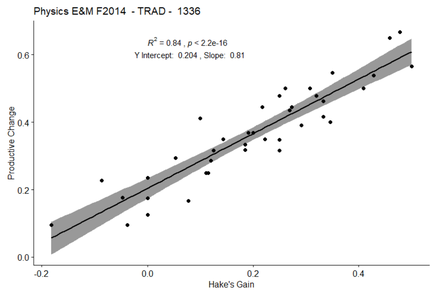




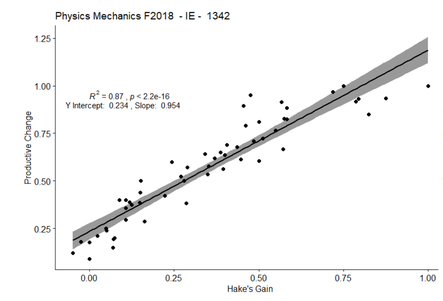
Productive Change vs Normalized Change

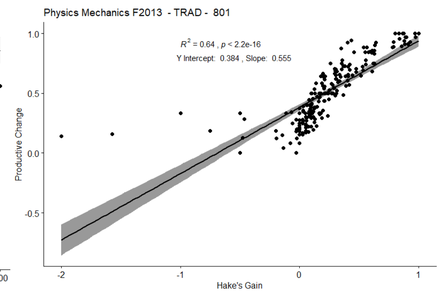
Physics Electricity and Magnetism





Physics Mechanics





Conclusions

We found that using the expected values for several metrics as thresholds allowed us to distinguished randomly generated data sets from real data sets. We also found a strong correlation between Productive Change and Normalized Change across other universities, suggesting that classes can be characterized by these correlations.

In further work, we will apply these thresholds to other institutional data and further analyze the effects each metric has on one another. We will conduct additional tests ensure that "serious" and "nonserious" populations are also accurately captured across any real data set.

References

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Acknowledgements

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