

## “Hidden Variables” in Conceptual Diagnostic Pretest Data?

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“Normalized Learning Gain” [Hake’s “ $g$ ”] on the Force Concept Inventory (FCI) is generally considered to be correlated only with instructional method. [ $g = (\text{posttest score} - \text{pretest score}) / (\text{maximum possible score} - \text{pretest score})$ .] Hake (1998) has found that  $g$  was *not* correlated with class-averaged FCI pretest score, but *was* consistently higher for courses in which “Interactive Engagement” methods of instruction were used. We have confirmed (Meltzer, 1997) that *individual* student  $g$  does not appear to be correlated with students’ pretest score, either on the FCI or on the Conceptual Survey of Electricity (CSE) (O’Kuma et al., 1998).

However, many studies in the literature assert that there is a correlation between students’ mathematical ability, and their performance in physics courses. Is it possible that such a correlation might also be reflected in learning gains as measured by  $g$  on the FCI, CSE, or similar conceptual diagnostic exams?

If normalized learning gain  $g$  could be shown to be correlated with *any* precourse measure (such as mathematical ability), then this would have to be taken into account when analyzing comparative FCI data. It could no longer be assumed that equal FCI pretest scores in courses that use identical instructional methods imply equal probability of attaining specified posttest scores. **Other, “hidden” variables would be required to fully characterize a student’s preinstruction “mental” state function.**

***Zeroth Order Analysis: Are students’ ACT Math scores correlated with their normalized learning gain  $g$  as measured by the Conceptual Survey in Electricity (CSE)?***

We have examined two separate samples of data to explore the possibility of this correlation. Both samples were drawn from students enrolled in the second semester of the algebra-based introductory courses at Southeastern Louisiana University. All students were included for whom both ACT Math score, and pre/posttest scores on the (abridged) CSE were available.

**RESULTS:** The results of the preliminary study were ambiguous, and indicate a need for further investigation. *FALL 1997: Correlation analysis was performed for individual students’ ACT Math score and their normalized gain  $g$ ;  $N = 46$ ; correlation coefficient = 0.22 and is **not significant** at the  $p = 0.05$  level. However, if one outlier is removed, then the correlation coefficient = 0.38,  $p < 0.01$ , and the correlation is significant.*

*SPRING 1998: Identical analysis was performed for this data set.  $N = 37$ ; correlation coefficient = 0.12,  $p = 0.49$ , correlation is **not significant**.*

Hake, Richard R. (1998), American Journal of Physics **66**, 64.

Meltzer, David E. (1997), AAPT Announcer **27(4)**, 89.

O’Kuma, Tom L., Curtis J. Hiegelke, Dave Maloney, and Alan Van Heuvelen (1998), AAPT Announcer **28(2)**, 81.