

Research Study Profile Sheet

Title: Using an online homework system enhances students' learning of physics concepts in an introductory physics course

Authors: K. Kelvin Cheng, Beth Ann Thacker, Richard L. Cardenas, and Catherine Crouch

Journal: American Journal of Physics

Date: 2004

Abstract:

We report the results of a comparison of student understanding of physics concepts with and without online homework, as measured by the force concept inventory. We compared students in large introductory courses taught by interactive engagement and noninteractive engagement methods and with ungraded homework and with online homework. We also compared the understanding of students in different grade subgroups. The increase in the average force concept inventory normalized gain was statistically significant for all students taught with online homework, indicating that graded homework increases student understanding of physics concepts. The gain was significantly higher for those students taught with interactive engagement methods together with online homework.

Research Questions:

1. Determine if the implementation of online homework in introductory physics classes leads to an improvement, compared to ungraded homework, in students' understanding of physics concepts, as measured by the force concept inventory.
2. Determine if the use of interactive engagement teaching methods makes a difference in students' understanding of physics concepts, compared to the use of noninteractive engagement teaching methods, in the presence or absence of an OHW system.

Research Design/Methods:

The Force Concept Inventory was given as a pre/posttest to students who were taught with and without interactive engagement methods, with assigned, but ungraded homework in 1999 and with an online homework system in 2000. The teaching method was labeled interactive if the instructor attempted to involve the students in thinking about a physics concept during the lecture. Usually, this involvement was done by posing a question to the students, allowing them to discuss it with each other, and then polling their responses by a show of hands. A method was labeled noninteractive if the instructor used a traditional lecture method with minimal, if any, student participation.

Analytical Methods:

All registered students took online pre/post-FCI tests administered by the Harvard Physics Education Research Group. The FCI pretest was administered during the first week of class. The FCI posttest was administered in the middle of the term, after kinematics, dynamics, and momentum were covered. The FCI normalized gain of each student is the ratio of the absolute gain to the maximum possible gain multiplied by 100. The average FCI pretest, average posttest, and average normalized gain and their t statistics were calculated for different groups. The effect size a measure of the magnitude of the treatment effect between two groups, was calculated from the difference of the means of the two comparison groups divided by the pooled standard deviation.

Results:

The distributions of the FCI scores, normalized gain versus pretest score for students with and without online homework are shown in Figs. 1A and 1B. The average normalized gain of the online homework group was between 30% and 70%, which is within the low-to-medium gain region. Normalized gain of the ungraded homework group was <30%, which is in the low gain region. The absolute gain versus the pretest score for students with ungraded homework and graded homework is shown in Figs. 1C and 1D.

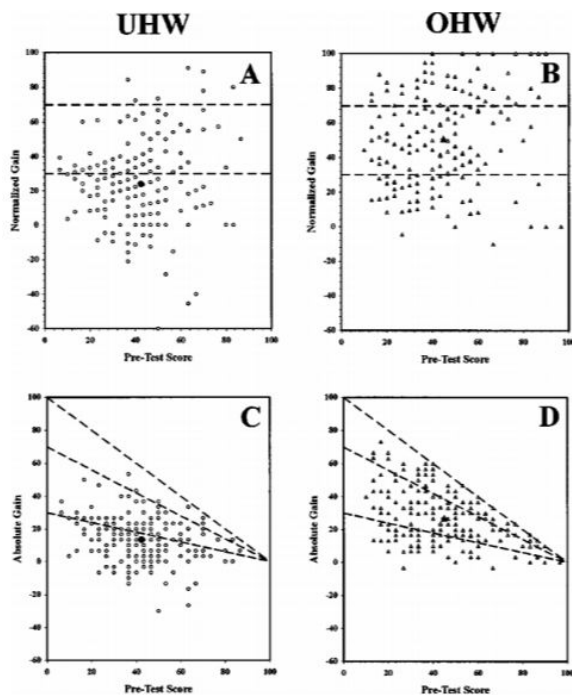


Fig. 1. FCI data of TTU students with UHW and OHW. Plots of FCI normalized gain (g) versus pretest score (S_{pre}) of TTU students with UHW (open circle) (A) and with OHW (open triangle) (B) are shown. The two horizontal dashed lines indicate the cutoff between low-to-medium normalized gain at 30% and medium-to-high normalized gain at 70% (according to Ref. 7). Plots of FCI absolute gain ($S_{post} - S_{pre}$) versus pretest score (S_{pre}) with UHW (open circle) (C) and with OHW (open triangle) (D) also are shown. The upper, middle, and lower dashed slopes indicate the 100%, 70%, and 30% normalized gain boundaries. The means of students taught by UHW and OHW are given by solid circle and solid triangle, respectively.