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# EFFECTIVE "HOMEWORK-FREE" BME PHYSIOLOGY INSTRUCTION

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**Abstract** - A method of teaching physiology that involved instant feedback on quizzes and in-class activities in lieu of homework was compared to more traditional instruction including homework. The comparison was conducted in an undergraduate biomedical engineering course. Results demonstrated no significant difference in exam scores for the two groups, calling into question the utility of homework as a learning activity for physiology instruction. The results of the experiment may have been affected by the terrorist attacks of Sept. 11, 2001.

**Keywords** - physiology, education, homework

## I. INTRODUCTION

The hypothesis of this study is that learning of systems physiology concepts including neurophysiology is more effective and efficient when in-class quizzes and activities with instant feedback are used in place of traditional learning activities including homework. While the author found no published references regarding the use of homework for physiology instruction, a review [1] of 84 experiments that dealt with homework in general revealed that 34 experiments supported the use of homework over other learning methods and 49 experiments found similar achievement using homework and other methods of learning.

## II. METHODOLOGY

The context of this study was the first third of a systems physiology course taken by all undergraduate biomedical engineering majors at Vanderbilt University, usually in the fall of the junior year. The 69 students taking the course in the fall of 2000 received traditional instruction while the 63 students taking the course in the fall of 2001 received modified instruction. The instructor, class meeting days and times, and classroom were identical for both years. The instructor has taught this course for several years, so there was no "novice instruction" effect between the two years.

The initial study period included the first eight 75-minute class periods of each semester during which the topics of control systems diagrams, feedback, cross-membrane transport, membrane potentials, action potentials, synaptic transmission, neuroreceptors, the peripheral nervous system, and the central nervous system along with a guest lecture on

functional magnetic resonance imaging of brain function. The guest lecture was given both years by the same person using essentially the same slides each year but with discussion points and multiple choice questions inserted by the course instructor in 2001. The instructor also gave a brief presentation on writing winning test answers both years.

The same reading materials were used both years. The specific selections of textbook readings were slightly more focused in 2001 than in 2000.

The traditional instruction in 2000 included lectures with lecture notes supplied online through the course web site prior to class sessions, three homework assignments, and reading assignments as noted above. Homework assignments were graded by a graduate teaching assistant and an undergraduate grader together, with about a one-week turn around time between submission and return of graded homework. Homework answer keys were posted online. Homework assignments from the entire semester, eight in all, counted for 15% of the semester grade.

Four types of modifications were implemented in 2001. First, four in-class quizzes on reading assignments were instituted. Second, homework assignments were eliminated. Third, in-class challenge-based activities and multiple-choice questions were added. Fourth, a Personal Response System (Avantec; distributed by EduCue, Alpaus, NY) was utilized. Lecture notes very similar to those used in 2000 were posted online through the course web site prior to class sessions. Quiz answer keys were posted online. Quizzes from the entire semester, nine in all, plus two homework assignments not associated with the period of comparison, counted for approximately 14% of the semester grade. In-class activities had a minor contribution to the semester grade.

The Personal Response System (PRS) stimulated 100% class participation in responding to in-class questions, provided instant feedback to students and faculty, and automated quiz grading. When entering the classroom, each student would pick up a small device similar to a television remote control. Each PRS device had a unique serial number and was assigned to a specific student. Multiple choice questions were computer projected onto a screen at the front of the room and the answering period was started. Students then pressed the number of their answer choice on their PRS device. The device sends an infrared signal to receivers at the front of the classroom. When the answer is received, the student's last name and their device serial number, but not

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their answer selection, are displayed on the screen. When all students had submitted their answers, generally within a one-minute period, the answering period was closed and a bar graph showing the number of students selecting each answer was displayed. The question and answer choices were then discussed before moving on to the next question or other instructional activity. Student specific data was stored by the PRS system in a spreadsheet for later analysis.

Quizzes on reading assignments were given at the start of four of the eight class periods. Students were handed a copy of the quiz on paper so that they could individually allocate their time between the four or five multiple-choice questions. Questions were designed to assess completion and understanding of reading assignments. After about 10 minutes, the PRS was used to submit answers to the first question, the totaled responses displayed, and the answers discussed. This process was repeated for the next question and so on. Both students and the professor had instant feedback about student understanding of the readings, which the professor used to guide emphasis in the subsequent lecture.

To compare the effectiveness of the two instructional methods, the professor created two exams (“A” and “B”) with questions covering very similar content and selected from same total content, with very similar styles. Then, using random selection (coin toss), questions from exam “A” and exam “B” were allocated between the 2000 Exam I and the 2001 Exam I. The exam was administered in the ninth class period of each year and graded by professor using the same criteria for each year. In both years, the exam grade was 20% of each student’s final semester grade.

### III. RESULTS

As noted in Table 1, the average exam score of students receiving the traditional instruction in 2000 was 66.6 +/- 12.6% while the average exam score for students receiving the modified “homework-free” instruction in 2001 was 70.1% +/- 10.7%. There was no significant difference in these exam scores.

**TABLE I**

	<b>2000</b>	<b>2001</b>
Number of Students	69	63
Homework Average	82.8%	n.a.
Quiz Average	n.a.	71.8%
Exam Average*	66.6 ± 12.6%	70.1 ± 10.7%

\*No significant difference (p = 0.09)

### IV. DISCUSSION

The exam scores for students participating in the modified instruction in 2001 were higher, but not significantly so, than the scores of students receiving the traditional instruction in 2000. However, a critical confounding event that may have lowered student

performance in 2001 and thus reduced the significance of the results was that the Sept. 11, 2001 terrorist attacks occurred the day of one of the class periods and quizzes in this study. Then, the Student Government Association organized a 9/11 memorial activity and walkout that disrupted another class period in this study.

Quizzes on the reading assignments made students much more accountable for reading assignments in 2001. Consequently, most students in 2001 came to class with some knowledge of the material already and thus were potentially better able to understand and assimilate the materials covered in class.

The new approach to instruction resulted in increased efficiencies. Student workload was reduced with no homework to complete. Teaching assistant (TA) workload was dramatically reduced with no homework to grade. The professor’s workload increased due to the need to create new in-class activities, although once created such activities can be reused in future years. The PRS system required ~5-10 minutes of set up and break down time every class period, although a permanent installation of the system would eliminate this time requirement.

The PRS benefited everyone. For the professor, instant feedback identified both misconceptions needing extra attention in class and areas of good understanding needing less time in class. For students, PRS feedback quickly identified misconceptions before becoming deeply ingrained as can be the case with homework completed out of class, submitted for grading, and not returned for approximately one week. By displaying the names and total count of student respondents but not revealing their answers publicly, the PRS promoted 100% participation and forced students to think about and select an answer to the questions

### V. CONCLUSION

In conclusion, the homework-free instruction was at least as effective as the traditional instruction that did utilize homework as teaching tool. The terrorist attacks of Sept. 11, 2001 occurred during testing of the homework-free method of instruction and may have had a negative effect on the results.

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### REFERENCE

[1] H.C. Foyle, G.D. Bailey, “Research. Homework Experiments in Social Studies: Implications for Teaching,” *Social-Education*; v52 n4 p292-94,296-98 Apr-May 1988.