

Effective "Homework-Free" BME Physiology Instruction

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Objectives

- To incorporate a wireless communication system into physiology instruction for increased formative assessment in class
- To add more active learning to the classroom instruction
- To improve the way out of class time is used
- To compare this approach to traditional instruction

Classroom Communication Systems

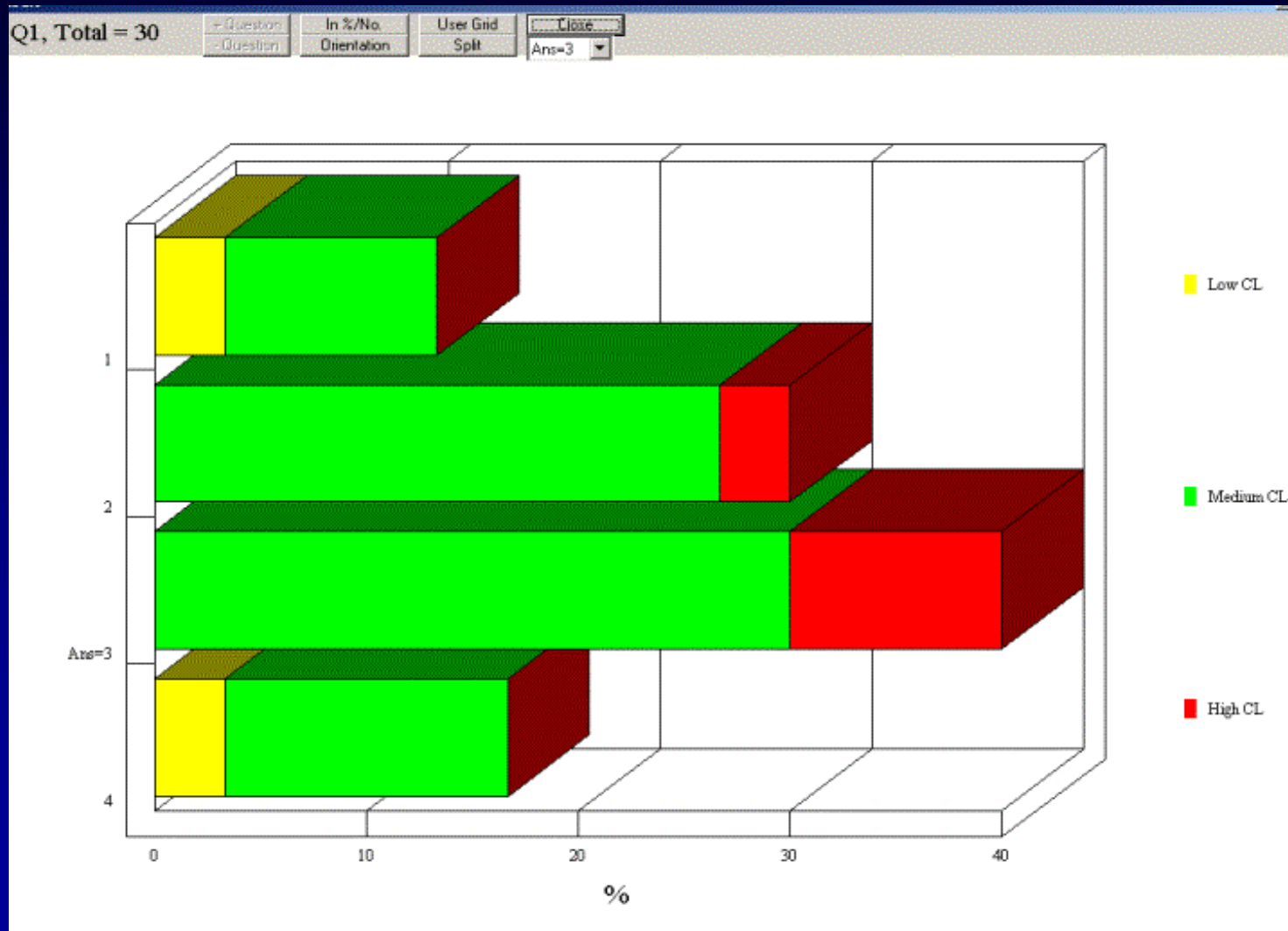
- Personal Response System (PRS) by Educue LLC, Alplaus, NY, www.educue.com
- Classtalk by Better Education, www.bedu.com
- Classroom Performance System (CPS) by eInstruction Corp., Denton, TX, www.eInstruction.com
- Interactive Presenter™ by Dolphin Interactive, <http://www.ballotbox.fi/index.html>
- TI-Navigator™ by Texas Instruments, Inc., Dallas, TX, www.ti.com

Personal Response System

- At start of class, each student picks up a uniquely numbered small device similar to a remote control
- Question displayed on screen at front of room and answering period started.
- Students press their answer choice on device



PRS Results Display



Active Learning

- Numerous publications attest to the effectiveness of active learning.
- Basic idea of active learning is to transform learners from passive recording devices into critical decision makers who analyze and synthesize concepts during the class period.

Active Learning

- Asking questions of the student “audience” during lecture is an attempt to stimulate active learning, but with the low response rate typical of a large class, it is a generally ineffective attempt.
- Mechanisms such as wireless communication systems that ensure participation by all students in active learning exercises are desirable.

Active Learning Exercise Sample

In multiple sclerosis (MS), some nerves become demyelinated. One of the symptoms of MS is difficulty with motor control, especially walking. Basic control of motor function occurs when the motor cortex sends a command signal to the extrafusal muscle fibers (E), which produce a force (f) that acts on a load (L), resulting in a change in the position variable (x). Various proprioceptors (P) detect position and feed that information back to the brain to provide input for correction of the command signal. Draw a systems diagram to model this basic motor control system. (After a few minutes, three possible answers were displayed and students selected the one closest to their diagram.)

Use of Out of Class Time

Traditional instruction has long included reading assignments and homework assignments to be completed out of class.

Reading Assignments

- Can supplement in-class material, prepare students for class, and reinforce material covered in class
- Often not completed unless an accountability mechanism is used
- Quizzes on readings encourage completion and inform student & instructor about understanding

Reading Assignment Quiz Sample

Consider a typical nerve cell at its resting membrane potential of -70mV . If, hypothetically, the Na^+ - K^+ pumps ceased to function, what would happen to the intracellular $[\text{Na}^+]$ and $[\text{K}^+]$?

- (1) intracellular $[\text{K}^+]$ would rise; intracellular $[\text{Na}^+]$ would rise
- (2) intracellular $[\text{K}^+]$ would fall; intracellular $[\text{Na}^+]$ would rise
- (3) intracellular $[\text{K}^+]$ would fall; intracellular $[\text{Na}^+]$ would fall
- (4) intracellular $[\text{K}^+]$ would rise; intracellular $[\text{Na}^+]$ would fall
- (5) intracellular $[\text{K}^+]$ and $[\text{Na}^+]$ would remain the same

Homework

- Can provide opportunity to practice skills, expand upon material covered in class, prepare for an upcoming class, & synthesize and develop new ideas
- Is of debatable value according to literature
- Typically takes a long time to grade resulting in a feedback loop with long delays

Comparison

- Context was BME 251 Systems Physiology – taken by all undergraduate BME majors at Vanderbilt, usually in the fall of the junior year
- Fall 2000 – 69 students, traditional instruction, reading assignments, and three homework assignments
- Fall 2001 & 2002 – 63 & 40* students, respectively, lectures combined with in-class activities, four quizzes on reading assignments, use of Personal Response System, and no homework assignments.

*One of two sections.

Comparison

- Same number of class periods spent on tested material in 2000, 2001, 2002
 - ◆ Seven 75-minute class periods
 - ◆ All at start of fall semester & all from 11:00 – 12:15
 - ◆ Additional 75-minute guest lecture on fMRI
 - ◆ Extra material and extra class periods in 2002
- Same reading materials
 - ◆ Human Physiology: From Cells to Systems, 4th Ed., Lauralee Sherwood
 - ◆ 20 page handout on systems, feedback, etc.

Content

- Intro/Orientation
- Biological control systems & feedback
- Membrane transport & membrane potentials
- Action potentials
- Central & peripheral nervous systems
- Studying the brain with fMRI - Dr. Victoria Morgan
- Writing winning test answers (brief presentation)

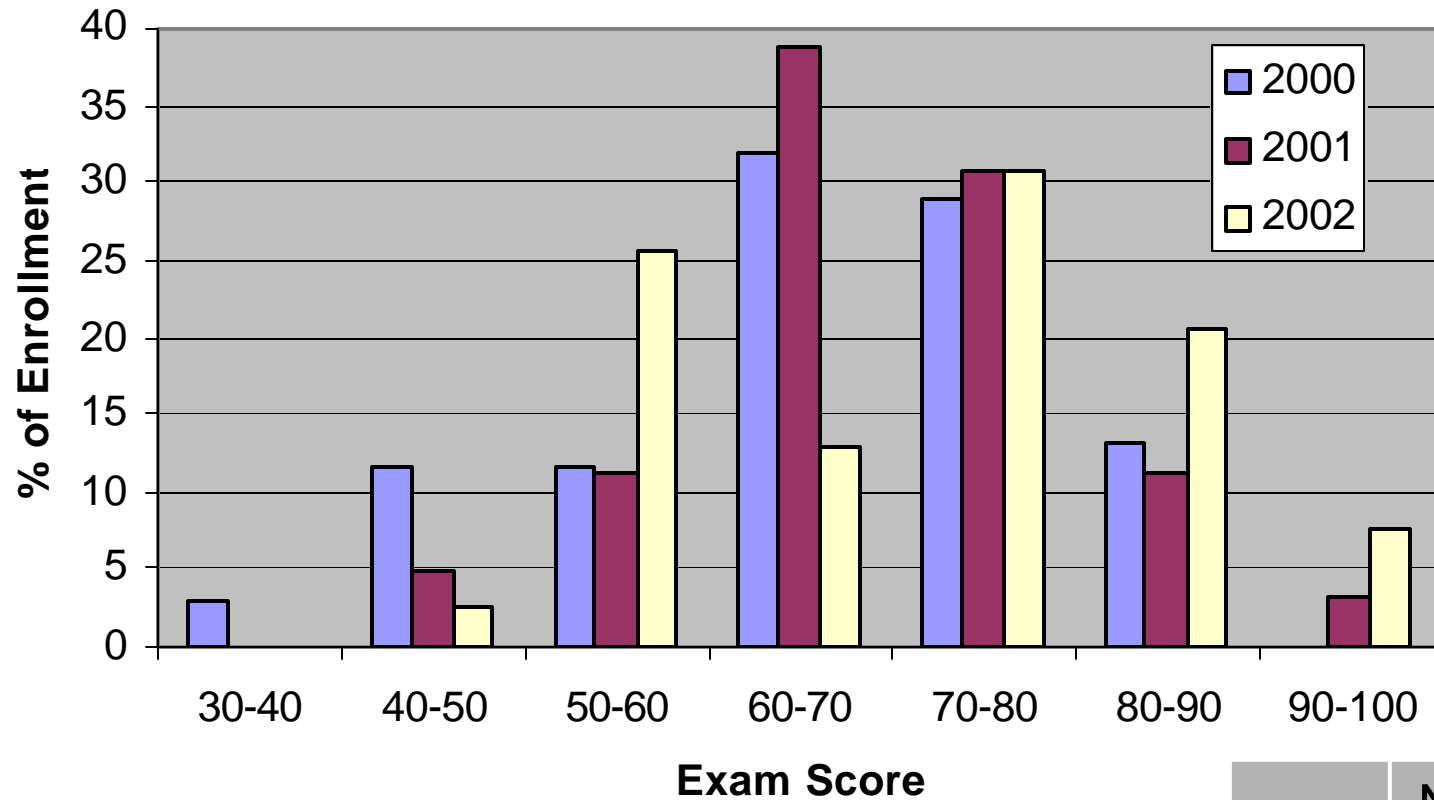
Formative Assessment

- Fall 2000 – Homework assignments graded by a graduate teaching assistant and an undergraduate grader together
 - ◆ ~ one week turn around time
 - ◆ Answer keys posted online
- Fall 2001 & 2002 – Multiple choice quizzes taken on paper at start of class with students submitting final answers via PRS; PRS usage for in-class activities
 - ◆ Answers discussed in class; keys posted online
 - ◆ Automated grading
 - ◆ Instant feedback

Summative Assessment

- Two exams (“A” & “B”) with questions of similar style and content (selected from same total content) created by professor in fall 2000.
- Using random selection (coin toss), questions from exams “A” and “B” allocated between the 2000 exam and the 2001 exam.
- Exam administered and graded by professor using same criteria for each year.
- Year 2000 exam re-used in 2002.
- Students in all years given access to 1999 exam for study.

Results



	N	Mean \pm S.D.
2000	69	66.6 \pm 12.6
2001	62	70.1 \pm 10.7
2002	39	72.2 \pm 14.3

Results

- Exam scores in 2001 somewhat but not significantly higher than in 2000.
 - ◆ Sept. 11, 2001 terrorist attacks occurred the day of one of the class periods and quizzes in this study.
 - ◆ Student Government Association 9/11 memorial activity disrupted another class period in this study.
- Scores in 2002 significantly higher than in 2000 if only those cohorts are considered ($p < 0.05$).
- If all three cohorts are considered, an analysis of variance indicates no significant difference

Discussion - I

- Personal Response System benefited everyone
 - ◆ For students
 - PRS quickly affirmed understanding and identified misconceptions before becoming deeply ingrained
 - PRS system protected anonymity in class so that students were not inhibited (100% participation)
 - ◆ For professor, instant feedback identified both misconceptions needing extra attention in class and well understood areas needing less time in class.

Discussion – II

- Students much more accountable for reading assignments in 2001 & 2002 since quizzes covered reading material.
- Student workload reduced with no homework to complete.
- Teaching assistant workload dramatically reduced with no homework to grade.
 - ◆ TA created quizzes, answer keys, and related PRS files under professor's supervision
- Professor workload increased due to need to create new in-class activities.
- PRS system required ~5-10 minutes of set up and break down time every class period.

Conclusion

- Modified instruction with use of a wireless communication system, in-class exercises, quizzes on reading assignments, and no homework provides modest improvement in exam scores.
- Teaching assistant and student workloads are reduced.

This work is in press as an article entitled “Formative Assessment in Physiology Teaching Using A Wireless Classroom Communication System”, due to appear in the December 2002 issue of *Advances in Physiology Education*.