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Redefining classroom instruction

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Goldberg, Harry R., Eileen Haase, Artin Shoukas, and Lawrence Schramm. Redefining classroom instruction. *Adv Physiol Educ* 30: 124–127, 2006; doi:10.1152/advan.00017.2006.—In this study, the role of the classroom instructor was redefined from a "lecturer" responsible for delivering the core curriculum to a "facilitator" at the center of an active learning environment. Web-based lectures were used to provide foundation content to students outside of the classroom, which made it possible to improve the quality of student-faculty contact time in the classroom. Students reported that this hybrid format of instruction afforded them a better understanding of the content, a higher probability of retaining the content, and the opportunity to spend more time thinking about the *application* of the content compared with more traditional lecture-based methods of instruction.

hybrid learning; active learning; virtual lectures

IN A VARIETY OF STUDIES, it has been shown that the comprehension of information is enhanced when students are encouraged to engage actively in the learning process (1, 6, 9, 10, 12, 14, 16, 20, 23). As the demands on faculty time increase and as the volume of information for which students are responsible mounts, the use of formal lecture-based content delivery may also increase. This potential shift toward lecture tends to reduce the opportunity to use active learning methods such as discussion or team-based learning in the classroom. In this study, foundation content for an introductory course in human physiology was delivered via the Internet. This use of technology enabled the faculty to spend more time discussing content with the students and less time lecturing to the students. Our prediction was that this method of instruction would establish a common baseline of understanding among students and help them develop a deeper understanding of the material (2–5, 7, 8, 11, 13, 15, 17–19, 21, 22).

All first- and second-year lectures at the Johns Hopkins School of Medicine are videotaped and made available via the Internet on the day the lectures are presented. Most students use this resource for review or to compensate for the occasional missed class. In this study, faculty members in the cardiovascular (CV) section of the first-year physiology course, Organ Systems, challenged this traditional use of electronic lecture technology: all students were *required* to view the lecture content *before* attending class. This prerequisite made it possible to use class time for a variety of learning activities that would otherwise have not been possible because of time constraints. The current study was *not* designed to compare the educational effectiveness of traditional lectures and electronic lectures; that study was conducted by one of the authors [H. R. Goldberg (8)] in 2000, where it was shown that electronic lectures can be educationally more effective than traditional lectures.

Organ Systems is a 7 wk, six-module course covering renal, respiratory, CV, gastrointestinal, endocrine, and respiratory physiology; the CV section of Organ Systems is 2 wk in duration. Organ Systems serves the academic needs of ~130 medical and graduate students and is the final required course of the academic year. This placement of Organ Systems made it an ideal candidate for comparing the instructional format used in the CV section of the course with all other courses taken during the academic year as well as to the renal and respiratory modules of Organ Systems.

The majority of students reported that their understanding of CV physiology was greater than their understanding of the content presented in other classes they had taken during the school year and that they valued the course's emphasis on application over fact acquisition.

METHODS

The CV section of Organ Systems consisted of 10 lectures. Five of the CV lectures were digitized, enhanced with professional illustrations and animations, and then made available to all students in the course via the Internet. These lectures could be watched at any time and for as many times as desired. It is expected that these lectures will be slightly modified from year to year and be used for several years. The remaining five lectures were delivered by faculty in the lecture hall. It should be noted that these *traditional* lectures were videotaped during their lecture hall presentation and made available to students via the Internet. The total number of lectures in the CV section of Organ Systems was reduced from 13 to 10 lectures to allow the students adequate time to view the web-based lectures and to compensate for the potential increased demand on a student's time. The content normally delivered in the eliminated lectures was integrated into the discussion section of the course.

The control in this study was the faculty's and student's view of the educational effectiveness of classroom lectures, and the experimental group was the faculty's and student's view of the educational effectiveness of the hybrid method of instruction (electronic lectures followed by a discussion section). It would not have been possible to divide the class in half to establish a control and experimental group of students because students would not accept having content (in the form of electronic lectures) being withheld from half of the class. The decision for which lectures were to be digitized was based on the faculty member's preference to deliver content via lecture or through discussion. The content and method of delivery for each lecture is shown in Table 1. To reduce the

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Table 1. *List of Organ Systems lectures and methods of delivery*

Topic	Delivery Method
Framework of CV physiology	Electronic only
Cellular physiology of the heart	Traditional
Molecules to cells	Traditional
System integration I and II	Electronic only
Heart contractility	Traditional
Neural control of CV	Electronic only
Smooth muscle	Traditional
Hemorrhage	Electronic only
The electrocardiogram	Electronic only

CV, cardiovascular.

risk of students falling behind in their assignments, students were required to take an on-line quiz before each discussion.

Students were divided into groups of 30 for the postelectronic lecture discussion. At the start of each session, there was a 20-min period of lecture-specific questions and answers. An audience response system would have assured the participation of all students; this system will be implemented next year. The remaining 40 min of discussion included one or two of the following methods of instruction: interactive computer-based simulations, clinical correlations, discussions related to current trends in research, and student presentations. Three laboratory sessions (4 h each) and two clinical correlations were scheduled, and there was a final exam review for each lecture. The generalized format for content delivery in the CV section of Organ Systems is shown in Fig. 1.

Student assessment was based on the quizzes that followed each of the five virtual lectures (5%), a research report (10%), and a final examination (85%). The research report was an assignment that required students to generate a question (25% of the report grade) and then present an answer to their own question in a two-page paper. This assignment encouraged students to explore areas of interest that went beyond the lecture; the only requirement for this assignment was that the topics had to relate to CV physiology. Student reports included the following:

- How does the CV system change during pregnancy and how is preeclampsia related to those changes?
- What is the potential for stem cell therapies in cardiac illness?
- They are both cyclooxygenase inhibitors, so why is aspirin supposed to be good for the heart and vasculature and Vioxx bad?
- What are the effects of airline flight on the CV system?

The exam questions were equally divided between traditional and electronic lectures, included fact recall and questions related to applications, and included both multiple-choice and essay-type formats. The questions were segregated by a faculty member. A questionnaire was distributed to all students at the end of the CV module, to which 83% of the students responded.

Table 2. *Comparison of test scores based on traditional vs. virtual CV lectures*

Instructional Modality	Test Score, %
Questions derived from lectures delivered in the classroom	76.7
Questions derived from lectures delivered via the Internet	77.2

RESULTS

Quantitative Analysis

The test scores for the final exam questions based on content delivered in the traditional lecture hall versus content delivered using Internet-based lectures are shown in Table 2. The average test scores for each instructional modality were essentially identical. It is not surprising that these scores are similar because the lecture notes distributed to students were extensive, students were able to review the Internet version of the traditional lectures, and there was a preexam review for all lectures. To reiterate, the purpose of this study was to use electronic lectures to free faculty members from lecturing and to improve the quality of student-faculty contact time, not to compare traditional with electronic lectures.

Qualitative Analysis

A student questionnaire comparing the value of the hybrid method of instruction (virtual lecture/discussion) to other courses and to the renal and respiratory modules of othe Organ Systems modules produced the following results (Table 3 and Fig. 2).

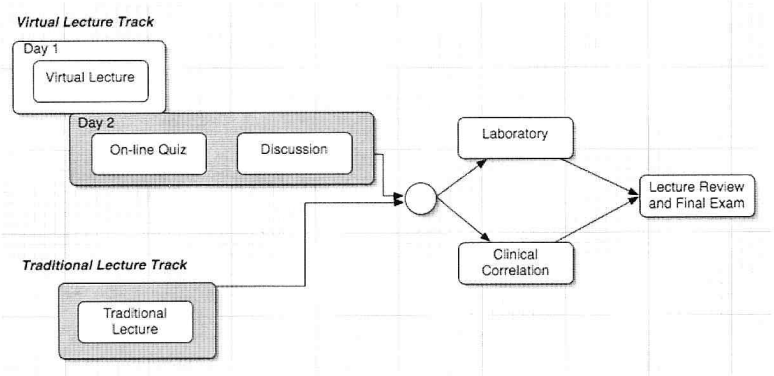

Fig. 1. Chronology of the educational modalities for all students in the cardiovascular (CV) section of Organ Systems.

Table 3. *Summary of student questionnaire responses on the value of the virtual lecture/discussion track used in CV physiology*

Question	Response, % class
Question 1: The amount of time I spent thinking about the application of facts in CV physiology rather than the facts alone was	
Greater than in any other class	73
The same as in any other class	23
Less than any other class	2
Question 2: The amount of time I spent exploring topics of interest in CV physiology was	
Greater than in any other class	49
The same as in any other class	45
Less than any other class	3
Question 3: The probability of my retaining CV content is	
Greater than in any other class	57
The same as in any other class	38
Less than any other class	3
Question 4: My level of understanding of the CV content was	
Greater than in any other class	45
The same as in any other class	47
Less than any other class	5

Qualitative analysis by students (samples). Four student reviews that represent a reasonable sample of all student evaluations are listed below.

- I actually really like the idea of listening to the faculty member's lecture online before attending a discussion. This allows students to watch lectures on their own schedules (which definitely helps those of us who are more wide awake and think better in the afternoons), and also provides a forum to think about the lecture material and ask relevant questions of the lecturers.
- I enjoyed this delivery format quite a bit. The electures were very efficient ways of delivering information–they were taught well and allowed the student to slow down or speed up depending on his/her comprehension of the particular topic.
- I found the e-lectures useful, but they would certainly be less useful without the follow-up discussions. The combination of the two was a good thing.
- I was surprised by the effectiveness of the electure format. I generally prefer seeing a live lecture and more traditional ways of learning. However, I thought the electures were well done and I very much appreciated the ability to see the material, digest it a bit, and then have discussion with the faculty member. I think the discussions worked best when they were focused on applying and visually demonstrating concepts.

Qualitative analysis by faculty group leaders. Several faculty were asked to provide their view of the postelectronic lecture group discussion. Two representative evaluations are included, those of Dr. Elizabeth Hunt and Dr. Lawrence Schramm.

The following evaluation is by Dr. Elizabeth Hunt:

> I was asked to teach a small group session for the first year medical students on cardiovascular physiology. From the very beginning of the session, I was astounded at the questions being asked. I began by describing a clinical case that involved a patient with tachycardia and hypotension. Quickly, the students caught on that the patient might be in hypovolemic shock and they mention that the preload may be low. When asked how to assess for shock, they give me a few clinical skills and frantically write down all the other "clinical pearls" I mention about capillary refill, mottling, assessing for jugular venous distension, etc. . .Then, after THEY mentioned that we need to move the patient onto a better part of the Starling Curve, we get into the practicalities of volume resuscitation, and compare approaches in the adult vs. pediatric patient, and the controversy over colloid vs. crystalloid. They specifically challenged me on the issue of whether or not the Hb will actually drop in hemorrhagic shock, if not yet volume resuscitated, etc. . .We then discuss how these signs and symptoms will vary with cardiogenic, septic, anaphylactic or hypovolemic shock. They were very prepared, and the level of conversation in regards to the physiologic aspects of the cases that I presented was similar to ones that I would have with second year residents in the PICU. I also had several medical students approach me after the session about rounding in the PICU. I was very impressed by how much the students already knew when the walked in the room, and had a lot of fun making the clinical aspects of cardiovascular physiology "come alive" through the real life cases that we discussed.

The following evaluation is by Dr. Lawrence Schramm:

> For many years, I have taught a cardiovascular regulation laboratory to the first year Medical Students and the Biomedical Engineering Ph.D. students, who take the Organ Systems course. We use a large-scale computer simulation of the cardiovascular system that has realistic "chart recorder" and tabular output, and we look at the effects of a variety of vasoactive compounds on the circulation. In addition, we study the role of the baroreceptors in responding to challenges to the cardiovascular system. Finally, we look at the effect of blood loss on circulatory dynamics with and without CNS circulatory regulation. Over the years that I have taught this lab, first with dogs

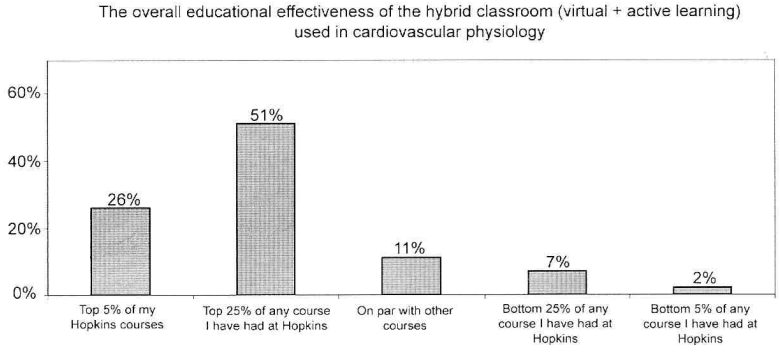

Fig. 2. Overall student evaluation of the hybrid delivery format used in the CV section of Organ Systems.

and now with computers, I believe that I have become well "calibrated" in what kinds of questions students and what kinds of misconceptions students have when the come to the lab. The lab comes at the very end of the cardiovascular portion of Organ Systems. Therefore, I have a chance to assess the students' thinking at its most advanced.

The onset of recent changes in presentation of cardiovascular physiology resulted in an abrupt and positive change in the atmosphere of this lab. The students came to the lab with a far greater ability to seek deeper knowledge of cardiovascular regulation. Whereas in the past, much of the time in lab was spent delivering fundamental material (actually, redelivering material already covered in lecture), most of my time is now devoted to discussing advanced topics in response to more highly informed questions. Not only has this substantially improved my enjoyment in the lab, it appears to have energized the students as well.

Conclusions

The goal of this project was to improve the educational quality of student-faculty contact time. The use of the lectures delivered through the Internet enabled the role of the classroom instructor to be redefined from a lecturer responsible for delivering foundation content to a facilitator at the center of an active learning environment.

The *quantitative* measurement of the results of this study as related to both a "deeper understanding" of the content (as best measured by the accurate diagnose of disease) and the long-term retention of content will require a longitudinal study that would compensate for a student's diverse learning experience. In the present study, student surveys indicated that the educational value of delivering foundation content electronically and then using the class for discussion was greater than the educational value of lecture alone. Students reporting that they had spent a greater percentage of time thinking about the application of facts rather than facts alone and that they had spent a greater amount of time exploring topics of interest support this conclusion. Furthermore, faculty evaluations of the course design were extremely positive: students were more engaged than they had been historically, their questions were superior to those students of years past, and the overall educational experience was significantly enhanced. It is anticipated that the increased richness of the student's learning experience described in this study will be translated into a deeper understanding of the content and an increased retention of the material.

GRANTS

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