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PREPARING STUDENTS TO PARTICIPATE IN AN ACTIVE LEARNING ENVIRONMENT

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Most students have spent the majority of their school career in passive learning environments in which faculty were disseminators of information, and students were required to memorize information or use specified algorithms to “solve problems.” In an active learning environment, students are encouraged to engage in the process of building and testing their own mental models from information that they are acquiring. In such a learner-centered environment, faculty become facilitators of learning, and students become active participants, engaging in a dialogue with their colleagues and with the instructor. To create a successful active learning environment, both faculty and students must make adjustments to what has been their respective “traditional” roles in the classroom. For the instructor who is committed to promoting active learning, the challenge lies in helping students understand the necessity of becoming active colleagues in learning. This process can be facilitated if the curriculum includes exercises to direct students’ attention to a number of issues that impact their learning. This paper describes four such exercises designed to help students form appropriate course expectations, recognize the need for seeking clarification when communicating, recognize the role of personal experience in building mental models, and become familiar with study aids for building formal models.

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An active learning environment is one in which students engage in the process of building and testing their own mental models from information that they are acquiring (6). The call to promote active learning in science and medical education is not new (2, 9). However, the passive learning environment of the teacher-centered lecture remains the predominant learning environment encountered by students. In a learner-centered active environment, faculty become facilitators of learning, and students assume responsibility for their learning. Herein lies the challenge. To create a successful active learning environment, both

faculty and students must revise their respective traditional roles in the classroom.

The instructor must alter his or her behavior in the classroom to be consistent with his or her educational objectives for the course (5). The critical change is in attitude. The instructor must recognize his or her role as helping the learner to learn rather than merely imparting information to the student. If this attitude change occurs, necessary curricular changes will follow. However, implementing the new environment successfully may be difficult; if the students are not

willing to accept the change, faculty and students have conflicting goals.

The question then is, "How can faculty help students recognize the need to participate in the classroom?" The problem is that most students have spent the majority of their school career in passive learning environments in which they were required to demonstrate only that they had assimilated information that was disseminated in class. As a result, they have become adept at organizing information in formats that are conducive to memorization but are not necessarily appropriate for building the integrated conceptual models that form the foundation for analyzing physiological systems. Furthermore, most students are comfortable in this passive role, and the prospect of becoming active is somewhat uncomfortable and, perhaps, even intimidating. To meet this challenge, faculty can engage students in a number of exercises designed to help them recognize challenges that face them and their colleagues whenever they are engaged in a learning process. Some of these exercises can be included as part of an overall orientation to the curriculum. Others are best included as part of specific courses.

The exercises and techniques described in this paper are intended to help faculty who have made the commitment to promoting an active learning environment prepare students to *participate* in that environment. They are designed to help students form appropriate course expectations, recognize the existence of communication problems and the need to seek clarification, and understand some of the factors that influence mental model building. Some of these exercises have been used by our group to help orient first-year medical students to the basic science curriculum (issues related to communication and building mental models), and I have used others as part of the first week's activities in a first-year medical physiology course (course expectations and formal model building).

COURSE EXPECTATIONS

When faculty plan a course and when students enroll in the course, each has expectations about the course content, course format, and the role that each will play in the course. Unfortunately, faculty are seldom

aware of the student's expectations, and students often do not fully understand or share the faculty's expectations. Consider the following common examples in the context of a physiology course.

Faculty usually expect students to develop the knowledge and skills needed to solve physiological problems, and they assume that students have enrolled in the course, even if it may be a program requirement, because they too want to "understand" physiology. That is, they are motivated by a desire to "learn" (gain new insight into) how their bodies work and be able to predict what will happen when changes occur (i.e., solve physiological problems). Students, however, are more often motivated primarily by a desire to pass the course. Thus they expect to learn the answers to the questions that will appear on course examinations. Based on the students' past experience, this, most likely, means being able to answer fact-oriented multiple choice questions. In short, faculty expect students to be engaged in the process of building mental models to be used in solving physiological problems, whereas students expect to be engaged in the process of memorization. Unfortunately, faculty often lose sight of their own expectation when designing course activities, and the resulting course is more consistent with the students' expectation than with that of the faculty.

Faculty expect to engage in a dialogue in which students will seek clarification of points that are confusing to them. Students, however, look upon the faculty as a source of expertise, who, having had extensive experience, will know which points are confusing and will, therefore, provide appropriate clarification. Thus there should be no need to engage in dialogue. The instructor will "tell us all we need to know to pass the exam." Faculty expect students to participate in course activities. Furthermore, they expect students to approach these activities (e.g., laboratories, discussion groups, etc.) with a degree of enthusiasm and curiosity that will result in maximum learning. Based on past experience, students expect to be passive recipients of information. Thus they do not approach course activities in a manner consistent with faculty expectations. Even in laboratories, where faculty design activities to be inquiry driven, many students expect to be told what to do, what to

observe, and how to interpret those observations. They do not expect these exercises to be inquiry driven.

Student expectations must correspond to those of the faculty if the learning environment is to be successful. This is clearly impossible if the expectations of faculty and students are not compatible. Hence faculty must help students understand the expectations that form the basis for the course design, and they must help students reorient their expectations to match them. How can this be accomplished?

Many instructors begin their course by describing the course elements. However, all too often, these descriptions focus on the number and type of examinations, the grading scheme, and other details that students interpret as being consistent with their own expectations. Few faculty tell students how they view their own role and the students' role within the context of the course.

One approach to orienting students is to merely extend the introductory comments to include a description of the respective roles of instructor and student. Certainly, when students are told that the instructor views his or her role in the classroom as a facilitator and, consequently, class time will be devoted to discussions in which students are expected to participate rather than lectures in which students are expected only to listen and take notes, students will understand what is expected of them. However, with this approach, the instructor addresses expectations that he or she considers relevant. There may be student expectations that are relevant, but the instructor may not have considered these expectations; hence, these would not be addressed. Furthermore, if the instructor's intent is to help the learner to learn, this approach fails to take advantage of an early opportunity to demonstrate an example of student-centered dialogue that must be necessary if the instructor is to be a successful facilitator.

For the past several years, I have used the following approach, based on classroom assessment techniques described by Angelo and Cross (1), to begin a dialogue with the class. This approach engages each student in a form of dialogue at the outset and demonstrates the

desire for interaction between faculty and student. In addition, it provides an opportunity for the instructor to gain some insight into the students' expectations so that these can be addressed specifically.

On the first day of the first-year medical physiology course, blank 3 × 5-in. note cards are distributed to the class. The students are told to write answers to the following two questions without putting their names on the cards. "What is my (the student's) job in this course?" and "What is your (the instructor's) job in this course?" The responses are then collected, and the instructor reads a sample of them to the class, discussing each with respect to his or her own expectations. Thus the students' expectations become the focus of the discussion.

A limited sample of some typical responses to these questions from first-year medical students is shown in Table 1. In discussing student responses, the instructor can focus on key words to make specific points about his or her expectations for the class. For example, *student 1* says that her job is to be prepared for class. The instructor can use this response to tell the class *how* he expects students to be prepared for class. *Student 1* expects the instructor to present lectures and to be available for questions. In response, the instructor may tell the class that he does not intend to lecture, in a traditional sense, but rather that he intends to lead a discussion of the topic of the day.

Student 2 expects the instructor to prepare him to pass the boards. This comment provides an opportunity to discuss the role that the course plays in preparing students for the boards. *Student 3* expects to be presented with case studies as a learning tool that will help her apply rather than merely memorize information. This comment provides an opportunity to emphasize the instructor's expectation that students will engage in problem solving and to discuss specifically if and how case studies will be used in the course. *Students 4* and *5* say that their job is to understand the workings of the human body. In response to this comment, the instructor can explain the kind of problems she expects students to solve to demonstrate that they understand physiological principles.

TABLE 1
Selected examples of student responses
to expectations exercise

Student	My Job (Student)	Your Job (Instructor)
1	To be prepared for class/lab	To come to class with a well thought out informative lecture that stresses the things that are important.
	To try to participate where necessary	To be available for questions
2	My job is to learn what physiology is and how I can apply it clinically as a doctor. So often what is learned in class is not truly used in clinical practice.	Your job is to teach the principles I need to practice and to pass the boards.
3	To learn physiology in such a way that I can see how it relates to the other basic sciences. To internalize the material. Be prepared to understand how physiology fits into case studies.	Teach what you know from your intellect and heart. Give us opportunities to learn without rote memorization. Case studies when possible.
4	My job is to understand the workings of the human body and learn it in a manner that I will be able to retain the information and understanding and use it in the future through my practice.	Your job is to teach it to me in a way that I can understand and that makes the subject come alive.
5	To keep up on the readings and do my best to understand the material and be able to apply the information.	To present the information clearly and accept questions when asked. To want the students to walk away with a good understanding of this class.

The responses of *students 4* and *5* illustrate how student responses can also provide faculty with the opportunity to clarify and reinforce the key elements of the active learning environment that the instructor intends to foster. It is not necessary to respond to each student's card, since many of them express the same general theme. However, it is important for the instructor to read each card after class and respond at the beginning of the next class session to any relevant

issues raised by student expectations that were not discussed on the previous day.

We begin our course with this exercise because it immediately introduces the students to an interactive environment, and it lets the class know that the instructor welcomes student input. This message is critical if the instructor expects students to participate in discussions. This exercise also helps the instructor to gain some insight into the concerns of the students. This is valuable if his or her intent is to help the learner to learn.

It is important to recognize that, after establishing the "rules of the game," the instructor must conduct the course in a manner consistent with those rules. For example, if the instructor tells the class that the goal of the course is to develop problem-solving skills, the course activities must include problem-solving exercises, and exams must test problem-solving skills rather than only recall of facts.

COMMUNICATION

The success of any interactive environment depends on the ability of the participants to communicate effectively. There is a growing diversity in first languages spoken by students and faculty. This, of course, raises a number of challenges related to establishing a common language in which to communicate. However, even within a common language, there can be diversity of interpretation that can lead to a diversity in the mental models resulting from a conversation. The first step to effective verbal communication in the classroom is ensuring that students recognize that what they "hear" is not always what was said and that they must be willing to seek clarification whenever doubt occurs.

Students must recognize that they may not interpret the meaning of the words that they hear in the same way as their colleagues. Thus the mental models that result from their understanding of words that are used may not be consistent with those of the instructor or of their colleagues. Recognition of this fact is critical because communication is one way that we test our mental models. Thus effective communication is essential if students and instructor are to reach a common understanding of the phenomena being discussed.

Students must recognize, and be comfortable with voicing, their need for clarification, and faculty must be willing to seek clarification from students so that the meaning of questions and comments may be clear to the whole class. The challenge is to help students realize that differences in interpretation are a common occurrence.

We have approached this challenge by including the following exercise in a workshop intended to introduce first-year medical students to the basic science curriculum. Students are shown a short video of a dancer performing. The class is then divided into groups of three to four students each, and the groups are directed to "Describe what kind of information you would seek if you wanted to understand what is going on in her [the dancer's] body when she performs." The instruction is repeated, and the groups are given ~10 min to complete the task. Before proceeding with a discussion of the video designed to emphasize the integrative nature of the basic sciences, each group is asked to describe the assigned task.

We have used this exercise on several occasions in both student and faculty workshops. In one student workshop, six different descriptions of the task were elicited from eight groups of students. The responses ranged from "make a list of topics" to "design experiments and describe the kinds of measurements that you would make." Each student in the room heard the same words spoken at the same time. Each student heard the words two times. Yet, the groups interpreted the words differently. On each occasion that we have used this exercise, similar results were obtained, and members of the "class" were surprised by the diversity in meaning attributed to the directions. Furthermore, the participants commented on the need to seek clarification if class members are to arrive at the same interpretation.

BUILDING MENTAL MODELS

Interpretation of language is not the only factor that plays an important role in the process of building mental models. Experience is also an important factor. Students readily recognize that they may not glean the same information from a plot of data that a colleague does. This seems reasonable to them because they have not all had the same degree of practice reading

graphs. That is, their past experiences have not been the same. However, few students realize that interpretation of nearly all information (i.e., their mental models) depends on past experience, and, because each member of the class has had different life experiences, each student integrates "new" information into a unique conceptual framework. Furthermore, these mental models are modified with the acquisition of new relevant data. Recognizing this fact helps students appreciate the need for discourse as they build and test mental models of physiological systems. This, in turn, leads to a greater willingness to participate in the type of discourse that characterizes an interactive (active) learning environment.

We have used another orientation exercise to help students appreciate the diversity with which seemingly obvious data are interpreted and that mental models are modified in the light of new data. In the first part of the exercise, students view a short videotaped segment showing a bird preening its feathers amid bleached logs and dune grass on a patch of sand. The sound track is that of an isolated ocean cove and includes the sound of waves and the sounds of gulls. After viewing the videotape, the students are asked to describe the scene. A discussion ensues in which students are asked to explain how they arrived at their conclusions regarding the scene (i.e., their mental model of their observations) and what they would look for in a second viewing that might further confirm their conclusion (i.e., how they would test their mental model). The scene is then shown again, only this time, the view broadens to reveal that the bird is part of a display in an aquarium. The ensuing discussion focuses on how the group would interpret the scene if they viewed it for a third time, that is, how their mental models of the scene have been modified in light of the most recent data.

We have conducted this exercise with first-year medical students and with physiology faculty participating in a workshop held at a national meeting. The descriptions of the scene provided by students and faculty after the first viewing were similar. Although all who viewed the scene described a bird preening itself, other aspects of the description varied considerably. Viewers who were from the East and West coasts reported that the bird was at the seashore. They

explained that their cue to the location of the bird was the sound of waves and gulls on the soundtrack. Students and faculty from the Midwest, however, interpreted the scene as a bird preening itself near a freeway, probably near a garbage dump. They interpreted the sound as freeway noise, and, as they explained, since gulls can be found around garbage dumps, the sound of gulls indicated to them that the bird must be near a garbage dump. In both groups, at least one individual disagreed with both of these interpretations and suggested that the bird was in a zoo rather than in the wild. When pressed for the rationale underlying her answer, the student replied that because the scene was being viewed in school, the exercise must involve a "trick," and that trick must be that the bird is not in the wild but in a zoo setting. Thus the same visual and audio cues resulted in at least three general mental models of the scene, each dependent on the past experience of the model builder.

This simple exercise generates considerable discussion about the factors that influence interpretation of what is seen and heard. Upon completion of the exercise, students report that they had not realized the diversity among classmates of mental models (interpretations) of a seemingly simple scene. In addition, they voice a new appreciation for the need to communicate with colleagues and faculty (i.e., seek clarification) when dealing with new information and new situations.

FORMAL MODEL BUILDING

The goal of the videotape exercise is to help students realize that their interpretation of the environment is based on preexisting mental models, of which they are probably not even aware, and that these models undergo continual modification based on new data. In physiology, students are encouraged to build "mental models" of physiological systems that will serve as the basis for solving physiological problems. The latter models differ from the former in that they are more *formal* representations of the links among system elements (e.g., causal relationships) that determine physiological mechanisms. To be successful at this type of model building and, hence, successful in an active learning environment, students must adopt techniques that foster identification of these relation-

ships. Unfortunately, the information-processing techniques common to most students in passive learning environments do not encourage this type of behavior. The challenge is to help students recognize the limitations of the techniques that they have used in the past as well as the advantages of techniques that will help them construct the formal mental models that are necessary for physiological problem solving.

I have approached this goal by engaging students in a "laboratory exercise" designed to have them explore various mapping techniques as alternatives to the organizational techniques that they currently use (e.g., outlining). Each student is given a several page excerpt from a standard textbook dealing with a physiological mechanism (e.g., muscle contraction). The students are told to read the excerpt as they would any new textual material. That is, if they normally underline or highlight the text, they should underline or highlight. If they normally take notes, they should take notes. They are then given time to complete the task.

After the group has completed reading the excerpt, the notes of those students who took notes are collected and distributed to students who did not take notes. They, in turn, describe to the class what appears on the paper just handed to them. The ensuing discussion focuses on how well the study techniques used by class members (note taking, underlining, highlighting, etc.) help identify relationships among concepts. For example, if an outline format was used by a student, the group is asked how relationships among concepts can be identified if one concept, which constitutes a subheading category, fits under two concepts that constitute major headings.

This discussion is followed by an introduction to "mapping" techniques that serve as helpful organization tools (3, 4, 7, 8). These are not new techniques, but few students are familiar with them. Examples of building concept maps (see Fig. 1) and system control diagrams (see Fig. 2) are presented to the class. Working in groups of three to four students each, the class is instructed to reread the excerpt. This time, however, they are told first to develop a concept map of the mechanism described in the excerpt and then to develop a systems control diagram of the mecha-

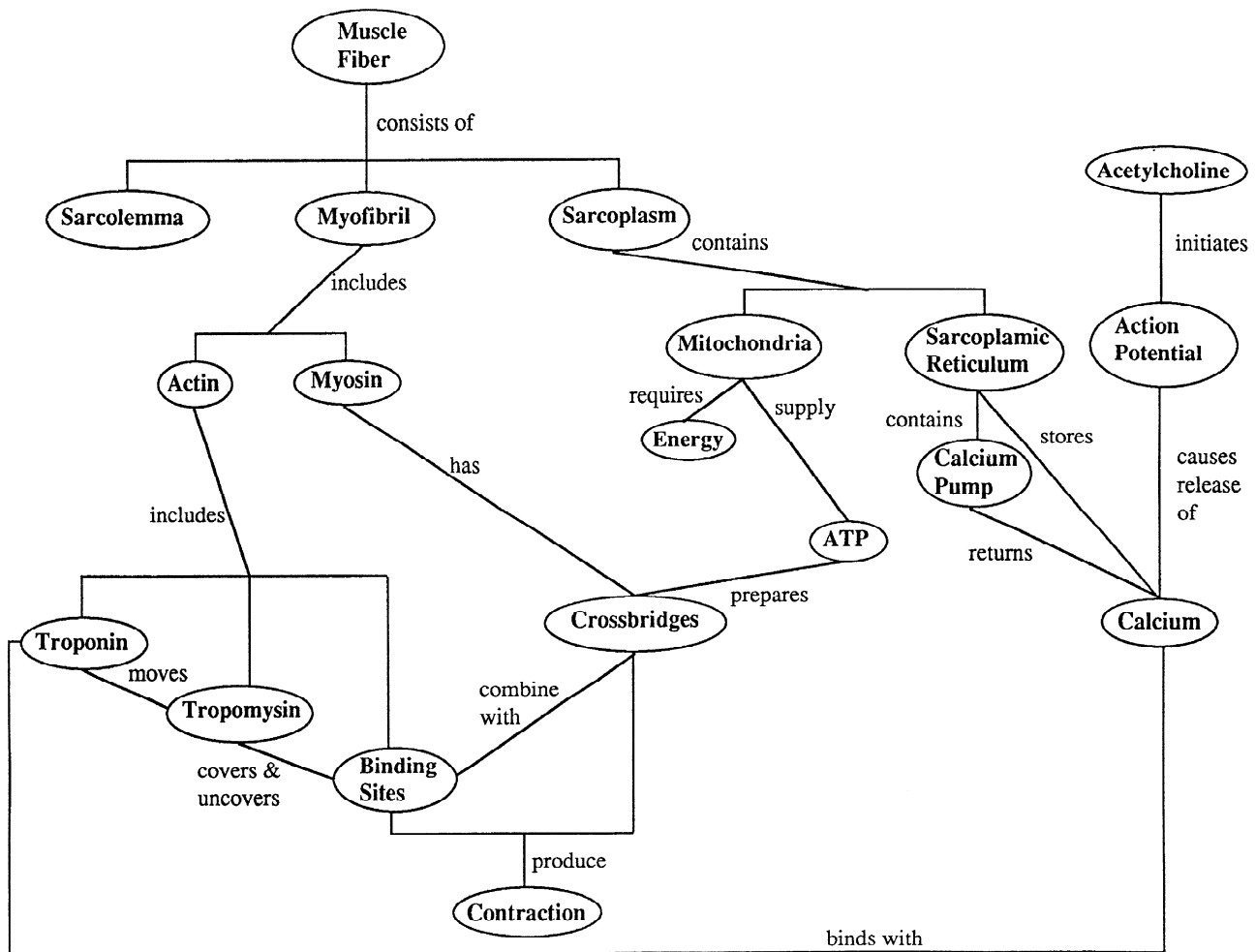


FIG. 1.

Example of a concept map (7, 8) that may be constructed by a student seeking to examine concepts and links associated with muscle contraction. Concepts, appearing in ovals, are linked by lines and linking words that describe relationships. This type of map helps students to build associative links among concepts but not necessarily causal links.

nism. Upon completion of each task, one or two groups present their diagrams to the class. Using these diagrams and the note-taking formats presented earlier as a focus for discussion, the class explores the potential efficacy of the products of the various techniques as aids in predicting what will happen when the system is perturbed (i.e., physiological problem solving).

Through this exercise, students are forced to address issues related to their study goals, their study techniques, and how they construct their own formal mental models of systems (i.e., how they “put it all

together”). It also encourages them to reassess how they study in relation to the kinds of problem solving (model testing) activities that are common to active learning environments.

MAINTAINING STUDENT PARTICIPATION

Faculty often design course activities under the assumption that students will respond as the faculty intend. Hence, the instructor who recognizes the advantages of an active learning environment and decides to implement activities to foster such an environment may assume that students will participate appropri-

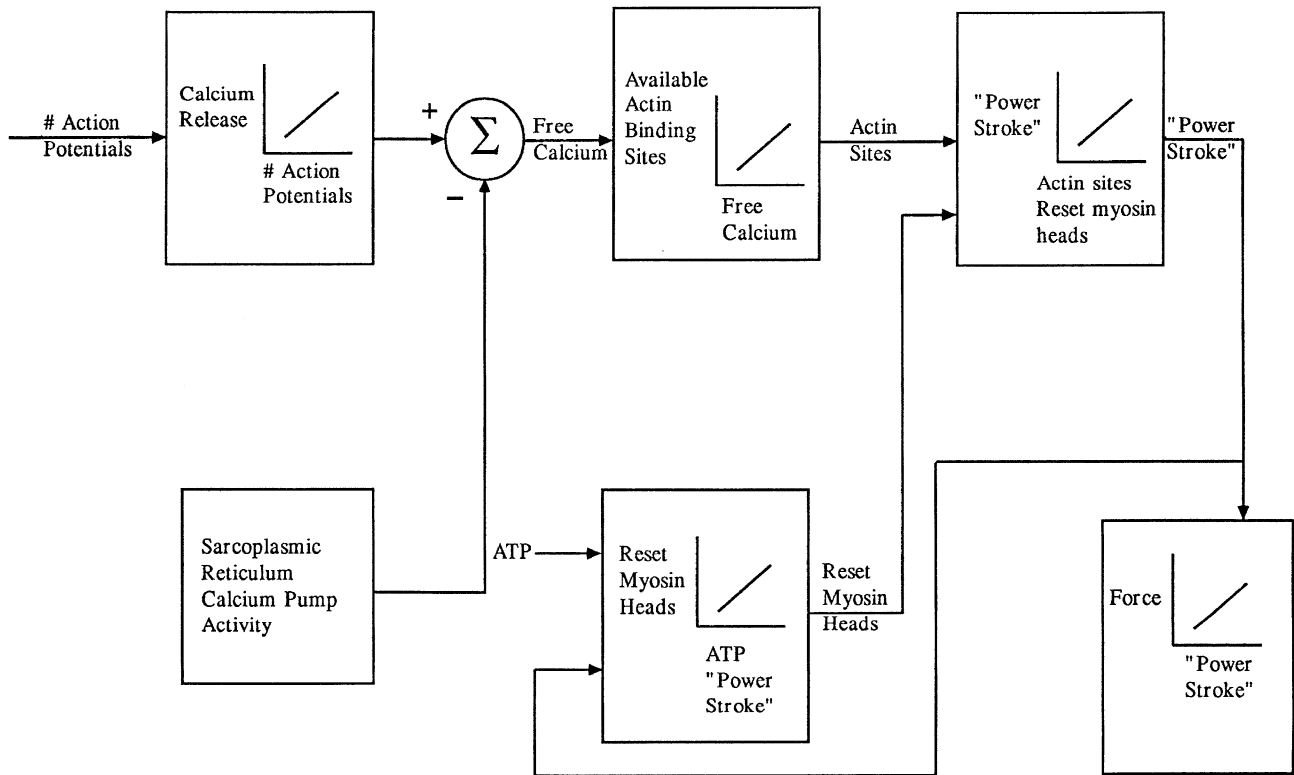


FIG. 2.

Example of a block diagram modeled after a systems control diagram. Intent is to provide a conceptual aid rather than a mathematical representation of the system being modeled. For example, Σ is used to suggest that the amount of free calcium depends on release and removal of calcium rather than the more appropriate mathematical representation of rates of concentration changes and an integrator.

ately in these activities. However, students are conditioned by past educational experiences that, in most cases, have been in passive learning environments. This conditioning not only discourages student participation, it does not provide students with a reason to want to participate. After all, in the end, “the teacher will tell me all I need to know to pass the course.” If faculty expect students to participate appropriately in an active learning environment, they must help students overcome the “training” of previous educational experiences that required them only to be passive recipients of information.

The exercises described above are offered to faculty who have decided to implement active learning activities in the classroom. They are intended to help students recognize the need to become active participants in the learning environment. They also introduce students to the types of interaction expected in

an active learning environment. However, these exercises represent a first step. They are not sufficient to ensure continued student participation in the classroom. By conducting these or similar exercises, faculty are, in effect, expressing a commitment to facilitate active learning within the classroom. They must recognize this commitment and act accordingly. Students will continue to participate only as long as course or curricular activities fulfill the promise of providing an interactive environment that is learner centered. Thus faculty must ensure that course activities are consistent with the commitment to active learning. It is important to recognize that examinations and other assessment tools fall into the category of course activities that must be consistent with the commitment to active learning. Examinations that only require recall of facts rather than application of factual information to new situations can undermine the instructor’s attempt to maintain student partic-

ipation in the classroom. The message received by students from inappropriate exams is that “performance in this class is determined in the same way as in classes where I just sit and listen, so why should I go through the work of testing my mental models?”

In summary, by deciding to implement an active learning environment in the classroom, faculty enter into an implicit contract with students. Under the terms of that contract, the instructor becomes the “coach” whose responsibilities include helping students to understand why they should agree to “play the game,” ensuring that course activities follow the “rules of the game,” and reassuring students that, although “playing the game” is not as easy as being a spectator, the goal of understanding and applying information can only be reached by continuing to be an “active player.”

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