UNDERSTANDING PHYSIOLOGY BY ACTING OUT CONCEPTS

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Typically, classes in anatomy and physiology are taught via lecture and visual aids. This seems to work well for students who are primarily auditory and visual learners but not for those who learn better through kinesthetic experiences. This is the first report describing the use of improvisation to act out physiological concepts within an anatomy and physiology course. Improvisational techniques encourage active participation and allow students to personally interact with and experience difficult concepts in the classroom. In this paper, sensory modality preferences for learning will be discussed briefly. Improvisational techniques will be described, and examples of improvisations useful to convey intricate physiological concepts will be provided. Last, student responses to the use of improvisational techniques in an anatomy and physiology course will be reported.

Key words: improvisation; physiological concepts; kinesthetic experiences

Historically, classes in the life sciences (e.g., anatomy and physiology) have been taught via lecture and visual aids. In recent years, there has been great interest in active, rather than passive, learning in the classroom. Many ideas for promoting active learning in both small and large groups can be found in a report of a workshop held in 1993 by the New York Academy of Sciences (4). Despite numerous strategies such as role playing, improvisation (acting out) of physiological concepts is not mentioned. Use of improvisation in the classroom not only assists learners through active participation but allows the instructor to gauge the level of student understanding of complex interrelationships.

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erb that emphasizes the importance of active learning: tell me—I forget, show me—I remember, involve me—I understand. To enhance learning then, the teacher needs to offer content in a variety of presentations that utilize auditory, visual, and kinesthetic experiences.

It is widely accepted that we only understand the complexities of a learning situation when we are personally involved in it. According to Spolin (7), “We learn through experience and experiencing and no one teaches anyone anything.” Merritt (2) reviewed selected published reports on learning style preferences among individuals in health care fields. In general, she found that throughout the studies reviewed subjects preferred concrete, teacher-structured learning environments. For example, the majority of 108 family practice residents evaluated for learning style by Sadler, Plovnick, and Snope (6) learned through a more active and concrete approach. In contrast, of 308 nurses working in critical care, the operating room, and infection control, 64% had an abstract learning style and preferred the self-directed, discovery approach to learning (1). Improvisation appears to cross these boundaries, meeting needs of many types of learners.

IMPROVISATION: WHAT IT IS, WHAT IT IS NOT

Improvisation has been used for many years to teach creative drama. Two excellent resources are Let’s Improvise: Becoming Creative, Expressive, and Spontaneous Through Drama by Polsky (5) and Improvisation for the Theater: A Handbook of Teaching and Directing Techniques by Spolin (7). Both provide an overview of improvisational techniques focusing on teaching drama. This report describes the use of improvisation to teach basic science.

Improvisation is a spontaneous response to new and unexpected situations under structured circumstances. It allows students to use their imaginations and push beyond the present to discover new worlds of ideas and experiences (5). This technique fits well with the one underlying goal of all teachers: to encourage students to think creatively and experience the topic being taught. Improvisation is not a rehearsed performance for an audience, and, quite frequently, the audience will be asked to join in.

Although improvisation is not rehearsed, it is structured. In fact, the instructor may have a written plan and must make it perfectly clear what is to be demonstrated, without providing too many specific details. In other words, the instructor must be able to give up control of the classroom to allow students to explore physiological relationships. There is no absolutely right or wrong way to demonstrate such relationships. Using improvisation, students gain greater insight into content by acting out the interrelationships.

RULES FOR IMPROVISATION

For improvisation to work, students must feel that they are in a safe environment. This is one in which they will not be physical, psychologically, or socially harmed. Students must be able to move around freely without danger of tripping over steps and electrical cords or bumping into tables and chairs. The instructor must “sell” the idea of improvisation by performing an improvisation alone at first or by participating in one. The instructor can set the stage during the very first class by designing an appropriate improvisation. Simply using one’s own body to act out the anatomical position and different planes can help students to feel more comfortable. Likewise, designating students to act as different elements and asking them to configure themselves as simple molecules (e.g., H₂O, CO₂, H₂, O₂) can set the stage for this technique early in the course. Use of brief improvisations initially helps students feel comfortable with this technique.

SIDE COACHING

Initially, the instructor must take an active role in designing and directing the improvisations. As students become more familiar with this technique, it is beneficial for the instructor to take a passive role and allow students to plan and demonstrate the interactions. The instructor, or later, a student, then guides students through the improvisation by using side coaching. Side coaching is a technique wherein
TABLE 1
Muscle contraction—sarcomeres

<table>
<thead>
<tr>
<th>Concept</th>
<th>Muscle contraction occurs as series of sarcomeres shorten. Sarcomeres consist of actin and myosin overlapping fibers. During muscle contraction, actin fibers slide over the myosin fibers, shortening the sarcomere. When each sarcomere in the muscle fiber shortens, the muscle contracts.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characters</td>
<td>4 Sarcomeres, line up facing class, stretch arms out at sides, and hold each others' hands</td>
</tr>
<tr>
<td>Contracted muscle</td>
<td>Each sarcomere bends its arms close to body while continuing to hold each other's hands</td>
</tr>
</tbody>
</table>

the director gives guidance without interrupting the improvisation. In other words, the actors ignore the director but modify what they are doing in response to the side coaching.

SETTING AND MATERIALS FOR IMPROVISATION

Improvisation can be experienced almost anywhere, and the classroom is no exception. All that is needed is a regular classroom with about 12 ft across the front of the room to move around. From mere space alone, a marvelous and diverse world of anatomical structures and physiological activities can be constructed and shared. Simple signs labeling each component of the improvisation and worn on strings around the neck or taped to the students' shirts add clarity to the representation. Simple versatile props can augment the improvisation. Costumes give the student permission to act differently from normal. Yet costumes and props should not be the focus. A box of hats, ropes, different colored pieces of cloth, and perhaps some wrapped candy are more than sufficient.

STUDENT RESPONSE TO IMPROVISATION

Surprisingly, adult students really enjoy this learning technique. A survey of 17 students registered for anatomy and physiology during the fall of 1994, when this technique was first tried, revealed that, by self-report, 12 students (71%) were visual learners, 4 (23%) were kinesthetic learners, and 1 (6%) was an auditory learner. When asked how well the instructor provided different types of information, students consistently reported that most information was provided in an auditory format, followed by a visual format, with kinesthetic experiences providing the least. Sixteen students (94%) stated that improvisation was helpful; a visual learner felt that it was not. Comments were very positive and included such statements as “Improvisation was fun,” “Learned more by participating,” “Was able to remember concepts better from improvisations,” “By doing this, we were able to see what these concepts look like,” and “I find myself anthropomorphising hormones now.” Suggestions made by students included, “Keep using improvisation, label the characters with hats or colored tags or some other type of identification,” “Do more—keeps us...
TABLE 3
The reflex arc

Concept
When one touches a hot stove, pain receptors in the skin are stimulated. An impulse travels to the spinal cord via an afferent (sensory) neuron. This impulse is transmitted to an association neuron and then to a motor neuron. The hand is then quickly removed from the hot stove.

Characters
Sensory neuron—first-order neuron
Association neuron
Motoneuron—lower motoneuron
Second-order neuron of spinothalamic tract
Third-order neuron of spinothalamic tract
Upper motoneuron

Scene
With chalk, outline the cerebrum with its motor and sensory strips, the thalamus, and the spinal cord on the floor. Students then stand on the appropriate spot. For example, the first-order neuron has its cell body right outside the spinal cord, one hand extends toward the "hot stove," the other extends into the spinal cord where it barely touches the association neuron. The association neuron is totally within the spinal cord bridging the first-order sensory neuron to both the motoneuron and the second-order neuron. The second-order neuron extends to the thalamus where it synapses with the first-order neuron, whose cell body is located in the sensory strip.

Candy may be used to demonstrate the release of neurotransmitters. Each succeeding neuron can only transmit the impulse if the previous neuron has passed on a piece of candy.

TABLE 4
Effective capillary filtration pressure

Concept
Movement of water out of the capillary depends on the balance among 4 forces. Within the blood stream are two forces: the blood hydrostatic pressure, which pushes fluid out of the capillary, and the blood osmotic pressure, which holds fluid inside the capillary. Within the interstitial space are two potential forces: the interstitial hydrostatic pressure, which pushes fluid into the capillary, and the interstitial osmotic pressure, which pulls fluid out of the capillary. At the arterial end of the capillary, the balance of pressures pushes fluid out; at the venous end, the balance of pressures pulls fluid back in.

Characters
Blood hydrostatic pressure (BHP) Tall student
Blood osmotic pressure (BOP) Medium student
Interstitial hydrostatic pressure (IFHP) Short student
Interstitial osmotic pressure (IFOP) Short student
Water molecule(s)
2 Ropes representing capillary membrane—ends held by 4 students

Setting
2 Ropes held parallel to one another
BHP between the ropes pushing out; BOP between the ropes pulling in
IFHP outside ropes pushing in; IFOP outside ropes pulling out

Students should try to represent their relative forces

Scene 1
Arterial end of the capillary
BHP + IFOP exceeds BOP + IFHP, water moves out of the capillary

Scene 2
Venous end of the capillary
BHP + IFOP is less than BOP + IFHP because BHP is less (tall student stoops down), water moves back into the capillary

When one first considers the use of dramatic techniques to teach anatomy and physiology, it is not unusual to feel that there is no place for improvisation in the basic science classroom. Yet, even those without any physiological interests quickly find something to relate to. For example, the first improvisation that I ever tried involved the path of blood flow through the heart. Four participants served as the four heart chambers by bobbing up and down rhythmically. Four others acted as the blood and traveled past the right atrium and ventricle, detoured to an area of the room known as the lungs, returned to the left atrium and ventricle, and then headed out to a different section of the room known as the systemic circulation. These participants were from secondary education, primarily drama, history, and literature. Yet, they commented that they had never understood before how the heart worked. They asked questions applying the content to more complex situations, like “What happens in a heart attack?” and “What happens if the blood flow is blocked?”

In summary, most students, irrespective of learning style, find improvisation not only to be entertaining but extremely useful in understanding concepts. One can only encourage you to try this technique once or two times before judging its effectiveness. To
get you started, some ideas are outlined in Tables 1–4. Possibilities are unlimited!

For encouraging me to try this technique, I thank Paula Sperry (Theatre Dept., Univ. of Denver), Norman Fringer (Director of Educational Support Services), and all my courageous students at the Univ. of Colorado Health Sciences Center.

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