USING SITUATIONAL PHYSIOLOGY IN A DIDACTIC LECTURE SETTING

Daniel Richardson

Department of Physiology, University of Kentucky, College of Medicine, Lexington, Kentucky 40536-0084

This project used the approach of “human situations” to teach about the cardiovascular system within an undergraduate physiology course (PGY 412). About two-thirds of the students had previously taken a college-level physiology course (sophisticated), whereas one-third had not (naive). Nine didactic lectures were organized around the common human situations of orthostasis, blood donation, and exercise. For acceptance evaluation, the students were given a questionnaire consisting of six expectation statements (e.g., compared with other life science courses, I expect that I will better understand the material) and asked to rate the degree to which they agreed with each statement on a scale of 1 to 5. On completion of the lectures, the students were given a questionnaire asking them to compare experiences with expectations. Experiences were significantly less than expectations for naive (P < 0.05) but not for sophisticated students. On a scale of 1 to 5, sophisticated students preferred the situations approach more than did naive students (3.1 vs. 2.4; P < 0.066). For performance evaluation, the students were given a set of questions used by the author in a previous PGY 412 course presented by traditional didactic lectures. There were no significant differences between present and previous scores (77 vs. 79%; P > 0.16). Furthermore, there were no significant differences between naive and sophisticated students in cardiovascular examination scores (P > 0.608) or in total course scores (P > 0.523). These results indicate that didactic lectures based on situational physiology will yield a performance outcome equivalent to traditional lectures. However, naive students may have difficulty with the procedure and require extra attention.

Key words: instructional methods; active learning; human physiology

The didactic lecture is one of the oldest and most widely used teaching methods in education. Although there are several recognized benefits to this method (1, 4, 12), the passive manner in which didactic lectures are usually presented is inconsistent with cognitive models of how people learn (2, 5, 6). In response to this consideration, education reformers advocate a “shift from lecture to active learning” (7). The assumption in this statement is that we must give up didactic lectures to “shift” to active learning methods. However, active learning is a not an instructional method, but rather a variety of activities that the students do (7) while participating in their own education (9) and constructing their own mental models of subject matter (8). These considerations beg the question: Can the didactic lecture be restructured to allow active learning? Although, a variety of procedures has been described for incorporating active learning exercises in the large class setting (11), there have been few attempts to reorganize the didactic lecture itself into a more active learning experience.
From a cognitive point of view, learning involves the internalization of new information into existing mental schemata—an organization of information based on personal experience (6). This consideration suggests that active learning of life science could be fostered if the presentation of material is centered around common experiences with which students may be familiar (i.e., have an existing mental schema). Along these lines, Hansen and Roberts (3) have described a human situations approach to teaching physiology, whereby common situations, such as fainting and exercise, formed the framework around which the relevant physiological concepts were discussed in small group sessions. This approach was well received by both students and faculty and, as judged by examination performance, resulted in excellent outcomes for both physiologically naive and sophisticated students.

The findings of Hansen and Roberts (3) suggest that a situations approach might be helpful in promoting active learning in a didactic lecture setting. As a first step in testing this possibility, the purpose of the present study was to determine the acceptability and performance outcome of a didactic lecture series in which the material was organized around common human situations familiar to the students. Although the long-range aim is to make the didactic lecture more active in nature, the situation approach itself, rather than active learning, was the central focus of the present study. A summary of the results has been presented in abstract form (10).

METHODS

Nature of the physiology course. The educational setting for this study was a one-semester four-credit hour upper-level course titled Principles of Human Physiology (PGY 412). The course is offered each semester by the Department of Physiology at the University of Kentucky and is taught in a didactic lecture format. Prerequisites are 1 year of college chemistry and 1 year of either biology or elementary physiology.

During the semester in which the present study was undertaken, PGY 412 had 137 students, most of whom were in allied health degree programs (e.g., clinical nutrition, physician assistant, physical therapy).

Sixty-six percent of the students in this class had taken a previous college-level physiology course, whereas the remaining thirty-four percent had not. Hereafter, these students will, respectively, be referred to as sophisticated and naive.

The course consisted of 61 class periods of 50 min each. A total of 57 of these were used to present information in didactic lecture format, whereas the remaining four periods were used for multiple-choice examinations.

The recommended text for the course was the sixth edition of Human Physiology: The Mechanisms of Body Function by A. J. Vander, J. H. Sherman, and D. S. Luciano (13). All reading assignments came from this text.

The course was team taught by six faculty, with the author (D. Richardson) presenting the cardiovascular system in a series of nine lectures. These lectures comprised the second major block of the course (lectures 14-22), with the first block being the neuromuscular system. Information from the cardiovascular and subsequent respiratory system lectures was combined for the purpose of the second of the four multiple-choice examinations.

Situational nature of the cardiovascular lecture series. This series focused on the cardiovascular adjustments to three common situations presented in the following order: 1) the upright posture, 2) donation of blood, and 3) physical activity. Most of the lecture time was devoted to the first of these, the upright posture (i.e., orthostasis), as it provided the basic foundations of cardiovascular physiology.

The lecture series began by using the maintenance of systemic arterial pressure as a focus concept for the cardiovascular system. That is, from the viewpoint that all adjustments of the cardiovascular system appear to be geared toward maintaining a stable systemic arterial blood pressure. Although focus concepts such as are subjective in nature, we have found them to be helpful in providing students a framework around which they can organize their understanding of a subject.
In presenting systemic pressure as a focus concept, the water tank analogy was used to illustrate the importance of pressure in providing a flow of water to separate buildings in a community. Because the University of Kentucky has a very visible water tower, complete with logo, the water tank analogy provided the students with a familiar situation in which to learn about hydrostatic pressure.

The concept of maintaining pressure in a water tank to provide water flow in keeping with the needs of individual buildings was then transferred to the domain of systemic arterial blood pressure and tissue blood flow. The next step was to consider the difference between pressure in an open container, such as a water tank, and pressure in a closed container, such as the circulatory system. This was done by having each student in the class blow up a toy balloon. The balloon experiment led to a didactic lecture on pressure as a relationship between volume and compliance. In this manner the students learned, through a combination of experience and lecture, the concepts of stressed and unstressed volume and the relationships between pressure, volume, and compliance.

At the end of the compliance lecture, a long distensible bag filled with water was stood on end to demonstrate the pooling effect of gravity. The class was then asked what they thought would happen to blood volume, hence, pressure, in their thorax, where the heart is located, if they stood up. Most agreed that pressure would decrease. They were then asked, “Would this reduce blood flow to your brain and make you dizzy?” Most agreed that it would.

At this point, the class performed an experiment in orthostasis. After some basic instruction, students measured their heart rate in the seated posture, then again after standing up. On completion of the experiment, it was noted, by a show of hands, that the vast majority of students experienced an increase in heart rate when they stood. However, again by a show of hands, very few students became lightheaded on standing. Thus the class observed that, in contrast to the water bag demonstration suggested, most people do not get dizzy when they stand (i.e., blood pressure tends to be maintained), and they postulated that heart rate might have something to do with this.

After the orthostasis experiment, an overview lecture was presented describing the salient cardiovascular adjustments to orthostasis. At the end of this presentation, the class was told that the next several lectures would be devoted to describing the mechanisms behind each of the cardiovascular adjustments that occur in response to orthostasis.

The next four or five class periods were devoted to presenting the basics of the cardiovascular system in a traditional didactic manner, but with the order of the presentation focused on orthostasis rather than following the outline of the text. For example, the baroreflexes were discussed early on as a mechanism for the increase in heart rate in the orthostatic posture, whereas, in the text baroreflex control is presented toward the end of the cardiovascular section.

At the end of this lecture series, the adjustments to blood donation in the recumbent position followed by orthostasis were described. It was pointed out that this combination results in about twice the volume stress as orthostasis alone and that the initial cardiovascular adjustments are similar to orthostasis but greater in magnitude. In addition, the situation of hemorrhage was used to describe the maintenance of plasma volume by hormonal and physical mechanisms and the regulation of red blood cell volume by erythropoiesis.

During the last class period, some of the more overt responses to exercise (e.g., labored breathing, sweating, and increase in heart rate) were briefly discussed in a Socratic manner so as to reinforce the students' familiarity with this topic. This was followed by a didactic description of complex cardiovascular regulatory interactions associated with an acute exercise bout.

Evaluation of student acceptability. Before beginning the cardiovascular lectures, the class was given a verbal and written description of the approach to be taken in this series, emphasizing how it would differ from a traditional didactic approach. They were then given the expectations questionnaire presented in
TABLE 1
Expectations survey

The purpose of this survey is to judge your expectations about the way in which the cardiovascular system will be presented and how it will affect your learning. Your response will not in any way affect your grade in this course.

Directions: Please respond to the five items below in accordance to the following code.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>D</td>
<td>Disagree</td>
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<tr>
<td>N</td>
<td>Neutral</td>
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<tr>
<td>A</td>
<td>Agree</td>
</tr>
<tr>
<td>SA</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

Comparing this approach to teaching the cardiovascular system to what I have previously experienced in biological or life science classes, I expect that I will:

1) Learn more about the subject matter.  
2) Enjoy the classes more.  
3) Obtain more information from the lectures.  
4) Better understand the material.  
5) Have to rely less on the textbook.  
6) Spend less time studying after class.

Table 1. Note that there are six statements, each of which the students evaluated on a five-point scale, ranging from strongly disagree (1) to strongly agree (5).

On completion of the cardiovascular lectures, the class was given the experiences questionnaire presented in Table 2. Note that this instrument contains the same six statements given in the expectations questionnaire only presented in the past tense. In addition, the students were given a separate document asking them to rank how well they liked the situations approach to teaching cardiovascular physiology on a scale of 1 (did not like it at all) to 5 (liked it very much). Space was provided on the experiences and situations ranking instruments for written comments.

Evaluation of performance outcome. Performance evaluation and grade assignment in PGY 412 were achieved by a series of four 50-point multiple-choice examinations. The cardiovascular and subsequent respiratory examinations comprised the second of the four examinations. For the purpose of the present study, 11 of 32 cardiovascular questions were ones that had been given to a PGY 412 class in 1988 by the author (D. Richardson), who, on that occasion, presented the cardiovascular lectures in a traditional didactic lecture format. For additional outcome evaluation, the present cardiovascular and respiratory examination results were compared, because they were given in the same examination, and these results were compared with the total course score.

RESULTS

Student acceptability. Table 3 compares average experiences versus expectations scores for the six items presented in Tables 1 and 2. Note that for both sophisticated and naive students experiences were

TABLE 2
Experiences survey

The purpose of this survey is to judge how you experienced the manner in which the cardiovascular system was taught and how it affected your learning. Your response will not in any way affect your grade in this course.

Directions: Please respond to the five items below in accordance to the following code.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
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</tr>
<tr>
<td>D</td>
<td>Disagree</td>
</tr>
<tr>
<td>N</td>
<td>Neutral</td>
</tr>
<tr>
<td>A</td>
<td>Agree</td>
</tr>
<tr>
<td>SA</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

Compared to what I was expecting from this section, I found that:

1) Learned more about the subject matter.  
2) Enjoyed the classes more.  
3) Obtained more information from the lectures.  
4) Better understood the material.  
5) Relied less on the textbook.  
6) Spent less time studying after class.
TABLE 3
Expectations vs. experiences

<table>
<thead>
<tr>
<th></th>
<th>Naive Students</th>
<th>Sophisticated Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expectations</td>
<td>3.55 ± 0.7</td>
<td>3.62 ± 0.1</td>
</tr>
<tr>
<td>Experiences</td>
<td>2.7 ± 0.5</td>
<td>3.1 ± 0.5</td>
</tr>
</tbody>
</table>

Data presented as group means ± SD of combined results of all 6 items from Table 1. *Significant from other groups by 1-way analysis of variance (P < 0.05).

less than expectations, but for the naive students the difference was greater and statistically significant.

When asked to rank how well they liked the situations approach on a scale of 1 (did not like at all) to 5 (liked very much), sophisticated students who had taken a previous physiology course ranked the approach higher compared with the naive students. Respective ratings from the sophisticated and naive students averaged 3.12 and 2.43. The difference was marginally significant by independent t-test (P < 0.066).

Only 10 students provided written comments, and 8 of these were critical of the situations approach, citing that the lectures seemed to be unorganized because they did not follow the text. One of the students who gave positive comments felt that the integrated approach helped him to focus on key concepts and “learn” the material, and another student stated that the approach made the lectures “more focused.”

Performance outcome. Table 4 presents the examination results relevant to this study. As indicated in METHODS, the 11 selected cardiovascular questions used in 1988 following a traditional lecture approach were the same ones presently used (1995) in conjunction with the situations approach. Although the 1988 score on these questions was only one percentage point higher, the difference was not significant (P > 0.16). Furthermore, there was a high correlation in the percentage of correct responses between the two classes (r = 0.943), indicating that these questions had good reproducibility.

For the 1995 data, there were no significant differences between the 11 selected questions and all 32 cardiovascular questions or between the cardiovascular and respiration questions. Thus the present (1995) cardiovascular-respiratory examination was homogeneous with regard to degree of difficulty within separate sections of the test.

Finally, the cardiovascular, respiration, and total course scores were subdivided in accordance to naive and sophisticated students. There were no significant differences between these two groups (P > 0.500).

DISCUSSION

The objective of this study was to evaluate student acceptability and performance outcome of a situations approach (3) to presenting cardiovascular physiology in a didactic lecture format. Although the lectures were not strictly didactic, because some student activities were included (e.g., blowing up balloons to learn about compliance), collectively, these activities comprised less than five percent of the lecture time.

One of the major findings of this study was that student acceptability, as judged by comparing experiences to expectations (Table 3) and by student ranking of how well they liked the course, was less for naive students who had no previous physiology experience compared with sophisticated students who had taken a lower-level physiology course. As judged by the few written comments provided, the major difficulty students had with the situations approach was that the order of lecture presentation did not follow the text, which, for these students, gave the lectures the appearance of being unorganized. From the results of the expectations versus experiences instruments (Table 3) we assume that this problem was more acute for the naive students. But with so few students volunteering comments, this is not certain.

Despite a lower acceptance of the situations approach by the naive students, their score on the cardiovascular examination was only one percentage point lower.

<table>
<thead>
<tr>
<th></th>
<th>All Students</th>
<th>Naive</th>
<th>Sophisticated</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cardiovascular questions</td>
<td>75 ± 11%</td>
<td>74 ± 12%</td>
<td>75 ± 10%</td>
</tr>
<tr>
<td>Respiratory questions</td>
<td>74 ± 13%</td>
<td>75 ± 10%</td>
<td>75 ± 14%</td>
</tr>
<tr>
<td>Total course score</td>
<td>77 ± 10%</td>
<td>78 ± 9%</td>
<td>77 ± 10%</td>
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</table>

Data presented as group means ± SD. In 1988 (traditional lectures) students scored 79 ± 14%, and in 1995 (situational lectures) students scored 77 ± 15% on selected cardiovascular questions.
than that of the sophisticated students, and the difference was not significant (Table 4). Similar results were obtained by Hansen and Roberts (3) who used the situations approach to teach physiology in small group sessions. Their naive students had a final score of 85 vs. 89% for the sophisticated students. However, they did not give a comparison as to the acceptability of the approach between the two groups.

The fact that, as indicated by examination performance, the naive students learned the material as well as did the sophisticated students despite a lower acceptability of the situations approach, is consistent with the schema theory of learning (6), which basically holds that new material is more radially learned if it is presented within the context of familiar setting (i.e., an existing mental schema). However, a much more critical test as to whether the situations approach fits the schema theory of learning would be the degree to which the students retain the material. If the material is indeed internalized by incorporating it into existing schemata, then long-term retention should be higher compared with traditional lecture approaches. Although we could not test this within the present experimental design, Hansen and Roberts’ study (3) subjectively indicates that students of their situations course do better at retaining general principles when they enter advanced courses.

Although the central focus of this study was on acceptability and performance outcome, not active learning, qualitative indicators within the results suggest that active learning was fostered by the situations approach. For example, even students who were strongly opposed to the approach indicated in their comments that they kept quite busy in class, taking notes, listening carefully, etc. In addition, both naive and sophisticated students spent more time reading the text and studying after class (items 5 and 6, Tables 1 and 2). Furthermore, subjectively we found that students raised questions and interacted with the instructor more frequently in the cardiovascular section compared with other sections of the course. In as much as these are all characteristics of active learning (7), the situations approach seemed to have fostered an active learning environment.

Modell and Michael (8) define an active learning environment as one in which students individually are encouraged to engage in the process of building their own mental models. Although a didactic lecture, no matter how structured, can not assist individual students in building mental models, this could be done collectively for the class as a whole. To get an indication as to whether our students may have been engaged in constructing mental models, three of the questions on the cardiovascular examination required that the students be able to predict changes in end systolic and end diastolic cardiac volume in response to certain physiological situations. Predictions are one way of testing mental models. The collective percent of correct responses on these three questions was 74%, a value comparable with class scores on the whole cardiovascular examination (Table 4). In this author’s experience (unpublished), performance on predictive types of questions used in conjunction with traditional didactic lecturing has been quite poor (40-60% correct responses). These results, although highly speculative, suggest that the situations approach may help students in the process of constructing mental models.

In conclusion, the results of the present study indicate that teaching cardiovascular physiology by the situations approach in a large class/didactic lecture setting results in performance outcome equivalent to traditional lectures. In addition, subjective indicators suggest that the situations approach promotes active learning. However, first time (i.e., naive) students may have difficulty with the procedure and require extra attention.

Address reprint requests to D. Richardson.

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References


