“Physiological curiosity of the week”: a teaching tool to facilitate self-directed learning and student participation during a cardiovascular physiology course

Ronan M. G. Berg
Renal and Vascular Research Section, Department of Biomedical Sciences, Faculty of Health Sciences, University of Copenhagen, Copenhagen, Denmark; and Centre of Inflammation and Metabolism, Department of Infectious Diseases, University Hospital Rigshospitalet, Copenhagen, Denmark

Submitted 1 February 2012; accepted in final form 17 August 2012

A RECURRING CHALLENGE for the physiology teacher is to motivate self-directed learning among students. The curricula are large, and the individual courses are often clutched together; hence, many students never get around to actually studying the subjects until a few weeks before the exams, at which time they have to resort to memorizing rather than understanding the material. Consequently, many show up to classes unprepared, and in my experience, this largely impedes the active learning strategies that are implemented to facilitate meaningful learning, particularly case studies on complex physiological phenomena. In general, students are extremely result oriented and often express that these case studies are “too much work” and “not relevant enough for the forthcoming exam.” They want answers, not more questions, and fail to appreciate that it is in the process of obtaining the right answer that one learns physiology.

How can I as a teacher change student perceptions of case studies and thus enhance their self-directed learning? Well, a competition almost always works. I therefore came up with a competition called “the physiological curiosity of the week.” Each term, I teach two classes of second-year medical students for a double lesson a week in a 5-wk cardiovascular physiology course. At the end of each double lesson, I would introduce what I called a “physiological curiosity” to the students. This curiosity differed from the typical case studies used in our faculty in that rather than presenting some complex clinical case story, it encompassed only some very simple physiological data and a clear question. I attempted to design the questions so that they could not be answered simply by looking up information in a textbook, although it would nevertheless be directly related to the students’ curriculum; the students would have to interpret the data at hand and synthesize a number of physiological concepts to answer the question appropriately. I encouraged students to form teams of two to four people and then submit a ~200-word abstract with an analysis and interpretation of the curiosity before next week’s lessons. I would rate each abstract 0–100 points based on the students’ abilities to 1) analyze the data systematically (0–20 points), 2) interpret the data adequately (0–20 points), 3) integrate the appropriate physiological concepts (0–20 points), and 4) put the curiosity into perspective (0–20 points) as well as on an overall assessment of the abstract (0–20 points). The cumulated scores would be presented each week, and the winning team in each class that had obtained the highest cumulated score at the end of the course would receive an undisclosed symbolic prize (in this instance, a pen flashlight for each team member) and a diploma.

I composed four curiosities based on experimental physiological data from healthy volunteers and patients and introduced each curiosity as a detective case at the end of the final lesson each week. I then discussed the curiosity with the students before highlighting the cumulated score of each team. The first curiosity focused on the impact of ions on the cardiac action potential. Here, students received a table with plasma levels of sodium, potassium, chloride, and calcium from a human subject, with the question: “How can changes in extracellular ions affect the heart beat?” The following week, I notably used the students’ answers to demonstrate...
strate how both hypokalemia and hyperkalemia may be fatal in patients and discussed the impact of trigger calcium on cardiac contractility. For the second curiosity, I introduced a 30-s recording of continuous invasive blood pressure and respiratory rate from a healthy subject, with the question: “How does normal breathing affect blood pressure?” In the following lesson, we discussed how intrathoracic pressure affects cardiac preload, how this relationship is affected by mechanical ventilation and the pathophysiology of pulsus paradoxus. The third curiosity involved raw data on systemic hemodynamics (heart rate, stroke volume, and blood pressure as well as hematocrit and plasma protein concentration) from a semisupine subject during water immersion to the neck, with the question: “Does bathing in a tub have beneficial effects on blood pressure?” In the following lesson, we discussed baroreflex regulation and the physiological consequences of gravity. The fourth and final curiosity involved hemodynamic data (heart rate, stroke volume, blood pressure, and central venous pressure) during an incremental norepinephrine infusion (from 0 to 0.12 μg·kg\(^{-1}·\text{min}^{-1}\)) in a critically ill patient, with the question: “Does norepinephrine really decrease heart rate?” The roles of the various catecholamine receptors in cardiovascular function and the involvement of the baroreflex in the integrated hemodynamic response to catecholamine administration (1) as well as the pathophysiology of shock were then discussed in the following lesson. So, in a sense, I turned the typical approach to case studies around; instead of introducing the students to a difficult case study, the curiosities raised apparently simple questions, and in the following lesson I could then build further on the students’ rapidly evolving mental models of physiological concepts (which I monitored through the abstracts) by means of plenary discussions of complex pathophysiological phenomena.

The physiological curiosity of the week was incredibly popular (Fig. 1), and although participation was entirely voluntary, more than two-thirds of all my students participated, forming five teams of two to four people in each class. This is a remarkable improvement compared with when I used the conventional case study approach, where fewer than five students normally showed up prepared. It was my impression that the collaborative nature of the competition required the students to familiarize themselves with the fundamental physiological principles and actively use them, thus promoting meaningful learning (2). Accordingly, the abstracts improved remarkably week by week, despite that the curiosities became increasingly complex; thus, in the first week, the abstracts received ratings ranging from 25 to 55 points, but in the final week they ranged from 75 to 95 points! I became increasingly amazed as to how eager the students were to participate in the plenary discussions and how well they used the fundamental physiological concepts to discuss gradually more complex questions. The physiological curiosity of the week thus seemed to be successful for enhancing self-directed learning, and student involvement increased notably with enhanced student-student and student-teacher interactions during lessons.

**GRANTS**

R. M. G. Berg is supported by a grant from the Faculty of Health Sciences of the University of Copenhagen. The Centre of Inflammation and Metabolism (CIM) is supported by Danish National Research Foundation Grants 02-512-55. This work was further supported by the Danish Council for Independent Research-Medical Sciences, the Commission of the European Communities (Grant Agreement 223576, MYOAGE). The CIM is part of the UNIK Project: Food, Fitness and Pharma for Health and Disease, supported by the Danish Ministry of Science, Technology, and Innovation. The CIM is a member of the Danish Center for Strategic Research in Type 2 Diabetes (the Danish Council for Strategic Research, Grants 09-067009 and 09-075724).

**DISCLOSURES**

No conflicts of interest, financial or otherwise, are declared by the author(s).

**AUTHOR CONTRIBUTIONS**

Author contributions: R.M.G.B. conception and design of research; R.M.G.B. performed experiments; R.M.G.B. analyzed data; R.M.G.B. interpreted results of experiments; R.M.G.B. prepared figures; R.M.G.B. drafted manuscript; R.M.G.B. edited and revised manuscript; R.M.G.B. approved final version of manuscript.

**REFERENCES**