Improving teaching skills: from interactive classroom to applicable knowledge

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Vujovic P. Improving teaching skills: from interactive classroom to applicable knowledge. Adv Physiol Educ 40: 1–4, 2016; doi:10.1152/advan.00139.2015.—Making the transition from more traditional to more interactive lecturing can be successfully achieved by applying numerous teaching techniques. To use lecture time in the most efficient way, a lecturer should first instruct students to acquire basic knowledge before coming to class. Various in-class activities then can be used to help students develop higher thinking skills and gain better understanding of the studied material. These in-class activities can take many forms (multiple-choice questions of various complexities, compare-and-contrast tasks, quantitative and problem-solving tasks, questions dealing with interpretations of tables, graphs, and charts, etc.) and should be designed to help student integrate their knowledge, to facilitate communication among students, and at the same time to allow the lecturer to closely monitor the learning process as it happens in the classroom.

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WHEN I WAS FIRST APPOINTED as an assistant professor at the University of Belgrade in Belgrade, Serbia, in 2011, I was very pleased to hear that I was assigned to teach the Animal Physiology course, which is a required course for second-year undergraduate biology students. I have always liked lecturing and felt confident about my skills, since I had already been a teaching assistant for 5 yr. I vividly remembered how lectures often felt like they were not contributing enough to my learning process, and I was determined to make a difference by making my lectures worth attending.

Part 1: Recognizing the Need for Increasing Teaching Competencies.

Not long after the beginning of the fall semester, the first frustrations appeared. My main goal was to make students actively participate during lectures. It was when I tried to establish two-way communication with my students that I ran into difficulty. Even the simplest questions, such as “Did you understand that?,” were often met with a muted response. Introducing some humor helped break the ice, and I managed to get a modest discussion started. But it was always the same small group of students who were willing to attempt answering my questions, while the others remained unengaged. I did not know how to overcame that problem, and then it dawned on me that never during my university education did I undergo any kind of teaching training. Despite my willingness to change something, I did not really know how or what needed to be changed. I realized it would take much more than simply being well prepared for lectures to become a successful university educator. In other words, I realized I needed to get help.

Fortunately enough, an opportunity to learn more about teaching came quicker than I could have hoped for. It was in the spring of 2013 that the United States (U.S.) Department of State and the U.S. Embassy in Serbia announced the Fulbright Faculty Development Program, which provided junior university faculty members with the opportunity to cultivate teaching skills and techniques based on personal observation of U.S. educational methods. The application for the Fulbright scholarship required putting together a narrative project and personal statement, which made me sit down and think hard about what skills I was aiming to acquire. After thinking it through, I decided on understanding the theory behind human learning and increasing my knowledge and skills in interactive teaching techniques as my specific goals.

Applicants were also encouraged to obtain a letter of invitation from the prospective host institution. Given that I did not know anyone in person, I randomly e-mailed a few professors who were affiliated with various U.S. universities. Among the first to reply was Dr. Deborah Mowshowitz, who works as a Professor of Biology and the Director of Undergraduate Programs and Lab Operations at Columbia University. Even though she kindly accepted to be my host and mentor, she also suggested that I contact Dr. Dee Silverthorn, who worked as the Distinguished Senior Lecturer at the College of Natural Sciences of the University of Texas at Austin, TX. Dr. Mowshowitz said that Dr. Silverthorn was famous for her modern and proactive approach to teaching physiology and that I could learn a lot from her. I subsequently e-mailed Dr. Silverthorn, who invited me to come to the University of Texas. Finally, after two rounds of selections, I was informed that I had received the scholarship, and, in January 2014, I arrived in Austin, TX.

Part 2: Lessons From the University of Texas

One of the first things that I quickly understood by observing Dr. Silverthorn’s lectures is that to create an interactive classroom, a lecturer has to instruct students on how they need to prepare for the class. At the beginning of the 21st century, when the sources of information are abundant, it seems pointless to waste limited lecture time on repeating definitions or listing the basic functions of an organ system when students can easily read about them in a textbook. In other words, students should be held responsible for acquiring the basic knowledge on their own before coming to class. One way of assuring that students will complete their preclass duties is by having them complete online quizzes before coming to class and then making this assignment a significant part of the final grade.

The second thing I learned was that it is the teacher’s responsibility to carefully structure lecture time and design in-class activities that enable students to develop higher forms of thinking, such as analyzing and evaluating concepts and processes. I realized that the only way to avoid long sessions of
traditional teaching with the professor lecturing and students quietly taking notes was to create questions and tasks that would help students acquire higher levels of understanding the material.

As for the in-class activities, I witnessed the various forms they can take. I learned that it is always good to start a class by having students answer a few multiple-choice questions that test their understanding of the material studied at the previous lecture. These can then be followed by several multiple-choice questions that check to what extent students are familiar with the basic knowledge related to the unit that will be covered that day. The answers at the University of Texas are recorded using an electronic response system (“clickers”) so the lecturer can get immediate insights into how successful students are at giving answers.

Most of the time, the majority of students did not have trouble answering the multiple-choice questions at the beginning of the lecture. But every now and then, the results revealed that there were certain misconceptions about previously covered material: a substantial percentage of students would choose the same wrong answer. Instead of the lecturer immediately jumping to clear the misconception, in a situation like this the instructor can resort to a “talk to your neighbors” technique, more formally known as think-pair-share. This specific technique allows students to correct their misconceptions by discussing them with their peers. The efficiency of this approach was regularly proved since the number of the students who correctly answered the question was significantly increased after they had a chance to have a brief discussion with their neighbors. Making room for peer-to-peer teaching also showed that the success of interactive teaching depends not only on communication between the teacher and students but also on communication among the students as well.

The benefit of peer-to-peer teaching can be maximized by exposing students to the influences of as many of his or her peers as possible. This can be achieved by “shuffling”: instructing students to sit next to people who, for example, wear the same color top or who were born the same month. The use of these random criteria helps put students in touch with more peers than they would normally interact with.

As for the increasing the number of students who are willing to actively participate during lectures, it is well known that fear of publicly giving the wrong answer is one of the greatest obstacles to establishing an interactive classroom. After spending time at the University of Texas, I realized this fear universally applies to students of different nations and cultural background. Despite all the encouragement and reassurance that there is nothing wrong with giving an incorrect answer in class, the fear of embarrassment prevents many students from partaking in discussions during lectures.

During my stay at the University of Texas, I was lucky enough to learn a trick on how to leave the fear of embarrassment out of the equation. During Dr. Jan Machart’s lectures, I noticed that she sometimes used the “nameless index cards” technique to test students’ understanding of a certain topic. She would ask a question, and students would write their answers on unsigned index cards. After students were finished writing answers, the index cards were collected and redistributed throughout the classroom. Ultimately, each student would receive someone else’s anonymous answer. When called upon, they were willing to openly discuss with the rest of the class whether the answer was correct or not because it was not their answer. This is an example of how in-class activities can be designed to help student integrate their knowledge, to facilitate communication among student, and, at the same time, to allow the lecturer to closely monitor the learning process as it happens in the classroom.

Just as students are expected to prepare for lectures, teachers are expected to do the same. Creating in-class activities and tasks is probably the most time consuming but also the most rewarding aspect of interactive teaching. I have already mentioned multiple-choice questions as a form of in-class activities. I learned that this kind of task can vary in its complexity. In addition to testing basic knowledge, multiple-choice questions can also test the ability of students to integrate smaller pieces of information into a so-called “bigger picture.” Furthermore, these questions can be used not only as a testing tool but as a learning tool as well. Having students rephrase incorrect answer choices into correct statements can help them fill in the gaps in their knowledge.

In addition to multiple-choice questions, there are other forms of in-class activities that can improve students’ comprehension and ability to apply basic knowledge. These activities include quantitative and problem-solving tasks, questions dealing with interpretations of tables, graphs, and charts, and tasks that require comparing and contrasting various physiological processes.

Part 3: Breaking Old Habits

After observing innovative approaches to teaching physiology and trying my hand at teaching students who were already used to a more interactive approach, I was eager to go back home and try to apply what I learned in Austin. Numerous reforms to modernize and improve the quality of teaching and learning have been taking place recently at the University of Belgrade. Young faculty members are continuously encouraged to take part in workshops and seminars designed to help them improve their teaching skills. In regard to the course organization, the duration was restricted to one semester and mandatory tests and quizzes throughout the term were introduced. Nevertheless, some of the old habits proved hard to die, so, in many cases, the final grade largely depends on how a student performs on the final oral exam. This means that Serbian students are conditioned to put the most effort in studying just before the final oral exams, which are taken several times throughout an academic year (sometimes months after a student attended lectures). In other words, students are often occupied with preparing for other exams while attending lectures for ongoing courses. Therefore, I assumed that although my students would theoretically be happy about the changes in course organization, they would at the same time show resistance to taking on a more proactive role in their acquisition of knowledge. I anticipated that my greatest challenge would be to make them stay focused and give their best during the semester.

Owing to my experience from the University of Texas, I already knew it would be useful to come up with a list of goals and aims to remind students why taking extra effort would be rewarding in the end. Considering that the Animal Physiology course is a mandatory course for sophomore students who major in general biology, the most important goal of this
course is to lay the foundation and equip students with knowledge and concepts required for more specific courses (Endocrinology, Immunology, Neurobiology, etc.) they take later on during their studies. In addition to specific physiology-related learning outcomes, the list also included more general goals, such as developing self-confidence and increasing competencies. I hoped that students would realize how developing these skills would be beneficial for them not just in regard to this course but in the long run as well.

In the absence of access to online quizzes I had to come up with a different strategy to make sure students did their due diligence and did the preclass reading. So just before each lecture, I had them submit in writing the answers to questions that tested their basic knowledge (i.e., definitions, terminology, basic concepts, etc.). Considering that none of my colleagues make similar requests, I feared it would be one of the points where students would oppose the changes. Surprisingly enough, they were compliant with this new demand, and the trend of successfully completing preclass duties remained unchanged for the rest of the semester.

Since I witnessed how the use of multiple-choice questions at the beginning of the lecture is crucial for monitoring the students’ comprehension of the previously covered material, I had to overcome the lack of an electronic response system. Dr. Silverthorn suggested that I prepare sets of different colored cards that could be used for answering questions in place of clickers. Students liked this novelty, and they enjoyed answering questions by raising cards. However, as soon as we reached the tasks that required more than simply regurgitating memorized pieces of information, the students were out of their comfort zone and the first signs of resistance appeared. I suddenly realized that my biggest challenge was not going to be making students study more during semester but rather changing their approach to studying.

At this stage, I told them they should once again go through the list of general and specific goals and aims, and I reminded them that getting better at something takes time and effort. I pointed out that I would guide them through and facilitate their transition from the passive note-taking role to the proactive one I wanted them to take on. To do so and help them integrate and apply the basic knowledge and develop higher levels of understanding the material, I introduced them to creating concept maps, another technique I learned from Dr. Silverthorn. I was aware that creating maps would help them organize concepts into a hierarchical structure, look for similarities and differences among the items they put on the map, question the relationship among the terms on the map, and consequently improve retention of their knowledge. But I also expected it would take time for them to get used to using this new learning tool. Therefore, I initially included a lot of slides with maps in my PowerPoint presentations that I used to review the covered material. I also created a lot of tasks that required them to present their answers in the form of a map. In time, most of the students realized the advantages of concept maps as a learning tool and started using them regularly on their own.

Given that the students were responsible for acquiring the basic knowledge before coming to class, there was ample time for more complex tasks, which students could work on during lectures. As the course progressed, it was more and more challenging to write questions that would disguise basic knowledge into different contexts and ultimately require students to fully realize how different organ systems function cooperatively to achieve the common goal. For example, instead of simply asking them to list the functions and target tissues of certain hormones and neurotransmitters, students were asked to predict hormonal and cardiovascular compensations after the ingestion of a large volume of hyperosmotic solution. In a similar type of question, students were required to trace a path of molecule X from the moment it was ingested through the mouth to the moment it was exhaled in the atmosphere or excreted in the urine rather than to simply name the anatomic structures of different organ systems. Even though students initially struggled with answering this type of question, they gradually became more successful at it. They needed less time to complete these tasks, and it was evident in the discussion sections that more of them were capable of doing so independently.

To assess whether students were also becoming more confident of their knowledge, I would occasionally include a question in discussions where not enough information was provided for a correct answer (e.g., “how does placing a 300 mosM cell in 500 mosM solution affect its volume?”). In the beginning of the course, all students would fall in a trap like this and attempt to give the correct answer. However, by the time we reached the cardiovascular physiology section, about a third of the class instantly recognized that you cannot simply predict the effect of epinephrine on an arteriole diameter without additional pieces of information.

As for the self-confidence, I would especially like to point out a student who after the third lecture came to my office hours and told me she was not capable of critical thinking and that she was also not capable of developing that skill. When I asked her specific problems regarding material were, she simply did not know what to answer. We made an agreement that she would return to my office hours the following week with specific questions and specific tasks she could not solve. I insisted that she give it a try on her own and come back and show me exactly where she got stuck. That day, I went home thinking that I might be demanding more than some of my students could achieve at that point in their education. Fortunately, it was not long before the same student proved me wrong. She came back to my office hours telling me that once she had overcome her mental blockage, she no longer felt she was incapable of dealing with the tasks I presented to her. She went on to confess that for the first 3 wk of class, the fear of actually trying new learning techniques prevented her from even attempting to solve the more complex tasks we were going thorough in lectures and discussion sessions. But once she actually sat down and allowed herself to give it a try, she realized could do it. I will add that after taking three tests, she achieved a solid 10 (equivalent to an A) and ended up being exempt from taking the final exam.

By the time we covered osmolarity and tonicity, communication, integration, homeostasis, and the nervous system, the students were familiar with most of the in-class activities that would be used for the remainder of the semester. That made teaching the physiology of the other organ systems an even more enjoyable experience. The novel in-class activities had a beneficial effect on class attendance as well. Although regular attendance was only 3% of the final grade, the 8 AM lectures were, on average, attended by 75 students (>80% of students who were taking the course). Another old habit that was
was 7 or lower would have to take the final exam. I also believed that students were previously unfamiliar with. I explained that the grading system was designed to allow room for making errors along the way. It meant that they would not be expected to score more than 90 points (out of 100) to achieve the highest grade. I also wanted them to know in advance where the grade cut offs are set, so they could monitor their own progress throughout semester. Bearing in mind that this was the first time I was using the new teaching and grading style, I was prepared to slightly adjust the scale at the end of the term if the tests turned out to be harder than expected. Fortunately, the students’ scores matched my expectations, and there was no need for making grading system more lenient.

Students were informed that there would be three tests throughout the semester followed by the final written exam. They were also informed that questions of various complexities would be included, from questions testing the knowledge of basic terminology and definitions (70%) to problem-solving questions (30%). All questions would be on previously studied material, but some of the questions would be designed in a way that students were previously unfamiliar with. I also made sure to mention that I was fully aware how getting used to a new teaching/learning style takes time, so showing continuous improvement on subsequent test scores would positively reflect on the final grade. For instance, even if a student scored poorly on the first test (below 40), he or she would still have a chance to achieve the highest grade as long as the average score on all three tests was above 70. This was meant to motivate students to keep giving their best even if they got off to a bad start. Students who after taking the three tests ended up achieving 8 (average score in the 50s), 9 (average score in the 60s), or 10 (average score in the 70s or higher) would be exempt from taking final exam. (At the University of Belgrade, 6 is the lowest passing grade and 10 is the highest grade.) The idea of exempting students with high test scores from taking the final exam was supposed to encourage them to give their best throughout the semester. Students whose grade after three tests was 7 or lower would have to take the final exam. I also informed them that if a student was not content with the grade after the final written exam, he or she would have an opportunity to take an oral exam as well.

The results of the tests confirmed that the majority of students were making expected progress. Despite the fact that the complexity of questions had increased, the students’ scores improved compared with the scores they used to have before changing the teaching and testing approach. Approximately 40% of students scored well enough on tests to be exempt from taking the final exam, and 70% of those students received the highest grade. Additional 50% of students passed the final written exam, which means that ~90% of students successfully finished the course by the end of the semester. This percentage is significantly higher than it used to be before the new way of teaching and testing was introduced, when only 30% of students would pass the exam at the end of the semester. Considering that students used to postpone taking the final exam for months after the lectures, these values further indicate that the transition from traditional to more interactive teaching/learning can significantly increase the efficiency of their studies.

Unfortunately, ~7% of the students failed to adapt to the new way of teaching, learning, and testing. What appears to be especially concerning is that some of these students failed not only to complete more complex tasks but consistently showed the lack of ability to define basic physiological terms. For instance, the term “portal system” was mentioned three times during the semester, when the physiology of the nervous, digestive, and renal systems was covered. About 4% of students failed to define portal system on each of the three tests and on the final exam as well. Getting through to those students remains one of the yet unachieved goals.

In hindsight, switching from more traditional to more interactive teaching proved to be rewarding experience for both my students and me. The interest in hearing about innovative teaching methods among colleagues is also evident, and so far I have been invited to present my experience to lecturers at the University of Belgrade Pharmacy School and Medical School. As a result of these presentations, several of my colleagues have already included some of the novel in-class activities in their lectures. I have realized that the role of the 21st century lecturer is not merely to transfer information but rather to facilitate the development of students’ ability to apply basic knowledge and gain higher levels of understanding. I understand that improving teaching skills is a lifelong process, and I look forward to the lessons that wait ahead.

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