The synaptic challenge

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Physiology has long been recognized as a subject that is difficult for students to master. Medical students, in particular, often fail to appreciate the relevance of learning and understanding normal body functions for their clinical studies (11). Over the past two decades, there has been increasing recognition in the physiology education literature of how innovative interventions can be used to address such issues. Not only has the importance of teaching and learning styles been highlighted (7, 8, 11), but the need for greater student participation in the process to promote more active learning has also been called for (3, 6, 9). The medical curriculum is vast, and students are expected to learn many subjects at the same time. As a result, medical students often experience stress and find it difficult to cope with the curriculum. In addition, some first-year students find theory and practical classes to be monotonous. One of the difficulties faced by faculty members is, therefore, to maintain student interest in preclinical subjects, including physiology. In recent times, the medical curriculum has placed greater emphasis on aspects such as peer teaching, including working with interdisciplinary teams, using evidence-based practice, integrating clinical medicine at the start of their courses, and using biomedical informatics.

At the Barão of Mauá University Center, the subjects of human physiology for undergraduate courses in medicine are taught with care to ensure the continual participation of students during theoretical and practical lessons. Students are advised on the care that they should demonstrate during practical lessons with experimental animals and enlightened about the importance of using videos and computerized models as a substitute for animal models when possible. Students are also consistently encouraged to develop creative methods of presenting the contents discussed during theory lessons.

The course on the physiology of the nervous system offered to undergraduate medical students occurs in the second semester of the school year. This course is part of the Nervous System study, which consists of neuroanatomy and neurophysiology and is taught with an integrated clinical vision by a neurologist. After the completion of the nervous system unit, students take the “Equipment and System I” course, in which they study embryology and cellular biology of the nervous system.

The complexity of the nervous system is well established. When the physiological content of these systems is presented to first-year medical undergraduate students, great care is taken with respect to various important educational aspects. First, the functional events are presented to students during the expository/discursive theory lessons in a concise, objective manner. Second, for the medical course, even though it is for first-year students, the subject is presented in depth because its concepts are important for future subjects in basic as well as clinical areas.

During the physiology theory lessons on transmission and synaptic interactions, the principal concepts addressed include characterizing chemical and electrical synapses, identifying the principal functional differences between the two types of synapses, discussing some functional events dependent on synaptic activity (principally neural and neuromuscular events), and correlating synaptic events with clinical and pharmacological situations.

Description of methodology. To encourage students to actively take part in their learning process, a challenge was launched. After a presentation of the principal concepts cited above during the 50-min theoretical class, students were divided into three groups \((n = 20)\). Division of the groups was done by the Course Coordinators at the beginning of the semester and applied to the practical classes. Groups were then divided into four subgroups with five students each to aid in the dynamics of the tasks during the proposed activity. All subgroups received the same advice independently of each other. Subgroups were advised to present the main functions and differences between chemical and electrical synapses in a way that was different from how it was presented during the theory lesson, which was considered to be somewhat of a challenge for such a practical lesson. None of the subgroups could use audiovisual aids or present their results as a lecture or debate. Another suggestion given to the subgroups was that they should work secretly, or, rather, that the other subgroups should not know what was being prepared. The main objective was to stimulate creativity and student enjoyment. All groups had 15 days to develop their ideas and prepare their presentation. Subgroups were also advised that their presentations should be up to 15 min long and that the presentation order would be determined by ballot.

Group presentations. The class was divided into three groups, as previously described; however, it was not possible for all groups to attend all presentations due to scheduling conflicts.

The creativity of the students in all groups was unquestionable. The subject material was presented in extremely varied ways. There were theatrical, musical, poetic, and fairytale presentations as well as questions and answers, memory games, and dancing. Two of the subgroups that presented songs were interesting in distinct ways: students in the first subgroup wrote lyrics based on the functional mechanisms of chemical synapses and used music chosen from the common tastes of the members of the subgroup, and the second subgroup composed the song and lyrics based on the function of the electric synapses. Of the various presentations, two stood out most: the theatrical staging and the fairytale.
The students that presented the fairytale prepared panels to illustrate the subject, focusing primarily on the synaptic mechanisms of chemical synapses. They described the pre- and postsynaptic cells and the synaptic gap as being pre- and postsynaptic kingdoms separated by a dark valley, the synaptic gap. Each of the kingdoms had a royal family, with the emphasis on the princes and princesses. The names of the princes and princesses were associated to the names of several neurotransmitters, both excitatory and inhibitory, as well as their specific receptors (for example, Princess “Acetyltcarina” and Princess “Acetylcarolina”). After the fairytale itinerary, it was shown that for the princes and princesses to be happy and the harmony between the two families of the two kingdoms to be restored, the princes should marry the princes. This analogy was used to explain that neurotransmitters must touch their specific receptors in the postsynaptic cell membrane to create a specific biological effect. Thus, when the biological effects were obtained, all the princes and princesses of the two pre- and postsynaptic kingdoms lived happily ever after.

The theatrical subgroup also had to explain functional chemical synapse events. According to the subgroups’ performance, a frog was to be the experimental model for explaining chemical synapses between two central nervous system neurons. A student, playing the role of the teacher responsible for the lesson, entered the scene and explained the aims and methodology that would be used in the class. Soon after, another student, playing the role of the laboratory technician, entered with another student dressed up as a frog. The laboratory technician explained the surgical proceedings that would be used to obtain the neurons for the lesson. At this moment, two more students dressed up as neurons entered the scene. There were also two white plastic bags in the front of the classroom. The student playing the teacher took over the scene again and began to explain the differences between excitatory and inhibitory neurons as well as the principal mechanisms related to the exocytosis of neurotransmitters. When he finished the presentation with the fusion of the vesicle membrane containing the neurotransmitter with the presynaptic membrane, two students appeared from inside the plastic bags, one dressed in black clothes and makeup, representing GABA. At this moment, the funeral march was played as background music. From inside the other plastic bag, another student, dressed as a cheerleader and wearing colorful clothes, stepped out and danced to a samba rhythm. She represented the excitatory neurotransmitter glutamate. Both students who represented the neurotransmitters chose two colleagues to assist with the scene, and they embraced them strongly while the student playing the teacher explained the interaction between the neurotransmitters and their specific receptors. After the biological effect occurs, the neurotransmitter is metabolized by specific enzymes; to represent these enzymes, two students entered dressed as death, carrying in their hands an enormous scythe. They ran after the students dressed as neurotransmitters to degrade them. The scene ended with the euthanization of the frog.

Shortly after the presentations, students were asked to answer a questionnaire. The questionnaire consisted of 16 objective and direct questions and was designed to analyze the impressions that students had during the performance of the proposed assignment. The questions had an overall purpose of outlining the kind of activity developed by the group, if the time available for preparing the task was adequate, if they had fun as they prepared the activity, if the work was worthwhile for the group, if all team members engaged in developing the activity, the main sources of information they used to build their presentation, if there was any interaction with other disciplines, if their expectation regarding the presentations somehow interfered in their learning process, and if this kind of educational activity was interesting for their learning experience, among other questions.

Final considerations. From all students who answered the questionnaire \((n = 60)\), 69.8% were women and 30.2% were men. As mentioned above, there is a wide range of different subjects presented in class. Regarding the time available for preparing the assignment (15 days), 90.16% of students answered that it was sufficient. Most students (96.72%) answered they had fun while preparing for the activity and that the enjoyment had been accompanied by learning (95.08%). A low percentage of participants (9.84%) stated they had relationship challenges among group members. Regarding group member’s participation in the proposed tasks, 93.44% of students said all team members had actively taken part in the assignment. Concerning the group formation, 90.16% of students stated they would rather be able to choose their peers as opposed to having the teacher assign the group participants. Most participants (93.44%) believed that working as a group was beneficial. The answers about students’ expectations regarding the presentations showed that 72.13% of people did not believe such expectations could threaten the learning process. The time available for the presentation (15 min) was considered enough by most respondents (96.72%). When asked if they preferred this kind of educational activity to a seminar, the majority (86.88%) responded they did prefer this type of activity and believed such activity to be positive for learning (98.36%). Finally, it was also consensual (98.36%) that this type of activity should be conducted more often throughout the school semester.

How should content be taught? The logical answer is that we cannot; therefore, we should not even attempt this Herculean task. Learning is not about committing a set of facts to memory but rather the ability to use resources to find, evaluate, and apply information. In fact, memorizing facts mainly teaches students how to take exams and primarily prepares students for more school. Furthermore, memorizing facts leaves little time for students to develop lifelong skills such as critical thinking, problem solving, communication, and interpersonal skills (5). Teachers can encourage these processes by carefully considering the type and organization of information as well as the instructional strategies they use (10, 13). There is a great difference between teaching and learning: there is too much teaching and not enough learning. Teaching is not telling students what we know but instead showing students how we learn (12). However, the curriculum is packed with so much content that to “cover the content,” teachers resort to telling students what they know, and students simply commit facts to memory. The packed curriculum leaves little time for students to acquire a deeper understanding of the subject or to develop lifelong skills such as critical thinking, problem solving, and communication (8). Therefore, we should strive to unpack the curriculum and reduce the amount of factual information stu-
students are expected to memorize. In addition, we should help students become active, independent learners and problem solvers.

When the activity in this study was first suggested, some of the students were not interested; some complained, stating that the allowed time was insufficient for developing the task; and others insinuated that it would be too much work. During the days that preceded the presentation, it was noteworthy how committed the class was to preparing for the activity. The results were discussed with students in the first lesson after the presentations, and students were asked their impressions of the activity, especially in terms of their assimilation of the content. All groups, without exception, demonstrated satisfaction with the results of the incorporation of the content, the dynamics used during the preparation of the presentation, the presentation itself, and the playful and challenging approach that was required to communicate the message.

Given the responses in the questionnaire as well as how the presentations evolved, it can be affirmed that this type of learning activity that puts the learner at the center of the teaching-learning process, turning the student into an active player in the process, is very useful for students and quite satisfactory from a didactic standpoint. The answers resulting from the questionnaire indicate that properly directed playful activities are a positive and complementary tool in the learning process. It is also noticeable that despite some difficulties working as a group, students still prefer this type of educational activity to seminars. It is important to mention that an additional goal of promoting a group activity is to offer students the opportunity to work as a team, which will be fundamental later in their professional lives. This suggests that despite some relationship difficulties among group members, each member’s individual involvement toward achieving a common goal overcame such difficulties. Also, based on the results of the presentations, the activity was considered satisfactory by the students, according to their questionnaire responses, and also by the instructor, judging by the contexts present by the students. The quality of the presentations was deemed satisfactory according to the instructor’s experience with this type of methodology. Furthermore, it created the opportunity for students to work on their interpersonal relationship skills. Thus, people who showed difficulties working as group members had the opportunity to experience it, and repeating this type of activity throughout the course may help them overcome such personal challenges. Despite a minority that stated that the expectations toward the presentation had negatively interfered in their quality of learning, the proposed activity had the acceptance of 86.88% of students. I believe it to be natural to have a number of students, in a group of 60 people, who prefer a different kind of educational assignment; nevertheless, it did not affect the quality of the teaching-learning process based on the students’ performance on the test about the synaptic interactions.

Diversification of the evaluation instruments used is supported by analyses of students learning under different protocols. The results obtained from this study show that a different evaluation tool was efficient to achieve the proposed objectives. Another point worth mentioning was the playful character encouraged by the task. Various studies have shown that when the work environment is happy, people interact with each other better, are more alert and critical, and are more productive. Learning is a bodily process. All knowledge has a physiological response. Being accompanied by feelings of pleasure is, in no way, a secondary aspect (1, 5). All students reported that the concepts of synaptic transmission were assimilated primarily during the planning stage, during which time all groups stated that they experienced great enjoyment. Few students sought out teachers from other disciplines related to the theme of the assignment. This response was below my expectations considering our school of medicine is an integrative course. I truly expected students to better interact with disciplines such as cellular biology, biochemistry, and molecular biology. However, the results presented by the groups, with no exception, did not affect the main goal of the assignment, which was to understand the physiology of synaptic interactions. Nevertheless, only varying the evaluation instruments is not enough. The evaluation has theoretical and practical components and has a methodological and pedagogical character that shapes students’ actions intentionally, directed toward the desired outcome (4).

New developments in the science of learning accentuate the importance of helping students to take control of their own learning. Understanding is considered important; thus, students should learn to identify when they understand and when they need more information (2). After the presentations, all groups reported that during their planning meetings, they were interested and dedicated, and they learned the proposed subjects. However, the activity was an efficient strategy for evaluating the understanding of the physiological mechanisms related to synaptic interactions.

The results outlined in this article relate to the physiology of the nervous system, particularly synaptic interactions. Nonetheless, these active methodologies, as well as the proposed questionnaire, can be applied to any organic system under study within physiology and also to other disciplines in the curriculum, emphasizing the importance of students as active members in the teaching-learning process.

DISCLOSURES

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

AUTHOR CONTRIBUTIONS

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