ILLUMINATIONS

The “Gut Game”: an active methodology to teach digestive physiology

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INTRODUCTION

During the teaching-learning process, students and teachers need to establish effective dialogues and exchange information and experiences to maximize students’ learning. However, many times, the number of important topics to cover in a course is so dense that teachers become lecturers who merely tell students what they know while students passively memorize concepts, instead of understanding and integrating them (7). The traditional lecture-based class is indeed effective to present large amounts of information, but it does not encourage peer-to-peer discussion and the development of problem-solving skills that are so much needed for future professionals (9). Moreover, traditional lecture generally does not promote deep and long-lasting learning (4, 5, 10).

A way to promote effective learning and to allow students to become part of their learning process is using active methodologies, such as flipped classroom, team-based learning (4), peer instruction, collaborative testing, and construction of educational models and experimental classes (7). We highlight the application of active methodologies, such as educational games, in the classroom as an option to overcome many of the disadvantages of lecture-based classes, as playful activities increase students’ motivation and stimulate the application and critical evaluation of theoretical concepts (1, 2, 9). Such activities have already been successfully used in several health sciences careers (8) and address very important but neglected goals in the teaching-learning process, namely students’ joy and enthusiasm (7). Educational games can be used at different steps of the learning process as motivators to engage in the subject, facilitators to learn complex or abstract concepts, and/or tools to review and retain previously taught content (6, 8).

Considering the potential of educational games for better learning, we developed a board game to cover key topics of gastrointestinal physiology in a quiz-like approach, while visually relating the progress in the game to the morphological organization of the system. This article aims to describe the “Gut Game” to educators to allow the reproduction of this interactive tool in their teaching environments and to present the perceptions of health sciences students about the game as a supplement to the traditional lecture-based class.

MATERIALS AND METHODS

Description of the Gut Game. The materials used in the game titled “Gut Game” consisted of a board (Fig. 1), a rules sheet, question (Fig. 2A) and action (Fig. 2B) cards, and three distinct square pieces to represent teams. All teaching materials are available online (All supplemental material is available at https://doi.org/10.6084/m9.figshare.12250043).

The board was constructed with a 42 cm × 59.4 cm black foam sheet as a background and several glued pieces shaped in accordance with the digestive system organs. There were three entrance organs: mouth/esophagus, liver, and pancreas. The reason the game has three different entrances is to include the accessory digestive organs into the game pathway and also allow the inclusion of questions about these. In accordance, these entrances were all represented with a number 1. Consequently, the respective following steps were stomach, gallbladder, and pancreatic duct, all of them represented with a number 2. All paths merged into the small intestine, which represented steps 3–5 and proceeded to the large intestine in steps 6–8, which was the finish line. The rules of the game were printed on a white sheet (21 cm × 29.7 cm) and laminated.

Six sets of question and action cards were made, adding up to 80 cards. Cards were printed in black on 150 g/m² white sheets (5 cm × 7 cm) and laminated to extend durability. One side of the card had printed questions or actions, while the other had a picture and the name of the respective organ. Question cards contained multiple-answer questions about each region of the system (mouth/esophagus, stomach, liver/gallbladder, pancreas, small intestine, and large intestine) (Fig. 2A). The questions used during the game were based on the digestive system topics previously presented through lectures and discussed in the classroom using physiology textbooks. To address different levels of difficulty and complexity, some questions addressed concepts directly, whereas others applied the content to everyday situations. Action cards (Fig. 2B) presented information and/or curiosities that could benefit (e.g., direct advance to the next organ) or penalize players (e.g., one round without playing). These action cards often associated healthy and unhealthy behaviors with corresponding consequences (e.g., players would be penalized when drawing the self-medication card). The six sets of question and action cards were separated into different boxes according to the organs they represented. These boxes were made with recycled tea boxes and were wrapped with foam sheets of the same color as the representative...
Proceeded until all players had reached the finish line (large intestine – rectum) and allocates it in the three equal-sized teams. Each team represents one piece (biomolecules, bile acids, or pancreatic enzymes) and allows the physiology professor to supervise the application of the game.

Classrooms are divided into groups of 10. Multiple boards can be used if the class is bigger, allowing the division of the class into smaller groups.

The board of this game in a class with a maximum of 30 students who observes mistakes and misconceptions. The game was played after three 3-h regular lecture-based classes covering undergraduate level topics in digestive physiology, such as morphology, secretions, motility, digestion, and absorption. The aim of playing the game after the traditional lecture classes was to summarize the concepts and clarify points of confusion in a complementary way. These classes were taught by the same teacher in both courses at different times. The students were randomly divided into three groups and started the match in one of the three gameboards.

**Game instructions.** First, the physiology professor (game moderator) must evaluate the class size and characteristics and decide the respective entrance organ (mouth/oesophagus, liver or pancreas) for the start of the match. Then, actions and question cards are mixed and go into the same box for each organ.

After that, a moderator picks a card according to the organ the team is in and reads it out loud. If the drawn card is an action card, the moderator reads it and reports to the team which effect it has (e.g., move one step forward or back, skip a turn). When the drawn card is a question card, each team has 2 min to discuss the question with their teammates before giving and explaining their answers. Each team takes one turn before the moderator moves to the next team. Whenever the teams answer correctly, they can move their piece one step forward. Otherwise, they must remain in the same place. Each turn, regardless of correct or wrong answers, the moderator proposes further discussion of the topics to assess the understanding level of students, translate theory into clinical perspectives, and elucidate mistakes and misconceptions.

The first group to reach the rectum (step 8) wins, but the match does not end until all players arrive at the finish line. Once all groups complete the game, the moderator finishes the activity with a general discussion, summarizing concepts and discussing the main issues that have arisen during the activity.

**Procedures.** In the second semester of 2018, undergraduate students from the fourth semester of Pharmacy (n = 24) and second semester of Analytical Toxicology (n = 15) of the Federal University of Health Sciences of Porto Alegre (UFCSPA) attending Human Physiology classes were invited to participate in the study. All students agreed to participate and were then asked to sign an informed consent form in accordance with ethical aspects previously approved by the Ethics Committee of UFCSPA (CAAE 53558718800005345).

The game was played after three 3-h regular lecture-based classes covering undergraduate level topics in digestive physiology, such as morphology, secretions, motility, digestion, and absorption. The aim of playing the game after the traditional lecture classes was to summarize the concepts and clarify points of confusion in a complementary way. These classes were taught by the same teacher in both courses at different times. The students were randomly divided into three groups and started the match in one of the three gameboards.

**Students’ perception assessment.** In the class following the game, students were asked to answer a questionnaire about their perceptions of the game. Students were ensured that their participation in the perception assessment was anonymous, voluntary, and would not incur any detriment to them. The questionnaires were collected in a box in the classroom to minimize students’ discomfort feelings and encourage honest answers.

**RESULTS**

The students expressed positive feelings about the game and active methodologies in general, and some students were critical about the traditional lecture-based class and praised the use of alternative methodologies. Constructively, three students stated that they would rather have the questions projected onto the board than hear a moderator read them. Summary feedback from students can be seen in Table 1.

**DISCUSSION**

The results of the present study demonstrate the value of using the “Gut Game” as an additional tool in combination with the theoretical lecture-based classes for the study of the digestive system. It is difficult to quantitatively assess the
outcomes of the application of different methodologies because grades per se do not always reflect effective learning. However, studies (11, 12) demonstrated that emotions, such as positive affect, have major impacts on different cognitive processes (e.g., information processing, communication processing, and motivation) that are important for learning. Active methodologies are approaches to induce positive emotions and hence improve learning and contribute to academic achievement. In our study, positive feedback from the questionnaires confirmed students’ satisfaction and enthusiasm with the Gut Game. These positive results were also found in many other studies that applied different active methodologies (e.g., gastrointestinal physiology puzzle, cardiac cycle puzzle, pharmacotherapy topics card game, and biochemistry online quizzes) as a way of teaching or as an additional tool in the learning process (1–3, 8–10).

Students showed curiosity and engagement in their learning process, giving even more value to the application of the Gut Game as an additional teaching tool of the digestive system. The game allowed students to discuss the content, visualize the subject in daily situations, and solve problems in a playful and relaxed activity. The game also promoted the development of different abilities as students highlighted with comments such as, “It made me pay more attention and detect mistakes” and “I think classes should be more than slide projections.”

Table 1. Some commentaries written by the students about their perception of the “Gut Game”

- “The game helped me to solve doubts and remember contents.”
- “It is nice to have activities other than theoretical classes.”
- “It was great for the review of the subject in an interactive way.”
- “It was very interesting and makes the content more inserted in everyday life.”
- “I found it quite fun and the questions were easy to answer orally.”
- “The activity helped me to understand the content in a relaxed way.”
- “It was very educational.”
- “Questions could be projected on the board to avoid confusion and decrease activity time.”
- “I found it to be a very educational and stimulating practice!”
- “The activity was very clear and interactive.”
- “Excellent questions for learning and reviewing in a very relaxed way.”
- “It is easier to retain contents in this way.”
- “I think classes should be more than slide projections.”
feel it helped me to relate theory and practice.” This active learning method supplements teacher-centric lectures and stimulates peer discussion, which helps students to actively build their knowledge and improve their understanding by explaining concepts in a relatable way (3, 8). The Gut Game also allowed the moderator to identify and address the points of greatest difficulty. In this way, the professor was able to modulate the questions and discussions to address points of confusion. In addition, the use of this active methodology can help students to clarify and retain concepts that were not completely understood, as described in sentences such as, “The game helped me to solve doubts and remember contents.”

As a limitation, we would like to mention that, although we had a positive preliminary perception from students, our study lacks a deeper evaluation of the impact of the application of the game, since it would only be possible with a larger number of students and preferentially in different courses and institutions. Whereas this article focuses on the presentation of the game to promptly share it with educators, it is in our prospects to further evaluate the outcomes of this methodology. Nonetheless, we highlight that the use of this game as a complementary teaching methodology is possible in several educational scenarios, since it does not require elaborate logistics (e.g., high technology, availability of computers, internet access), can be easily transported, can be used several times, and had a low cost for construction (~15 USD), which is crucial for regions that face economic barriers, such as developing countries.

In conclusion, with the advancement of technology, a vast amount of information circulates rapidly, taking from the teachers the role of transmitters of information and transforming them into facilitators of learning. Thus the task of teachers is to help students build their knowledge. In this way, the application of the Gut Game, in combination with traditional classes, could be useful for students to gain a better understanding of digestive physiology.

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DISCLOSURES
No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS
R.P.d.C., V.P.V., N.M.M., L.H.M., M.P., and L.L.P.G. conceived and designed research; R.P.d.C., V.P.V., N.M.M., F.K.M., L.H.M., M.P., and L.L.P.G. performed experiments; R.P.d.C., V.P.V., N.M.M., F.K.M., L.H.M., M.P., and L.L.P.G. analyzed data; R.P.d.C., V.P.V., N.M.M., F.K.M., L.H.M., M.P., and L.L.P.G. interpreted results of experiments; R.P.d.C., V.P.V., N.M.M., F.K.M., L.H.M., M.P., and L.L.P.G. prepared figures; R.P.d.C., V.P.V., N.M.M., F.K.M., L.H.M., M.P., and L.L.P.G. edited and revised manuscript; F.K.M. and L.L.P.G. approved final version of manuscript.

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