



THE USE OF EDUCATIONAL GAMES TO EXPLAIN COMPLEX CONCEPTS RELATED TO HUMAN PHYSIOLOGY

USO DE JOGOS EDUCACIONAIS PARA EXPLICAR CONCEITOS COMPLEXOS RELACIONADOS À FISIOLOGIA HUMANA

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Abstract

Different strategies have been proposed to improve the teaching-learning process in different fields. One option to optimize learning, increasing students' involvement and providing group discussions, is the use of educational games (EG). In this study, we evaluated the students' perceptions about the use of EG as a tool to facilitate the understanding of key concepts related to Human Physiology (HP). Educational games addressing the bioelectric membrane potential and the cardiac cycle were used to complement theoretical classes. After the games' use, the students were invited to evaluate their use. We verified that students consider that EG are interesting tools to improve HP teaching and that they contribute to the understanding of the content worked in the classroom.

Keywords: Teaching-learning process; Active teaching methods; Educational games.

Resumo

Diferentes estratégias têm sido propostas para melhorar o processo de ensino-aprendizagem em diferentes campos. Uma opção para otimizar o aprendizado, aumentando o envolvimento dos alunos e proporcionando discussões em grupo, é o uso de jogos educacionais (JE). Neste estudo, nós avaliamos as percepções dos alunos sobre o uso do JE como uma ferramenta para facilitar o entendimento de conceitos-chave relacionados à Fisiologia Humana (FH). Jogos abordando os potenciais bioelétricos da membrana celular e o ciclo cardíaco foram utilizados para complementar as aulas teóricas de Fisiologia. Após o uso dos jogos, os alunos foram convidados a avaliá-los. Verificamos que os alunos consideram o JE ferramentas interessantes para melhorar o ensino da FH e que contribuem para a compreensão do conteúdo trabalhado em sala de aula.

Palavras-chave: Processo ensino-aprendizagem; Metodologias ativas; Jogos educacionais.

1 Introduction

Despite the biological sciences are widely teaching by traditional methods, active teaching methods have been increasingly used. This type of teaching method aim to be a model of constructivist teaching-learning process, encouraging the peer interaction, increasing the interest in the content and making students an active part in the knowledge construction [1]. However, the change from a teaching-centered model to student-centered model is still a challenge. Teachers rarely have a specific training in active teaching methods, which could promote their engagement in create new strategies to increase de the students' interest and motivation to be more autonomous [2, 3].

In the last years, different strategies were proposed aiming the students' interaction and participation in the knowledge construction. Among these methodologies are the problem-based learning (PBL), team-based learning (TBL), among others [3, 4]. But not always is possible to change from traditional curriculum to an all-active course, as required in PBL, for example, since it involves curricular and institutional modifications. An alternative to optimizing learning is to promote, together traditional teaching, the use of active teaching methodologies [5, 6]. One way to do it is proposing the use of educational games (EG) to promote the content better understanding.

In physiological sciences some key concepts are import to understand more complex topics. For example, understanding the ionic differences between the two sides of the biological cell membrane (inside and outside) is fundamental for understanding the action potential. In turn, the action potential is a key concept to understanding the synaptic communication [7, 8]. But not only contents related to the nervous system can be teaching or reinforced by EG. Marcondes, Moura (5), described a EG addressing the cardiac cycle [5]. Some of the physiological concepts are frequently abstract and so the students' visualization of practical application is impaired, what prejudice their learning [7, 9, 10]. The use of games generally involves team activities, fun, and other factors that promote a better learning [7, 11].

Here we used an EG to facilitate the understanding of key contents of physiology. We demonstrated that the students consider that the games are interesting tools to use in Human Physiology teaching and that these tools contribute to promote a better understanding of the content taught in theoretical classes.

2 Materials and Methods

We propose the use of EG in a Human Physiology course, in which the principles of the different human organic systems functioning are studied. In all, sixty-three undergraduate students (21.7 ± 4.4 y.o.; 81% female) participated in the activities, being 34 from Nursing and 29 from Physiotherapy undergraduate of Federal University of Pampa (Uruguiana/RS/Brazil). The EG use was implemented in the first semester of 2017 by the Human Physiology professor and two tutors (veteran students who were previously approved in the Human Physiology course). The Institutional Education Committee from Federal University of Pampa approved the proposal (Institutional Review Board n. 10.005.18).

In the context of the present work, the two EG were used after a theoretical class, in order to complement and contribute to the retention of the new concepts. The undergraduate students were divided in groups of 5 to 8 students, according their own organization. At the end of the game, questions regarding the content were proposed to group discussion. We applied games related to two important key physiological concepts: (i) bioelectrical potential of cell membrane, and, (ii) cardiac cycle.

2.1 The membrane potential puzzle

To elucidate the concepts related to the resting and the action membrane potential of an excitable cell, we proposed the use of the membrane potential puzzle, previously created and validated by our group [6]. For this game we used a board and pieces; in the board there are empty spaces to be filled with the game pieces. Briefly, starting the game and following the instructions, the students filled the columns considering: (i) the effects of the electric stimulus on the membrane state and the changes that occur when the threshold is reached; (ii) the characteristics of resting potential and the different phases of action potential; and, (iii) the channels involved, their conformation changes, and the consequent increase/decrease of the membrane permeability to Na^+ and K^+ . The professor and tutors then proposed questions to the groups, to promote further discussion. Once all of groups had completed their puzzles, the professor finalized the activity, coordinating a discussion about the most important events of the resting and action potential.

2.2 The cardiac cycle puzzle

To elucidate the concepts related to the cardiac cycle, we proposed the use of

cardiac cycle puzzle described by Marcondes et al. [7]. Briefly, students should complete a puzzle developed on the basis of figures that show the path of arterial and venous blood in the heart, as well as the contraction and relaxation of the atria and ventricles at each stage of the cycle. After identify these characteristics they should named each cardiac cycle phase. After, the professor and tutors proposed questions to the groups, to promote further discussion.

2.3 Evaluation of the use of the educational games in Human Physiology teaching

In order to verify the students' perception about the use of EG in Human Physiology teaching, the students were invited to answer an anonymous questionnaire, evaluating the games' contribution to their learning. All questions were multiple choice ones. Some issues were assessed by a Likert Scale, which is based on a statement for which the respondents should mark their degree of agreement. The questions are illustrated in table 1.

Table 1. Questions used to evaluate the students' perception about the use of EG in the Human Physiology teaching-learning process.

Question	Answer options
How do you evaluate your performance in this course?	<input type="checkbox"/> Great <input type="checkbox"/> Good <input type="checkbox"/> Regular <input type="checkbox"/> Poor
Do you consider that the use of educational games collaborated to your performance in Human Physiology course?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Do you believe that the use of educational games contributed to your performance in others courses, besides Physiology? If yes, which ones? _____	<input type="checkbox"/> Yes <input type="checkbox"/> No
Would you recommend to other professors the use of educational games in their classrooms?	<input type="checkbox"/> Yes <input type="checkbox"/> No
The use of educational games contributed to my understanding of the Physiology content.	<input type="checkbox"/> I totally agree with this statement. <input type="checkbox"/> I partially agree with this statement.

- Neither agree nor disagree.
- I partially disagree with this statement.
- I totally disagree with this statement.

The educational games are interesting tools to use in Human Physiology teaching.

- I totally agree with this statement.
- I partially agree with this statement.
- Neither agree nor disagree.
- I partially disagree with this statement.
- I totally disagree with this statement.

The questions proposed to discussion in the end of the games contributed to increase my learning.

- I totally agree with this statement.
- I partially agree with this statement.
- Neither agree nor disagree.
- I partially disagree with this statement.
- I totally disagree with this statement.

In my opinion, the use of educational games to teach any course is... (Check how many alternatives you want)

- Important.
- Essential.
- Funny.
- Unnecessary.

In my opinion, using educational games in Human Physiology classes... (Mark as many alternatives as you want)

- Is interesting.
- Allows a better understanding of the contents taught in class.
- Is funny.
- Instigates the students' curiosity and the desire to understand more about physiology.
- Is boring.

Additionally, at the end of the questionnaire the students should attribute a grade from 0 to 10 to the activity (with 0 being the lowest and 10 being the highest grade).

Afterwards, the questionnaires were collected and the data analyzed. The results are presented according to the percentage of choice of each alternative.

3 Results

When asked about their own performance in Human Physiology course, 6.3% (n = 4) of the students evaluated it as great; 36.5% (n = 23) as good; 52.4% (n = 33) as regular; and 4.8% (n = 3) as poor [Fig. 1A]. All the students (n = 63) considered that the use of EG contributed positively to their performance in the Physiology Human course [Fig. 1B]. In addition, 77.8% (n = 49) believed that the EG using contributed to their performance in other courses beyond Physiology [Fig. 1C], citing Anatomy (36.5%; n = 23); Histology (12.7%; n = 8); Biomechanics (7.9%; n = 5) and others. Considering this, 100% of the students affirmed that they would recommend the use of EG to other professors [Fig. 1D].

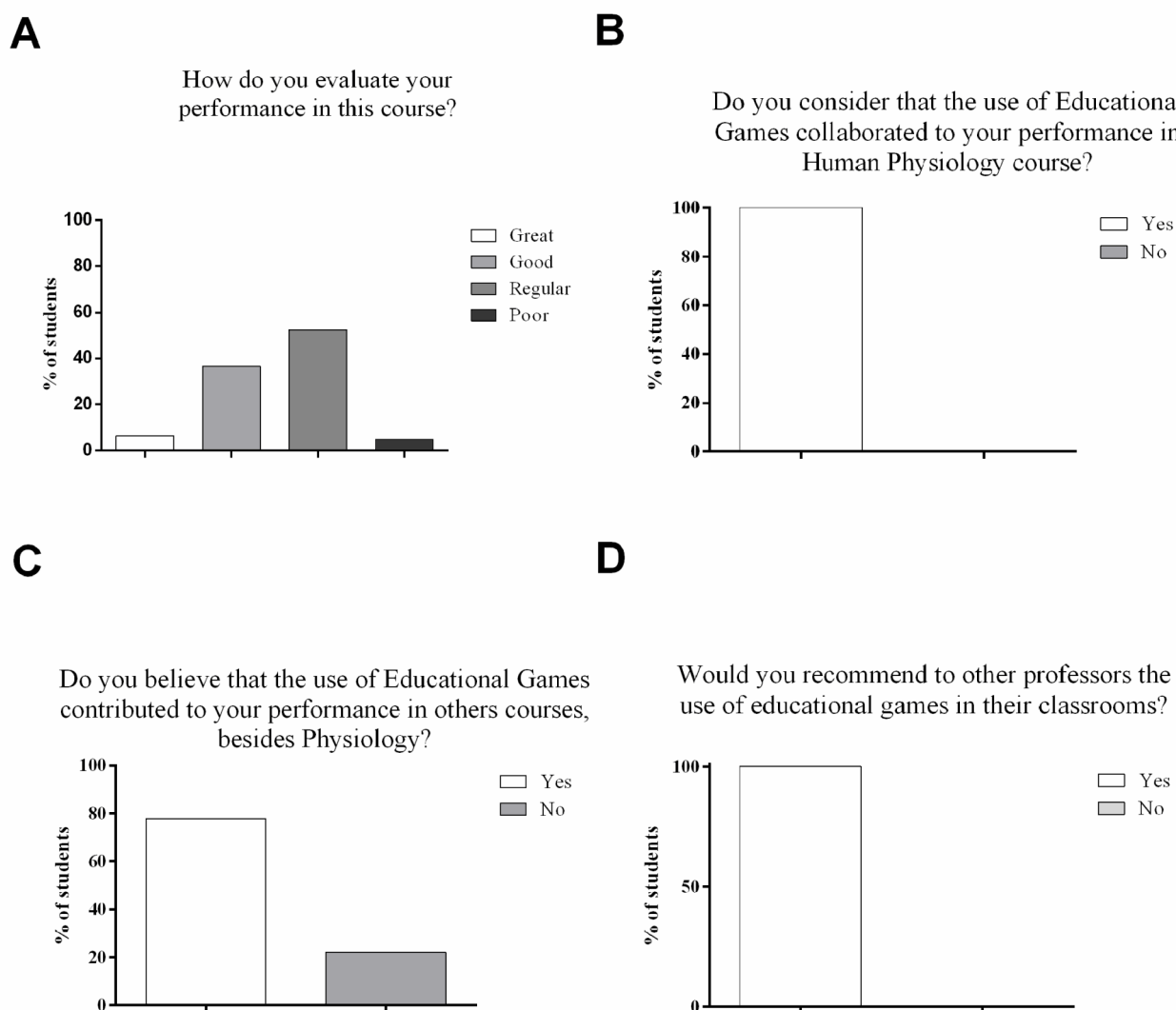


Figure 1. Students' perception about the impact of educational game using in Human Physiology teaching considering their performance in this and in other courses (n = 63).

The following three questions are affirmations for which students should state the degree of agreement. Most of students (88.9%; n = 56) totally agreed that the use of EG contributed to their understanding of the content taught in theoretical class [Fig. 2A] and that the use of the games is an interesting tool for Physiology teaching (96.8%; n = 61) [Fig. 2B]. The majority (95.2%; n = 60) totally agreed that the questions proposed for discussions in the end of the games contributed to increase their learning [Fig. 2C].

Additionally, 95.2% (n = 60) of the students considered the use of EG important to their understanding of the contents; 71.4% (n = 45) considered the use of this tool as funny, because it provided an informal moment of collective discussion; and 46% (n = 29) considered its use essential [Fig. 2D]. When instigated to opine about the use of the method in Human Physiology classes, 69.8% (n = 44) reported that its use allowed a better understanding of the contents; 55.6% (n = 35) that the use of EG is interesting; 52.4% (n = 33) that is funny; and 47.6% (n = 30) reported that the use of EG instigated their curiosity and desire to understand more about Human Physiology [Fig. 2E]. Anyone considered boring.

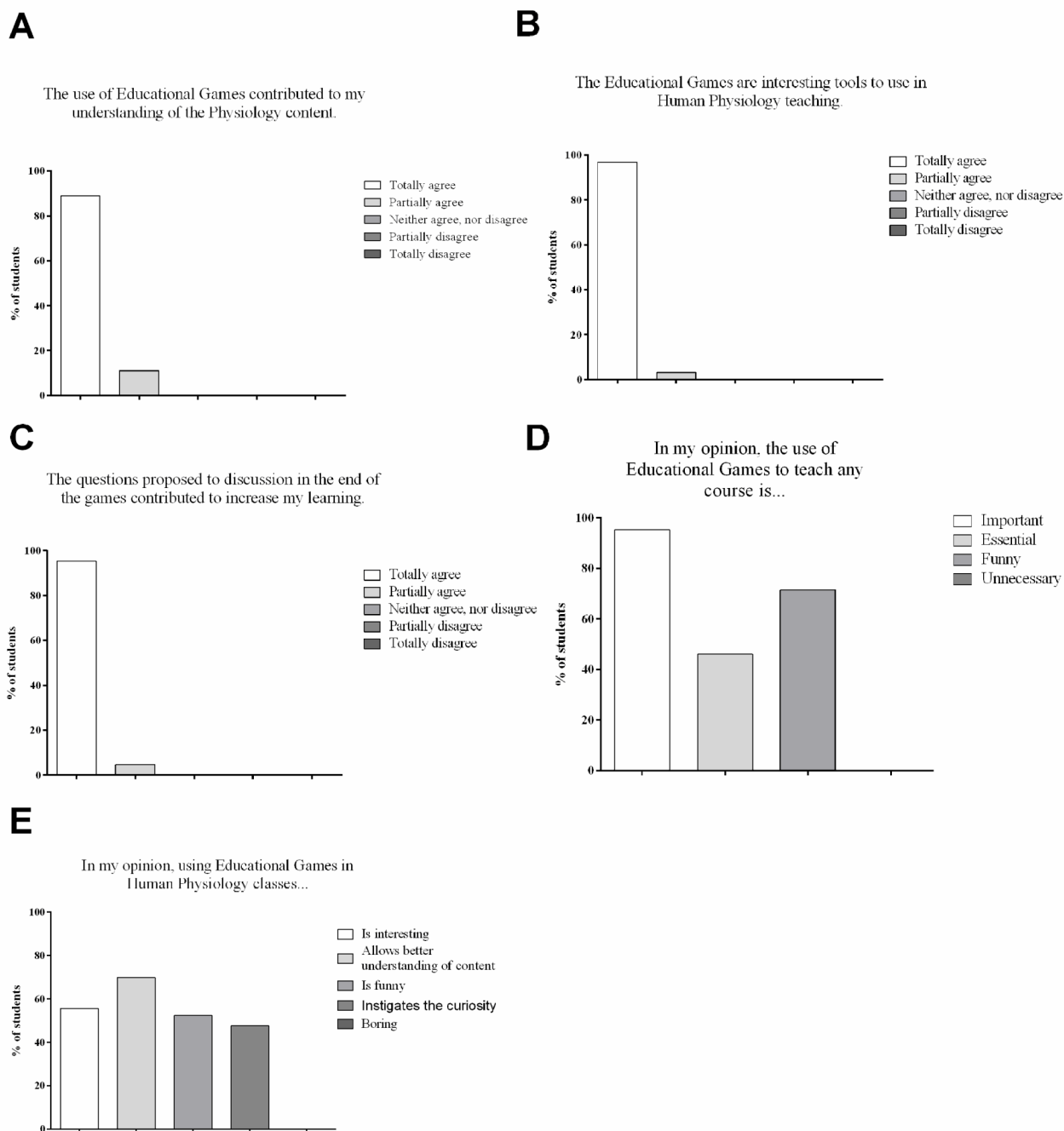


Figure 2. Students' perception about the impact of educational game using in Human Physiology teaching considering its contribution to the understanding and learning of Human Physiology.

4 Discussion

Our results revealed that the use of EG as a Human Physiology teaching method contributes to improve the perceived performance of undergraduate students not only in this specific course, but also in other courses, such as anatomy, histology and

biomechanics. This result is consistent with the data of Galey (12) which predicted that the use of active methodologies promotes an interdisciplinary learning process. In this sense, many studies have demonstrated the benefits of using an interdisciplinary approach [13, 14], since the topics addressed in theoretical and practical classes are correlated. For example, while the biochemistry aims to study the biological membrane constituents (phospholipids, cholesterol and proteins), the physiology aims to address the different types of transport through this organelle and how the different membrane constituents' characteristics and proprieties interfere in this movement. In the same hand, histology aims to study the differences in cellular characteristics between tissues. Thus, it is clear that the teaching-learning process can be facilitated when using methodologies that integrate the different contents.

About the specific content addressed in each game, students agree that the games contribute to their learning of the content previously taught in theoretical classes (membrane bioelectrical potentials and cardiac cycle), besides being an interesting tool for use in Physiology teaching. The use of games in teaching has been demonstrated as an effective methodology both in factors that interfere in learning, such as motivation and interest [6, 15], as in learning itself [16]. It is important to note that complex concept, such as membrane bioelectrical potentials and the cardiac cycle, can be favored when applying methods that help to better understand the content [5, 11, 16, 17].

Although the role of the active methodology is still controversial, a large number of works have been demonstrated its positive impact on the teaching-learning process [1, 11, 18]. Melo Prado, Hannois Falbo (1) verified that the use of an active methodology is more effective in the knowledge acquisition, in the self-directed learning and in the student's opinion on the method than the traditional methodology in the context of ward round [1]. However, in many cases, it is not always possible to take a full course of active methodologies. In these cases, a possible alternative is to identify complex contents and apply different methodologies to facilitate student understanding in this specific contents [5, 6, 18].

Here, we propose the use of EG associated with traditional teaching as a way of explaining complex concepts. The teaching of content through games was able to contribute to the understanding of the contents previously discussed, besides being an interesting, funny and essential tool in the teaching of human physiology [11]. This is consistent with other studies that have demonstrated that group work is an important pedagogical tool and used in conjunction with games can maximize the students' learning

process [3].

We admitted that the present work had some limitations. One of them is the fact that we didn't have the chance to verify the students' academic performance after the use of the games – we only asked for their perception about it. Although the self-perception of motivation and interest in the content studied is important for learning, other studies have already demonstrated that the use of educational games can really impact the performance in the course. For example, Cardozo, Miranda (19) demonstrated that an educational game made students had lower number of errors and higher scores in exercises addressing the content when compared to the control group.

5 Conclusion

Our results allow us to affirm that the use of educational games in the teaching of Human Physiology allowed a better understanding of the contents. Educational games are seen as a fun, and often, as essential to promote the contents' better learning. In addition, for many students, the use of this tool assisted them in other courses.

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