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Effect of an educational game on student´s learning: different approaches for evaluation

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Abstract

The aim of this work was to evaluate the effect of an educational game about cardiac cycle, used as replacing or complementing activity for traditional teaching methods, on the learning of physiology students by using different evaluation approaches. The comparisons were made between the grades obtained in pre- and post-tests applied before and after the use of the game, and between the number of correct answers of groups that performed an activity with the puzzle or had a lecture or reading, in the same or different careers. In all these approaches, the students who performed the activity with the educational game had a better performance in the assessment tests in comparison with those who did not use the educational game. This effect was observed when the puzzle replaced a lecture or reading activity and also when it was used as a complementary activity after a previous lecture. In conclusion, the results of the present study showed that one educational game used as active teaching-learning method can improve the students' learning, and that its effect on student´s learning can be evaluated by different approaches by the teacher during the classroom routine.

Keywords: *active teaching-learning methods; educational game; evaluation; physiology; professional education.*

1. Introduction

In addition to technical knowledge, undergraduate courses should provide the development of skills to educate health professionals with a generalist, humanist, critical, and reflective profile, to act in all levels of healthcare based on scientific and intellectual precision (Rodenbaugh *et al.*, 2012). For this, students should be engaged and motivated in order to learn; teaching methods play an important role in this process.

It has been reported that active teaching-learning methodologies may increase the engagement and learning of students (Prince, 2004; Mitre *et al.*, 2008). These methodologies include the educational game: a competitive activity, a simulation or a non-competitive exercise with rules and procedures (Allery, 2004). Educational games can be a complementary activity to lectures or replace them. While some authors reported that educational games improve students' learning (Rao and Dicarlo, 2001; Barclay *et al.*, 2011; Choudhury *et al.*, 2015; Luchi et al., 2017), others did not (McCarroll *et al.*, 2009; Diehl *et al.*, 2015).

Students from health sciences careers need to learn the morphofunctional characteristics of the circulatory system. In the future, this learning will be necessary for them to orient the population, diagnose and treat cardiovascular diseases adequately (Abreu *et al.*, 2014). However, it is not easy to students to relate the morphological characteristics of the heart with its continuous and efficient functioning. This theme is called cardiac cycle and is studied in physiology course.

Considering the teaching of the cardiac cycle, it has been developed by our group a cardiac cycle puzzle (Marcondes *et al.*, 2015). Students of Biology, Medicine, Pharmacy and Nursing careers evaluated the cardiac cycle puzzle as useful for their learning (Marcondes *et al.*, 2015). Cardozo *et al.* (2016) observed that Dental students who made an activity with this puzzle had fewer errors and higher grades in a test applied immediately after the activity, in comparison with students who had read about the same topic.

The aim of this work was to evaluate the effect of the cardiac cycle puzzle used as replacing or complementing activity for traditional teaching methods, on the learning of students by using different approaches during regular classroom routine.

2. Methods

This study involves 4 different approaches to evaluate the effect of the educational game on students' learning:

Study 1: Comparison of the performance of the same students from the same career, course and semester, in a test applied before and after the use of the cardiac cycle puzzle (pre- and post-test approach);

Study 2: Evaluation of the performance in a test by comparing students in the same career, course and semester, divided into 2 groups: control group who had a lecture about cardiac cycle, and game group who performed the activity with the puzzle.

Study 3: Evaluation of the performance in a test by comparing students, in the same career, course and semester, divided into 2 groups: control group who had studied the cardiac cycle by reading, and game group who performed the activity with the puzzle.

Study 4: Comparison of the performance in a test of students from the same course and semester, mixed from different careers, equally divided into 2 groups: control group, who had a lecture about cardiac cycle, and game group, who had the same lecture plus the activity with the puzzle.

The tests used for learning assessment were composed by open or multiple choice questions about basic concepts of the cardiac cycle and the application of these concepts in situations of cardiac alterations or pathologies. The same questions were used for control and game groups in the same study, but not among the different studies.

Participated of this work students aged 18 to 25 years, from 3 institutions and 4 careers: 132 from Dentistry, 50 from Medicine, 36 from Nursery and 48 from Physiotherapy courses. The students were taking Physiology courses. In all the sudies, the comparisons were made by comparing students from the same institution, who had used the puzzle and those who not. In order to avoid any comparison among the careers and institutions, the identification of which students who participated in each study will not be described.

2.1. Activity with cardiac cycle puzzle

Briefly, in groups of 4-5 participants, students received the puzzle containing pictures of the cardiac cycle phases, one table and chips for filling the table as described previously (see Marcondes *et al.*, 2015). They were asked to identify the correct sequence of the figures of the phases of the cardiac cycle. After that, the students were instructed to fill in the table with chips that indicated the state of the atria and ventricles (contracted or relaxed) and the cardiac valves (open or closed), the name of each phase of the cardiac cycle and the moment when cardiac sounds occurred. Graduate students or Physiology professors were monitors of the groups, showing whenever there was an inaccuracy, and asking questions, so that students could find out the mistake by themselves and correct it. The game represent a challenge because it is necessary to relate previous knowledge in order to place the chips in a correct way and answer questions about the relation of heart morphology and

physiology, as described previously (Cardozo *et al.*, 2016). During the activity, the students should have used the game to describe to the monitors the sequence of cardiac cycle events and explain how the morphological and physiological characteristics of the cardiac muscle contribute to the cardiac cycle (Cardozo *et al.*, 2016).

2.2. Study 1: pre- and post- test applied to the same students

Sixty-five students attended a theoretical class (50 min) on the basis of cardiac physiology. They were instructed to read about the cardiac cycle in a Physiology textbook for evaluation to be done in the next class. At the beginning of the second class, one pre-test composed of multiple-choice questions was applied. After this test, the activity with the cardiac cycle puzzle was performed. At the beginning of the third class, the test was repeated. The grades obtained in the pre- and post-test were compared by paired Student t test ($p < 0.05$).

2.3. Study 2: comparison between lecture and puzzle activity, in the same course and semester

Sixty-nine students were divided in two groups: control and game group. In class 1, both groups had a lecture about the characteristics of the cardiac cells together. All the students were oriented to study these topics and also the cardiac cycle in a didactic book. In class 2, the control group had a lecture about the cardiac cycle with a detailed description of the phases of the cardiac cycle, and the relation between the cardiac muscle characteristics and the events of cardiac cycle. The game group carried out the activity with the cardiac cycle puzzle. In class 3, all the students did a test with open and multiple-choice questions. The grades obtained in the test by students from control and game groups were compared by unpaired Student t test ($p < 0.05$).

2.4. Study 3: comparison between reading and puzzle activity, in the same course and semester

Fifty students were divided in two groups: control and game group. The same procedures described for study 2 were followed in class 1. In class 2, the game group performed the activity with the puzzle and the control group was instructed to study the discipline contents in textbooks and scientific articles during the same period. In class 3, all the students did a test with open and multiple-choice questions. The number of correct answers of control and game groups was compared by unpaired Student t test ($p < 0.05$).

2.5. Study 4: comparison between lecture and lecture plus puzzle activity, in a mixed class

Eight-four students from mixed classes with students from two undergraduate careers were divided in two groups: control and game group. Both groups had a lecture about the cardiac cycle with a detailed description of the phases of the cardiac cycle, and the relation between the cardiac muscle characteristics and the events of cardiac cycle. Additionally, the game group carried out the activity with the cardiac cycle puzzle. After all, all the students did a test with multiple-choice questions. The number of correct answers of control and game groups were compared by unpaired Student t test ($p < 0.05$).

3. Results

3.1. Study 1 – pre- and post- test: The grade obtained in the post-test was significantly higher than in the pre-test (Figure 1A; $(t_{(64)} = 4.445; p = 0.0003)$.

3.2. Study 2 – comparison between lecture and puzzle, in the same class: The group that performed the test after the game activity had higher scores, in comparison with the control group that attended a lecture before doing the test (Figure 1B; $t_{(67)} = 3.654; p = 0.0005$).

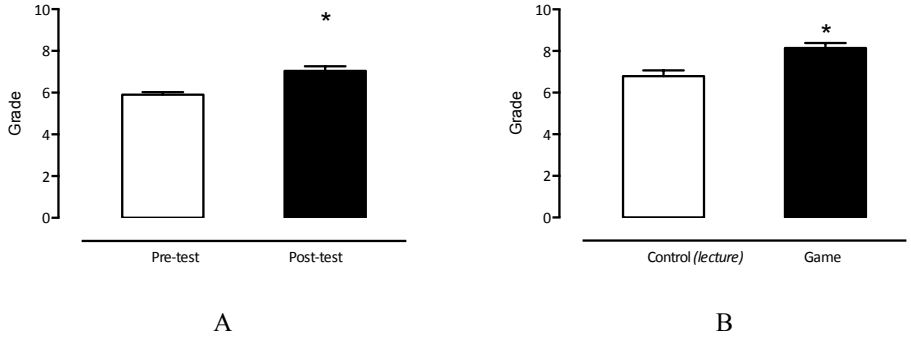

*Figure 1. Performance of the students in pre and post-test about the cardiac cycle. *Significantly different from pre-test.**(1A.)** Performance of the students who had a lecture or an activity with the cardiac cycle puzzle in a test about the cardiac cycle. *Significantly different from Control group (1B).Values are presented as mean ± SEM.*

3.3. Study 3 – comparison between reading and puzzle activity, in the same class: Students that performed the game activity answered more questions correctly, in comparison with those who learned the cardiac cycle by reading textbooks and articles (Figure 2A; $t_{(48)} = 20.90$; $p = 0.003$).

3.4. Study 4 – comparison between lecture and lecture plus puzzle: Students that performed the game activity additionally to the lecture answered more questions correctly, in comparison with those who learned the cardiac cycle by lectures (Figure 2B; ($t_{(82)} = 5.831$; $p < 0.0001$).

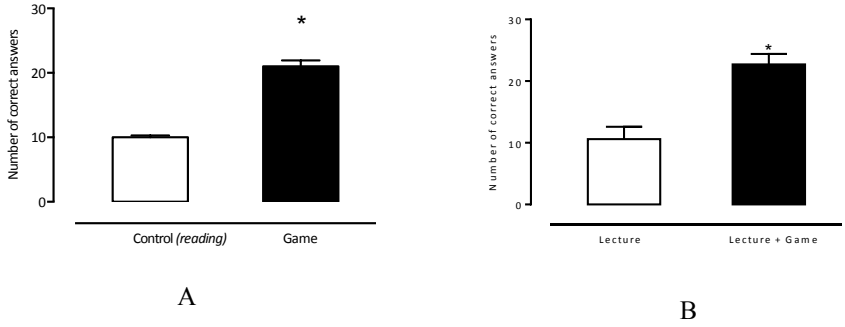

*Figure 2. Performance of the students who read textbooks and scientific articles or had an activity with the cardiac cycle puzzle, in a test about the cardiac cycle. *Significantly different from Control group(2A). Performance of the students who had a lecture or a lecture plus an activity with the cardiac cycle puzzle in a test about the cardiac cycle. *Significantly different from Control group (2B).*

4. Discussion

The data obtained in the present study indicate that there was an improvement in students' learning about the heart physiology after the use of the cardiac cycle puzzle in different real class conditions.

Considering that teachers play a fundamental role in developing the students' positive or negative regard for scholastic content, facilitating or hindering the learning process, respectively (Delors *et al.*, 1998; Leite, 2012), the use of active teaching-learning methodologies can help the development of positive regards of student for complexes themes studied in the professional education. Alternative methodologies can replace or complement traditional ones and both options can have positive effects on students´ learning. In this context, it is also necessary that teachers are convinced that any new

methodology that they intend to introduce in their classroom routine is efficient in promote learning. Otherwise, it's hard to convince them to change their teaching practice.

If the evaluation about the efficacy of a teaching method is done in a real classroom condition, it will decrease artificial effects and bias. Different evaluation approaches, with advantages and disadvantages, are available and can be chosen accordingly the scholar schedules.

The use of pre- and post-test is one possibility for the evaluation of educational strategies (Barclay *et al.* 2011). In the present study it has been used in the study 1. As advantage it can be included in the class schedule without a significant increase in the class duration. Only the time for the application of the tests will be added. However, the limitation of pre- and post-test is that in the post-test, the students know the questions. Therefore it is not possible to conclude that the improvement in the grades obtained after the use of the educational game is only due to do the use of the game. Even so, the pre- and post-test can provide evidences about the efficacy of the educational method, and some changes in the questions' writing and/or questions' order decrease the bias.

In the studies 2 and 3, the students in the same course were divided in two groups and only one group performed the activity with the puzzle, while the others had a lecture (study 2) or read about the cardiac cycle (study 3). As showed by other authors, these approaches allow the comparisons between the uses of an educational game with a lecture (Rubinstein *et al.*, 2009) or reading (Cardozo *et al.,* 2016). And, in the study 4, it was evaluated the effect of the educational game in addition to a previous lecture in mixed classes with students from two different undergraduate careers. In the present study, the higher number of correct answers of the game groups in the tests evidenced that it increased the comprehension of students about the studied theme, in comparison to lecture or reading about the theme. In this way, the difference between the groups was the use or not of the educational game, decreasing the bias of pre- and post-test.

In summary, the results presented here showed that the educational game increased the students learning about the cardiac physiology, when it has been used for replacing and also for complementing traditional teaching methods, supporting the efficiency of educational games.

In conclusion, the present study supports the hypothesis that the use of active teaching-learning methods may increase students' learning, and show how the evaluation of the efficiency of such methods can be applied by the teachers, during the classroom routine.

References

Abreu RNDC, Sousa AM, Dias LM, Almeida GH, Diógenes MAR, Moreira TMM. (2014). Health Education for Prevention of Cardiovascular Diseases: Experience with

Psychoactive Substances Users. *Rev. Espaço para a Saúde,* 15(3), 13–21.

Allery LA. (2004). Educational games and structured experiences. *Med Teach* 26(6), 504–5.

Barclay SM, Jeffres MN, Bhakta R. (2011). Educational card games to teach pharmacotherapeutics in an advanced pharmacy practice experience. *Am J Pharm Educ* 75(2), 1–7.

Cardozo, LT, Miranda, AS, Moura MJCS, Marcondes FK. (2016). Effect of a puzzle on the process of students' learning about cardiac physiology. *Adv. Physiol. Educ.* 40(3), 425–431.

Choudhury S, Pradhan R, Sengupta G, Das M, Chatterjee M. (2015). Let's " Play " with Molecular Pharmacology. *Educ Heal*, 28 (1), 83-86.

Delors J, Chung F, Gorham W, Manley M, Chung F. (1998). *Learning: the treasure within*.

Diehl LA, Meister I, Coelho M. (2015). Effectiveness of a serious game for medical education on insulin therapy: a pilot study education on insulin therapy : a pilot study. *Arch Endocrinol Metab* 59(5), 470–473.

Leite S. Affection in teaching practices. *Temas em Psicol* 20(2), 355–368, 2012.

Luchi KCG, Montrezor LH, Marcondes FK. Effect of an educational game on university students' learning about action potential. *Adv Physiol Educ* 41, 222-230, 2017.

Marcondes FK, Moura MJCS, Sanches A, Costa R, de Lima PO, Groppo FC, Amaral MEC, Zeni P, Gaviao KC, Montrezor LH. (2015). A puzzle used to teach the cardiac cycle. *Adv. Physiol. Educ.* 39(1), 27–31.

Mccarroll ML, Pohle-krauza RJ, Martin JL. Active learning in the classroom : a muscle identification game in a kinesiology course. (2009). *Adv Physiol Educ* 33(4), 319–322.

Mitre S, Siqueira-Batista R, Girardi-de-Mendonça J, Morais-Pinto N, Meirelles C, Pinto-Porto C, Moreira T, Hoffmann L. (2008). Active teaching-learning methodologies in health education: current debates. *Cien Saude Colet* 13(suppl 2), 2133–2144.

Prince M. Does Active Learning Work ? A Review of the Research. (2004). *J Eng Educ* 93(3), 223–231.

Rao SP, Dicarlo SE. Active learning of respiratory physiology improves performance on respiratory physiology examinations. (2001). *Adv Physiol Educ* 25(1-4), 55–61.

Rodenbaugh DW, Lujan HL, Dicarlo SE. (2012). Learning by doing : construction and manipulation of a skeletal muscle model during lecture. *Adv Physiol Educ* 36(4), 302–306.

Rubinstein J, Dhoble A, Ferenchick G. (2009). Puzzle based teaching versus traditional instruction in electrocardiogram interpretation for medical students – a pilot study. *BMC Med Educ* 9(4), 1-7.