

The “Anatomy Colored Cards Game” – An alternative, inexpensive and accessible teaching tool for anatomy students

Carlos R. Rueff-Barroso^{1,3*} • Géssica Silva Cazagrande¹ • Marco Aurélio Pereira-Sampaio¹ • Valéria Paula Sassoli Fazan²

¹Department of Morphology, Biomedical Institute, Fluminense Federal University, Niterói, Rio de Janeiro, Brazil.

²Department of Surgery and Anatomy, School of Medicine of Ribeirão Preto, University of São Paulo, Brazil.

³Department of Morphology, Health Sciences Center, Federal University of Espírito Santo, UFES, Brazil.

*Corresponding E-mail: carlosrueff@yahoo.com.br

Accepted 26th August, 2019.

Abstract. The aim of this research was to create, use and evaluate an alternative tool to audience response system (ARS) without the use of electronic equipment's, fast internet connection and Wi-Fi network, with a very low cost. The students' outcome in the tests and their perception of the activity was also evaluated. The “Anatomy Colored Cards Game” was created, and was used one week before the final anatomy test, in order to review basic concepts of anatomy. Each student received four colored cards made of paperboard (yellow, blue, green and red). After the distribution of the cards, the teacher showed a Power Point presentation with multiple choice questions, where each response corresponded to one color of the colored card. The students had 30 seconds to choose the correct answer and were asked to raise the colored card correspondent to their response. At the end of the activity, students were invited to blindly express their satisfaction with the activity. The outcomes of the students in the final exams were compared with the outcomes of students from the classes of the two previous years of the same course, which had the same lectures and laboratory classes with the same teachers. The students referred to the game as amusing, stimulant, useful and interesting. The final grades were improved and the failure rates decreased in the class that used the game as a learning tool. The “Anatomy Color Cards Game” proved to be a simple and inexpensive active methodology important as an auxiliary anatomy teaching resource.

Keywords: Teaching tool, human anatomy, color cards, game.

INTRODUCTION

Traditionally, anatomy has been taught through lectures based on text books, body dissections and demonstrations of prosected specimens. Teaching was mainly based on lectures when teachers transmitted information to students in a passive way (Wolff *et al.*, 2015). The students used their notes as the main source of information in order to memorize content, without discussing the basic concepts, functional and clinical applications of the learned content. In the last decades,

several methodologies have been implemented in order to improve the anatomy subject learning and to help students correlate the anatomical knowledge with the clinical practice (Percac and Goodenough, 1998; Boon *et al.*, 2001; Yiou and Goodenough, 2006; Rizzolo *et al.*, 2010; Havet *et al.*, 2012).

Currently, it is proven that the engagement of the students in the knowledge construction is more efficient in the retention of the basic concepts (Mazur, 2009).

Creating an interactive environment during lectures is the key to encourage students' participation and improves learning (Jelsing *et al.*, 2007). The audience response system (ARS) is a very successful technology used to create an interaction with students during lectures (Pradhan *et al.*, 2005; Alexander *et al.*, 2009; Doucet *et al.*, 2009; Kay and LeSage, 2009; Robson *et al.*, 2015). The ARS allows the instructor to design multiple-choice questions for students, who will respond by using individual handsets, known as "clickers." The responses are transmitted to a receiver connected to a computer that analyzes the answers together. Thus, the instructor can evaluate the learning of different topics and clarify any misunderstandings, through discussions with students.

However, the ARS has some limitations, such as the high cost of the equipment (Collins, 2008) and the need for an internet site and a fast Wi-Fi connection, which can turn its use unfeasible at low budget learning centers. Thus, a less expensive method, as efficient as the "clickers" and without the need of fast internet connection, could stimulate the students' interaction during lectures, with the advantage of very low cost.

The objective of this study was to create, use and evaluate an alternative tool to ARS without the use of electronic equipment's, fast internet connection and Wi-Fi network, with a very low cost. The students' outcome in the tests and their perception of the activity was also evaluated.

MATERIALS AND METHODS:

The first year class of the Pharmacy School of the Fluminense Federal University (called as group 3), was invited to participate voluntarily in the proposed activity. All 60 students of this class agreed to participate and signed personally a formal consent of participation in the study (approved by the Fluminense Federal University Review Board).

The "Anatomy Colored Cards Game" was used one week before the final anatomy test, in order to review basic concepts of anatomy used for understanding of the applied anatomy subjects, which will be inquired in further exams. Each student received four colored cards made of paperboard (yellow, blue, green and red). After the distribution of the cards, the teacher showed a Power Point presentation with multiple choice questions, where each response corresponded to one color of the colored card. First, the teacher read the question. Then, the students had 30 seconds to choose the correct answer. Finally, students were asked to raise the colored card correspondent to their response (Figure 1).

All questions have addressed basic concepts of anatomy, which are considered important for understanding more complex issues that will be inquired in the exams. Before starting the activity, the professor

showed a multiple-choice question with a known answer, only to demonstrate how the activity works. According to the students' responses and to the level of knowledge for each concept, the teacher promoted a discussion between students about this specific topic. Students who answered correctly were initially invited to explain the reason for their answer, and then, the students who answered wrongly were encouraged to join the discussion to demonstrate that they understood the concept. No student was forced to speak. Once the issue had been thoroughly discussed and the students had no more doubts, the teacher moved on to the next question.

At the end of the activity, students were invited to blindly express their satisfaction with the activity. Two weeks later, students were asked to blindly answer a questionnaire to evaluate this teaching/learning method. The outcomes of the students in the final exams were compared with the outcomes of students from the classes of the two previous years (called group 1 and group 2) of the same course, which had the same lectures and laboratory classes with the same teachers.

Parametric data was compared by means of one-way ANOVA followed by Newman-Keuls post-test, while non-parametric data was compared by Kruskal-Wallis followed by Dunns post-test. Data are shown as means \pm standard error of the mean (SEM). Differences were considered significant when $p < 0.05$. All data analysis and graphs were performed using GraphPad Prism version 5.0 for Windows (GraphPad Software, San Diego, CA, USA).

RESULTS

Students, who took part in the game, were inquired about their satisfaction right after the activity. Fifty-three (53) students answered this question (Table 1) and 92% declared that the activity was excellent. Two weeks after the activity, the same students were invited to respond another questionnaire, and 43 students answered this time. Table 2 shows that no student had difficulty to perform this activity. They mentioned that the discussions were useful for understanding the content and that the activity was effective as a method to review the topics.

Most (91%) students felt encouraged to study harder for the exam. They reported that the activity should be done more often and most of them (93%) said that it worked as a useful tool for their self-assessment. For 66% of students, this activity encouraged the interaction between them; and for 91% of them, the interaction between students and teachers was encouraged. No student felt embarrassed when showing their answers in front of the colleagues and teachers during activity. Finally, 98% of students stated that using the colored plates was a fun part of the activity.

The students were requested to show their feelings about the activity with one adjective. The most cited

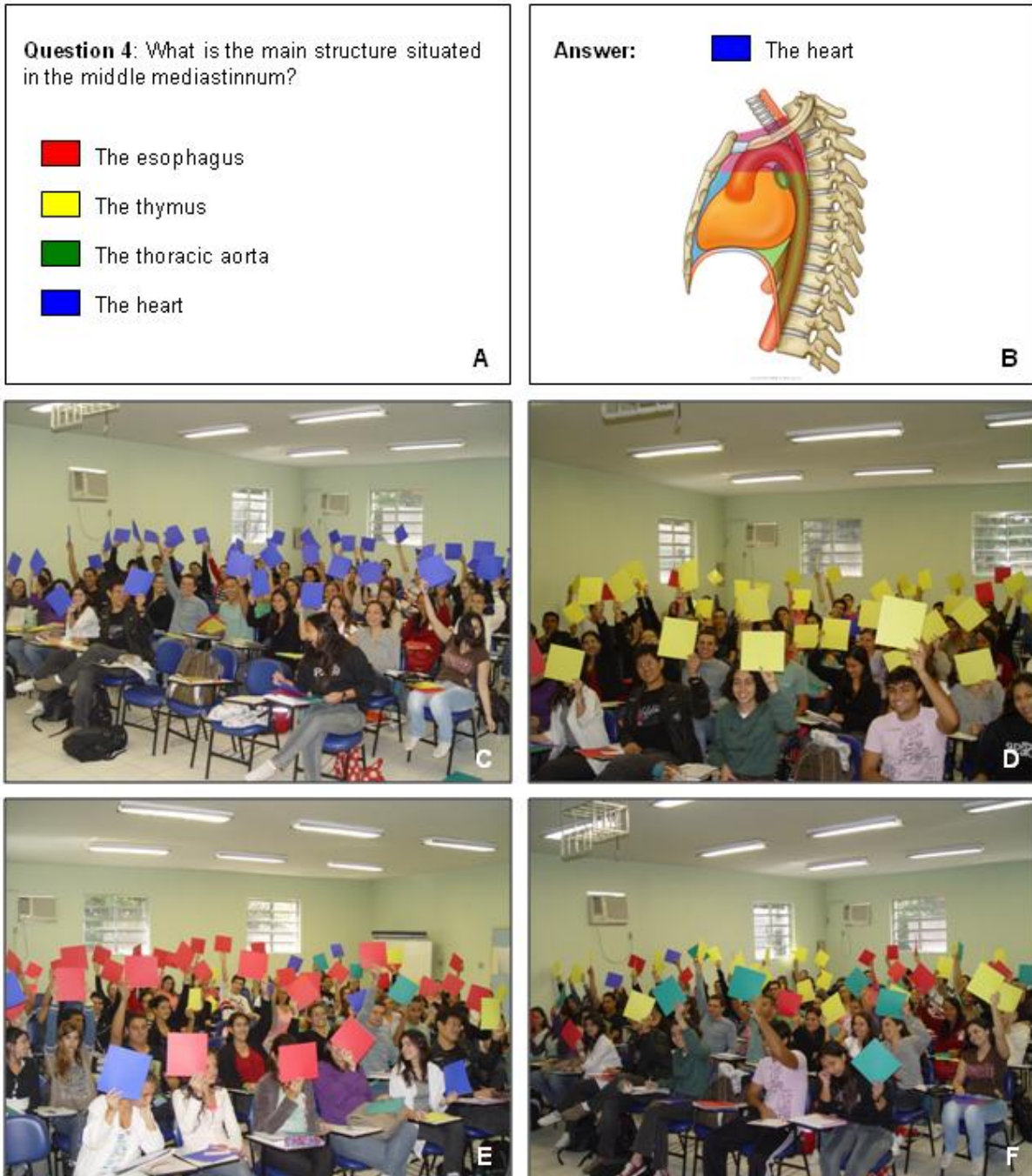


Figure 1. Example of a question (A) and the correct answer (B) presented on a power point presentation for the students. Panels C through F show participants of the game in different moments.

words were: amusing (26%), stimulant (13%), useful (9%) and interesting (9%). Figure 2 shows the words used by the students to describe their perception about the activity two weeks later. Only words that were cited at least twice were considered in the figure composition. Other words that were cited only once represented 12% of the total.

Figure 3 shows the comparison between the exams

grades of the group that participated in the activity compared to those who did not participate (in previous years). Grades from group 3 (G3 who attended the activity) were higher than grades from groups 1 and 2 ($p < 0.01$ and $p < 0.001$, respectively (Table 3). When the number of students who failed in the exams (grades below 60/100) was assessed, only 18% of the students from group 3 failed in the exams, against 30% in group 1 and 44% in

Table 1. Satisfaction inquiry answered by the students right after the activity.

Opinion	Answers (%)	Number of students(*)
Excellent	92	49/53
Good	6	3/53
Regular	2	1/53
Bad	0	0/53

(*) Only 53 students, from the 60 who attended the activity, answered the inquiry.

group 2.

DISCUSSION

The ARS has been largely used as an important tool to improve learning in several Universities from developed countries (Pettit *et al.*, 2015; Robson *et al.*, 2015; Bode *et al.*, 2015; Johansson *et al.*, 2017). On the other side, the ARS device is still considered an expensive system for developing countries (Cain and Robinson, 2008; Arneja *et al.*, 2009; Morrell and Joyce, 2015), mainly in South America, Africa and Asia. Therefore, a new inexpensive and efficient method was created as an alternative to the ARS, which has stimulated the students to think and discuss about different topics of Anatomy.

Nowadays interactive softwares (Audience Interactions Tools) that can be used in classrooms with smartphones have been developed (Gubbiyappa *et al.*, 2016; Gousseau *et al.*, 2016). They are also very efficient, attractive and fun. However, they continue to present limitations for not moneyed students and for Institutions that do not have a Wi-Fi connection in classrooms. Unfortunately, in underdeveloped countries and in some developing countries these issues are still present and educators of these centers need to use creativity to overcome these difficulties and continue to stimulate and teach their students.

In the proposed game, the students received colored cards when they came into the classroom, but nothing was explained about it until the beginning of the activity. During this period, the students were anxious to know what the cards meant. So, it created an animated and curious atmosphere, keeping the students very interested in participating in the activity. When starting the game, one of the major concerns was about the student's self-exposure when answering the questions. Using the ARS device, the students' answers are not identified (Levesque, 2011; Hoyt *et al.*, 2010; Dhaliwal *et al.*, 2015) either by the teacher or by the class mates. This differs from our activity, when the participants have to show their answers to everybody, at the same time, in the classroom. Some students could be very shy and insecure since they have to show the colored card with their answer in a public way for their class mates. However, the fun atmosphere created by the game let the

students gets excited to take part in the game, and seeing the answers of their colleagues was also a fun part of the activity. It seems that showing answers for all audience during the game was not a problem for any of the participants. When they are inquired if the activity constrained them in front of the classmates or the teacher, nobody had this feeling (Table 2). Furthermore, the game attendance could motivate the involvement of students in future lectures, solving the shyness of some students and increasing the interaction between teachers and students.

Humans are naturally receptive and influenced by the external environment and the use of color codes. In that context, colors were once thought to influence emotions and behavior (Valdez and Mehrabian, 1994). If used well, colors can facilitate learning and encourage the enjoyment of learning. It was noticed that the colored plates encouraged students to answer questions voluntarily, as they all wanted to lift their boards and look at the other raised boards. The data show that almost all the students agreed that using colored cards made the activity more fun and interesting. Previous studies have shown that colors have a systemic effect on the emotional state of the observer (Wilms and Oberfeld, 2018), and that emotions can improve performance on cognitive tasks in different domains such as memory, learning and perception (Fairfield *et al.*, 2013; Mammarella *et al.*, 2016; Palumbo *et al.*, 2017a, b).

Performing the activity was very easy for students, and all of them declared that the discussion of the topic after each question was useful to understand the content and effective to review the topics. The importance of discussing wrong answers has already been demonstrated in other studies (Wait *et al.*, 2009; Stein *et al.*, 2006). They also believed that the activity encouraged them to study harder for the exams. The activity was very good as a self-evaluation method, allowing them to know their difficulties (Table 2). The learning improvement was demonstrated when the grades from the students who participated in the activity were compared with the grades of the students who did not participate (Figure 3). Students from group 3, who attended the activity obtained higher grades (7.67 ± 0.25) than the students from groups 1 (6.58 ± 0.25) and 2 (5.94 ± 0.30), who did not attend the activity. After the use of this activity as a method to stimulate the students, the grades became higher and the rates of exam failure decreased. In group 3, only 18% of the students did not get the minimum grade to pass (60/100), while in groups 1 and 2, this number was 30 and 44%, respectively (data not shown).

Lots of new technologies such as websites, softwares, DVDs and digital tables are available for students to learn anatomy. Certainly, lectures and laboratory activities are still important for anatomy learning, but the traditional methods to teach anatomy must be assisted by more attractive tools (Jelsing *et al.*, 2007; Mazur, 2009).

Table 2. Evaluation inquiry answered by the students two weeks after the activity.

Question	Responses (percentage)					N(*)
	1	2	3	4	5	
No difficulty to perform the activity	0	0	0	30	70	43
The discussion of the topic after each question was useful to understand the content	0	0	0	5	95	43
The activity encouraged me to study more for the exams	0	0	9	33	58	43
The activity was effective to review the topics	0	0	0	7	93	43
This activity should occur more often during the classes	0	0	0	9	91	43
The activity worked as a useful tool for my self-assessment	0	2	5	14	79	43
The activity encouraged the interaction among students	0	7	28	40	26	43
The activity encouraged the interaction among students and professor	2	0	7	21	70	43
Showing my answers in front of my colleagues during the activity DID NOT constrain me	0	0	9	30	60	43
Showing my answers in front of my professors during the activity DID NOT constrain me	0	0	9	28	63	43
Using the colored plates made the activity more fun	0	0	2	7	91	43

Rating scale: 1 = strongly disagree; 2 = slightly disagree; 3 = neutral; 4 = slightly agree; 5 = strongly agree. N = number of students. (*) Only 43 students, from the 60 who attended the activity, answered the inquiry.

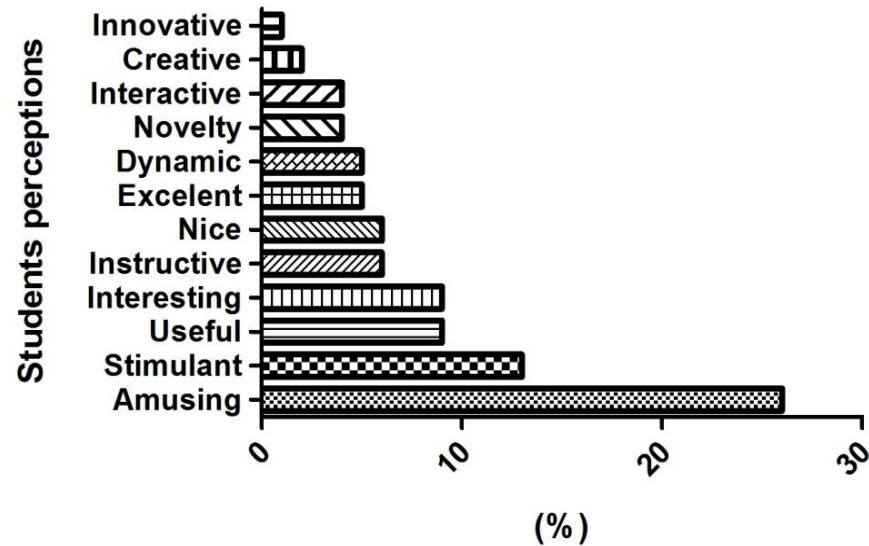


Figure 2. Words used by students to describe their perception about the activity, two weeks later. Only 53 students, from the 60 who attended the activity, answered the inquiry.

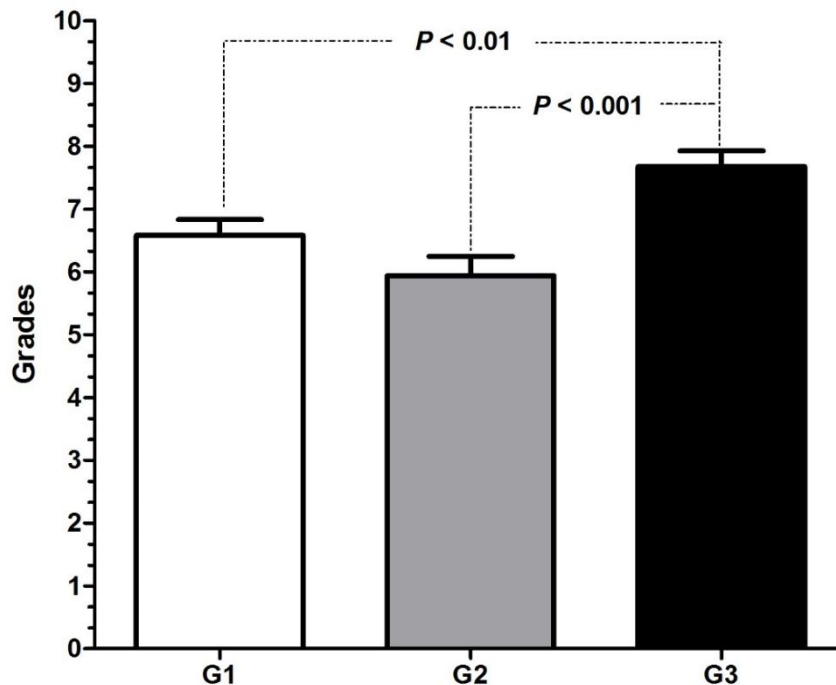


Figure 3. Outcomes of the exams from students who did not attend the activity and from the students who participated in the activity. G1 (group 1) and G2 (group 2) – Classes of students of the previous two years that did not attend the activity; G3 (group 3) Class from students who attended the activity. Data are shown as means \pm SEM.

Table 3. Outcomes of the exams from students who did not attend the activity and from the students who participated in the activity.

Groups	Mean \pm SEM	Number of students
G1	6.579 \pm 0.25(*)	43
G2	5.94 \pm 0.30(**)	56
G3	7.67 \pm 0.25(*, **)	60

G1 (group 1) and G2 (group 2) – Classes of students of the previous two years that did not attend the activity; G3 (group 3) Class from students who attended the activity. Data are shown as means \pm SEM. (*) $P < 0.01$; (**) $P < 0.001$.

It was demonstrated that the "Anatomy Color Cards Game" worked as an attractive tool, stimulating the students to learn, because most of the students agreed that this activity could be more helpful if it could be offered several times during the course. When the students were requested to express their feeling about the activity with one adjective, only positive words were written (Figure 2). This demonstrated that the students really look for alternative methods, which instigate and motivate their interest to learn, mainly when the method is enjoyable and fun. Making changes in teaching strategies is really necessary (Cain *et al.*, 2009) even more when dealing with this new generation, who has access to several technologies systems. The "Anatomy Color Cards Game" has some limitations. When students use the ARS, the system immediately forms an accurate

graph of the percentage of successes and mistakes of students to each question, displaying the results accurately (Robson *et al.*, 2015; Wait *et al.*, 2009). However, it was noted that this does not alter the result of the academic dynamic. Although the teacher did not get the exact number of answers, he has visual information that allows a sufficient analysis of the student's doubt about the topic. It is possible to observe the predominance of a certain color over the others, if there are two colors predominating or when all colors are shown as the "correct" answer. According to what is seen, the teacher recognizes promptly the doubts of the class. After that, a comment is made immediately with the class, followed by explanation about that subject. The ARS allows students to participate anonymously in seminars and lectures, with the collective results being

instantly and anonymously displayed on a screen to the group (Dhaliwal *et al.*, 2015; Wait *et al.*, 2009). Nevertheless, in the "Anatomy Color Cards Game", anonymity is not absolute and despite the students have shown great satisfaction in participating, it may happen that some introverted students do not feel comfortable participating. To avoid this kind of situation, at the beginning of the activity it was explained how the game would happen and asked who would like to participate. It was made clear that the activity was not mandatory and those who did not want to participate in the game could attend the class as listeners.

CONCLUSION

The "Anatomy Color Cards Game" proved to be a simple and inexpensive active methodology that can be used as an auxiliary anatomy teaching resource. The use of colors and the ludic atmosphere created by the game clearly influenced the students' learning and performance, which was demonstrated through positive results in the anatomy exam. Moreover, the activity improved the student's will to study and discuss Anatomy questions creating an amusing and comfortable environment during classes. Thus, the use of the proposed game to review the anatomy and neuroanatomy content is recommended and the research proposes the application of the game to other health sciences courses. Further comparisons between different courses can be performed in order to identify possible differences between students.

ACKNOWLEDGEMENT

Fazan VPS is a current recipient of a research fellowship from CNPq (Conselho Nacional de Pesquisa e Tecnologia); Grant number: 301333/2017-3.

DISCLOSURE STATEMENT

Material in this manuscript was previously presented in poster format, at the XXV Brazilian Congress of Anatomy, in Salvador, Bahia, 2012. The authors declare no conflicts of interest.

REFERENCES

- Alexander CJ, Crescini WM, Juskewitch JE, Lachman N, Pawlina W (2009). Assessing the integration of audience response system technology in teaching of anatomical sciences. *Anat. Sci. Educ.* 2:160-166.
- Arneja JS, Narasimhan K, Bouwman D, Bridge PD (2009). Qualitative and quantitative outcomes of audience response systems as an educational tool in a plastic surgery residency program. *Plast. Reconstr. Surg.* 124:2179-2184.
- Bode SF, Straub C, Giesler M, Biller S, Forster J, Krüger M (2015). Audience-response systems for evaluation of pediatric lectures-comparison with a classic end-of-term online-based evaluation. *GMS Z Med. Ausbildung.* 32:Doc.18.
- Boon JM, Meiring JH, Richards PA, Jacobs CJ (2001). Evaluation of clinical relevance of problem-oriented teaching in undergraduate anatomy at the University of Pretoria. *Surg. Radiol. Anat.* 23:57-60.
- Cain J, Robinson E (2008). A primer on audience response systems: current applications and future considerations. *Am. J. Pharm. Educ.* 72:77.
- Cain J, Black EP, Rohr J (2009). An audience response system strategy to improve student motivation, attention, and feedback. *Am. J. Pharm. Educ.* 73:21.
- Collins J (2008). Audience response systems: technology to engage learners. *J. Am. Coll. Radiol.* 5:993-1000.
- Dhaliwal HK, Allen M, Kang J, Bate, C, Hodge T (2015). The effect of using an audience response system on learning, motivation and information retention in the orthodontic teaching of undergraduate dental students: a cross-over trial. *J. Orthod.* 42:123-135.
- Doucet M, Vrins A, Harvey D (2009). Effect of using an audience response system on learning environment, motivation and long-term retention, during case-discussions in a large group of undergraduate veterinary clinical pharmacology students. *Med. Teach.* 31:e570-e579.
- Fairfield B, Mammarella N, Di Domenico A (2013). Centenarians' "holy" memory: is being positive enough? *J. Genet. Psychol.* 174:42-50.
- Gousseau M, Sommerfeld C, Gooi A (2016). Tips for using mobile audience response systems in medical education. *Adv. Med. Educ. Pract.* 7:647-652.
- Gubbiyappa KS, Barua A, Das B, Vasudeva Murthy CR, Baloch HZ (2016). Effectiveness of flipped classroom with Poll Everywhere as a teaching-learning method for pharmacy students. *Indian J. Pharmacol.* 48(Suppl 1):S41-S46.
- Havet E, Duparc F, Peltier J, Tobenas-Dujardin AC, Fréger P (2012). The article critique as a problem-based teaching method for medical students early in their training: a French example using anatomy. *Surg. Radiol. Anat.* 34:81-84.
- Hoyt A, McNulty JA, Gruener G, Chandrasekhar A, Espiritu B, Ensminger D, Price R Jr, Naheedy R (2010). An audience response system may influence student performance on anatomy examination questions. *Anat. Sci. Educ.* 3:295-299.
- Jelsing EJ, Lachman N, O'Neil AE, Pawlina W (2007). Can a flexible medical curriculum promote student learning and satisfaction? *Ann. Acad. Med. Singapore* 36:713-718.
- Johansson K, Strömbergsson S, Robieux C, McAllister A (2017). Perceptual Detection of Subtle Dysphonic Traits in Individuals with Cervical Spinal Cord Injury Using an Audience Response Systems Approach. *J. Voice* 31:126.e7-126.e17.
- Kay RH, LeSage A (2009). Examining the benefits and challenges of using audience response systems: A review of the literature. *Comput. Educ.* 53:819-827.
- Levesque AA (2011). Using clickers to facilitate development of problem-solving skills. *CBE Life Sci. Educ.* 10:406-417.
- Mammarella N, Di Domenico A, Palumbo R, Fairfield B (2016). Noradrenergic modulation of emotional memory in aging. *Ageing Res. Rev.* 27:61-66.
- Mazur E (2009). Education. Farewell, lecture? *Science* 323:50-51.
- Morrell LJ, Joyce DA (2015). Interactive lectures: Clickers or personal devices? *F1000 Res.* 4:64.
- Palumbo R, D'Ascenzo S, Quercia A, Tommasi L (2017a). Adaptation to complex pictures: exposure to emotional valence induces assimilative aftereffects. *Front. Psychol.* 8:54.
- Palumbo R, Fairfield B, Mammarella N, Di Domenico A (2017b). Does make-up make you feel smarter? The "lipstick effect" extended to academic achievement. *Cogent. Psychol.* 4:1327635.
- Percac S, Goodenough DA (1988). Problem based teaching and learning as a bridge from basic anatomy to clinical clerkships. *Surg. Radiol. Anat.* 20:203-207.
- Pettit RK, McCoy L, Kinney M, Schwartz FN (2015). Student perceptions of gamified audience response system interactions in large group lectures and via lecture capture technology. *BMC Med. Educ.* 15:92.

- Pradhan A, Sparano D, Ananth CV (2005).** The influence of an audience response system on knowledge retention: an application to resident education. *Am. J. Obstet. Gynecol.* 193:1827-1830.
- Rizzolo LJ, Rando WC, O'Brien MK, Haims AH, Abrahams JJ, Stewart WB (2010).** Design, implementation, and evaluation of an innovative anatomy course. *Anat. Sci. Educ.* 3:109-120.
- Robson N, Popat H, Richmond S, Farnell DJ (2015).** Effectiveness of an audience response system on orthodontic knowledge retention of undergraduate dental students - a randomized control trial. *J. Orthod.* 42:307-314.
- Stein PS, Challman SD, Brueckner JK (2006).** Using audience response technology for pretest reviews in an undergraduate nursing course. *J. Nurs. Educ.* 45:469-473.
- Valdez P, Mehrabian A (1994).** Effects of color on emotions. *J. Exp. Psychol. Gen.* 123:394-409.
- Wait KR, Cloud BA, Forster LA, Jones TM, Nokleby JJ, Wolfe CR, Youdas JW (2009).** Use of an audience response system during peer teaching among physical therapy students in human gross anatomy: perceptions of peer teachers and students. *Anat. Sci. Educ.* 2:286-293.
- Wilms L, Oberfeld D (2018).** Color and emotion: effects of hue, saturation, and brightness. *Psychol. Res.* 82:896-914.
- Wolff M, Wagner MJ, Poznanski S, Schiller J, Santen S (2015).** Not another boring lecture: engaging learners with active learning techniques. *J. Emerg. Med.* 48:85-93.
- Yiou R, Goodenough D (2006).** Applying problem-based learning to the teaching of anatomy: the example of Harvard Medical School. *Surg. Radiol. Anat.* 28:189-194.

<http://sciencewebpublishing.net/jerr>