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The Use of Gamification as a Teaching Strategy for Embryology

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Abstract

Several strategies based on active methodologies have been used to teach content in courses in the health area, in this context, the use of games aimed at education become valuable resources. This study is characterized as a quasi-experimental modality of quantitative approach and aimed to evaluate the performance of medical students in relation to the contents of embryology, compared to the use of a board game. The study was carried out in a Brazilian higher education institution. 245 medical students enrolled from the 1st to the 8th of the medical course participated in the research. The research participants answered a pre-intervention questionnaire with content referring to the embryological period of development. After the activity, the same questionnaire was made available to the students (post-intervention). Statistical analysis was performed using the GraphPad Prism software, using the D'Agostino & Pearson and Shapiro-Wilk normality tests, subsequently opting for the Wilcoxon and Mann-Whitney and Kruskal-Wallis statistical test for non-existent data. parametric and Student's T and ANOVA with Dunn's post-test for parametric data. Better results were observed in the post-intervention questionnaire for the participating classes, favorably pointing to the use of this teaching strategy, focused on embryology.

Keywords: embryology; medicine; active methodology.

1. Introduction

The way of transmitting the content and characterizing the student as a passive being has historically marked traditional teaching in the medical field in general (Marcuzzo, et al., 2019). The transition from a teaching-centered model of education to a learning-centered model involves a major "cultural shift" for universities as educational entities.

Among the fundamental pillars of this change is the so-called "methodological renewal" (Moya, 2017). Means by which the teacher is a key player in these changes, seeking to assist in the acquisition of skills and abilities, changing his role from depositary to facilitator of the learning process (Blanco, 2009). In this context, the student starts to assume an active role during all phases, allowing him to continue learning autonomously throughout his life (March, 2006).

The use of active methodologies emerges as a teaching strategy that allows observing the development of students in the daily context, resulting in improved, more critical and reflective training (Hyun, 2017).

When we consider the teaching of human embryology in medical curricula, we also observe the study centered on lectures and practical classes on synthetic embryological models and eventually on slides used in microscopy, in addition to a large volume of information. This scenario, combined with the demands that entering the University imposes on students, can lead to their disinterest in the discipline of embryology (Marcuzzo, et al., 2019). There is still a gap on active learning regarding teaching embryology. The development and use of new teaching methods, such as the use of games that work in an integrated and active way becomes urgent and necessary, to improve skills and abilities and to reduce non-reflective learning, focused only on the memorization.

Gamification theory is the term used to describe the use of board games, media, and computer games for educational purposes (Lin; Zhu, 2012). Games are playful and at the same time educational forms that promote meaningful learning, in addition to stimulating creativity, attention, memory, cooperation and collaboration, among other skills (Paiva et al., 2019).

This active method, aimed at teaching embryology, is not very well described. In addition, the literature provides a limited understanding of the design and effects of non-digital gamification (analog games), with research being more focused on the use of digital games (Qiao, 2022). Studies suggest that a game, by itself, does not necessarily produce learning, a pedagogical context is necessary to be used as a support tool in the educational process (Campos, 2019; Mello et al., 2019).

This study aims to evaluate the performance of medical students when using a board game involving human embryology content.

2. Method

This study was presented as a quasi-experimental modality of quantitative approach and was carried out in 3 (three) phases:

1st phase - Pre-intervention questionnaire: this instrument was made up of questions referring to the knowledge of the initial embryological period (1st to 8th week) of development. For this, a total of thirty questions were analyzed by six doctoral professors, specialists in the field of embryology, in order to validate the material in terms of content and target audience. (Polit; Beck, 2011; Joventino et al., 2013). Such specialists analyzed each question regarding the following questions: If the question was clearly written for the student, if the complexity of the question was adequate for the target audience, if the content of the question and its respective answer were related to the proposed theme in the game, and whether the question contributed to the development of the subject's learning objectives.

Subsequently, 10 (ten) questions were randomly chosen and applied in a questionnaire format with simple multiple-choice questions.

2nd phase - Application of the Board Game: the intervention activity was developed by the researchers and consisted of a board, entitled “Development Trail”. This material was previously printed on canvas (120 X 90 cm), containing 40 (forty) numbered boxes, of which 10 (ten) were identified with the symbol “?" in red boxes, symbolizing a question to be answered by the team. The teams were identified through 4 (four) colored embryo markers (blue, yellow, red and green) to represent each team. The members of each team were chosen by convenience. Progression across the board involved rolling dice. Figure 1 illustrates the board and the markers used.

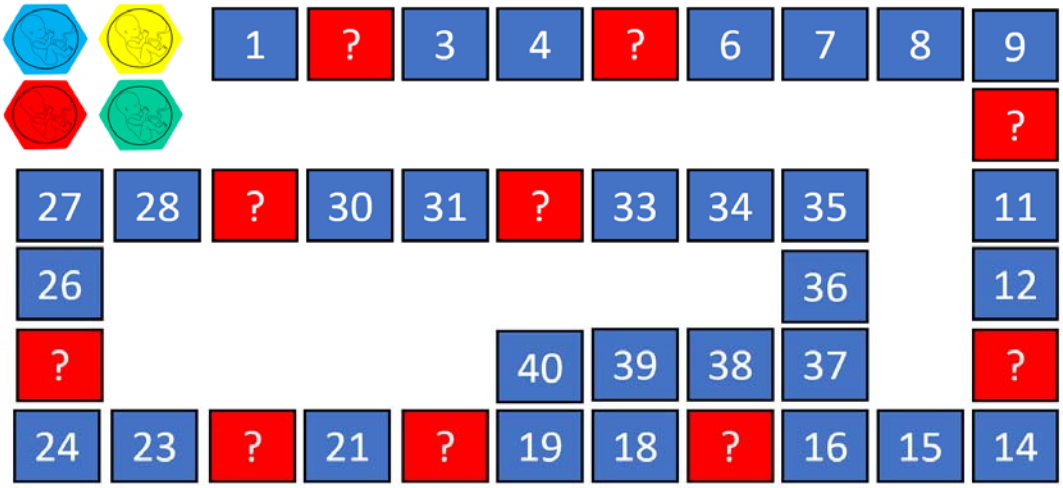

Figure 1. Board used in the activity.

3rd phase - Post-intervention questionnaire: the same questionnaire (pre-intervention) was reapplied immediately after the intervention. The total duration of the activity did not exceed one hour.

This study was carried out with students from the 1st to the 8th phase of a medical course (n = 317), from the Morphofunctional scenario, which works in an integrated way with the learning objectives linked to the areas of anatomy, histology, embryology and physiology. Students regularly enrolled in the first semester of 2022, at a Higher Education Institution in Alto Vale

do Itajaí, state of Santa Catarina, Brazil, were included. Students who did not want to participate, were absent on the day of the intervention or did not sign the Free and Informed Consent Form were excluded.

For the accounting of the size of the sample, the Epi Info software was used, considering a minimum of 174 participants for a confidence interval of 95%. However, what was obtained in this research were 245 participants, reaching a confidence interval of 99.9%

It is noteworthy that the applied questionnaires and collection procedures were carried out exclusively after approval by the Research Ethics Committee by opinion 5,310,394 (CAAE: 56194022.0.0000.5676).

Following the end of the collection, the data were transcribed and coded in a spreadsheet format using the Microsoft Excel 2013 program. The compilation of the samples was processed through conversion with the coding of the answers in a numerical scale, being A, B, C, and D converted to 1, 2, 3 and 4 respectively.

The distribution model of this work was studied by exploring normality through the D'Agostino & Pearson and Shapiro-Wilk test. Subsequently, the Wilcoxon and Mann-Whitney (two categories) and Kruskal-Wallis (above two categories) statistical test was chosen for non-parametric data. As for the parametric data, Student's t tests (two categories) and ANOVA (0ne-Way) with Dunn's post-test (above two categories) were applied. We sought to verify the mean and standard deviation of the samples, adopting the value of $p<0.001$. The GraphPad Prism software (Prism V.8.2.1, 2019) was the employment option for this descriptive statistical analysis.

3. Results

This research had the participation of 245 academics, among which the female public represented the majority 71.83% and the male constituted 28.17%, making up 176 and 69 academics, respectively. Regarding the number of participants per phase, the following distribution was obtained: 1st phase 13.95%, 2nd phase 13.03%, 3rd phase 13.49%, 4th phase 12.55%, 5th phase 13.95%, 6th phase 13.49% , 7th phase 11.63% and 8th phase 7.91%.

In Figure 2 we observe statistically significant differences in relation to the measurement of the students' post-intervention questionnaires when compared to the pre-intervention ($p<0.0001$), indicating that the students obtained an improvement in their performance after the intervention performed.

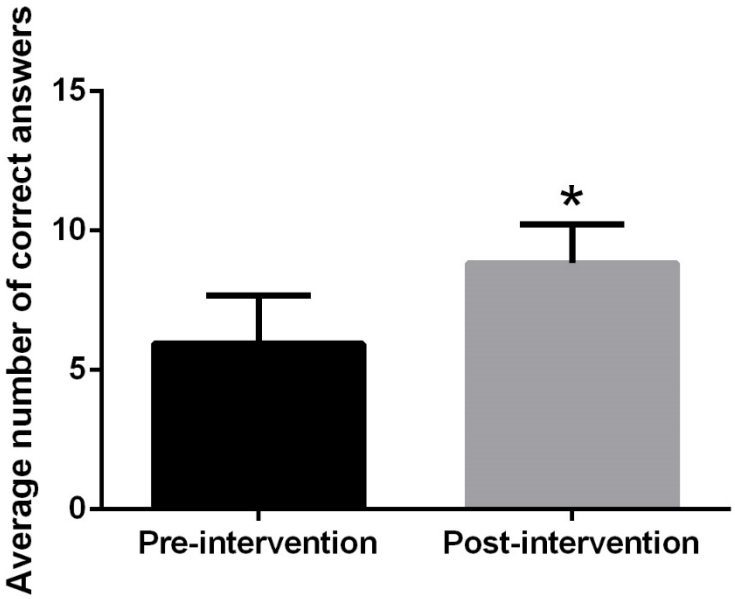

Figure 2. Number of correct answers during the pre-intervention and post-intervention questionnaires with the board game. For statistical analysis, the Wilcoxon test was used, where *p<0.0001.

Regarding the analysis of pre- and post-intervention performance by phases, it was observed that only the 5th phase did not obtain statistically significant significance of p<0.0001 when compared to the other phases, as observed in Table 1.

Table 1. Comparison of performance in the pre- and post-intervention questionnaires by phases

	Pre-intervention	Post-intervention	
	Mean ± SD	Mean ± SD	p-value
1[a] phase	6,412±1,328	9,400±0,7240	<0,0001[b]
2[a] phase	6,643±1,471	9,857±0,3563	<0,0001[b]
3[a] phase	6,086±1,788	9,029±1,224	<0,0001[b]
4[a] phase	6,086±1,788	9,259±1,095	<0,0001[b]
5[a] phase	6,086±1,788	7,968±1,683	0,0003[a]
6[a] phase	6,086±1,788	8,107±1,729	<0,0001[a]
7[a] phase	5,719±2,275	8,533±1,306	<0,0001[b]
8[a] phase	5,593±1,394	8,600±1,479	<0,0001[b]

Caption: SD = standard deviation; n= absolute number (245). Statistical Method Employed: T Student test for the 5th and 6th Phases; b Wilcoxon test for the other phases. It was considered statistically significant ($p<0.0001$).

The results of the post-intervention questionnaire for the 1st to 4th phases of the Basic Cycle (BC) were analyzed, comparing them with the results of the 5th to 8th phases of the Clinical Cycle (CC). It can be observed the mean and standard deviation of 9.367 ± 0.9696 respectively for the CB and 8.315 ± 1.558 for the CC, as shown in Figure 3.

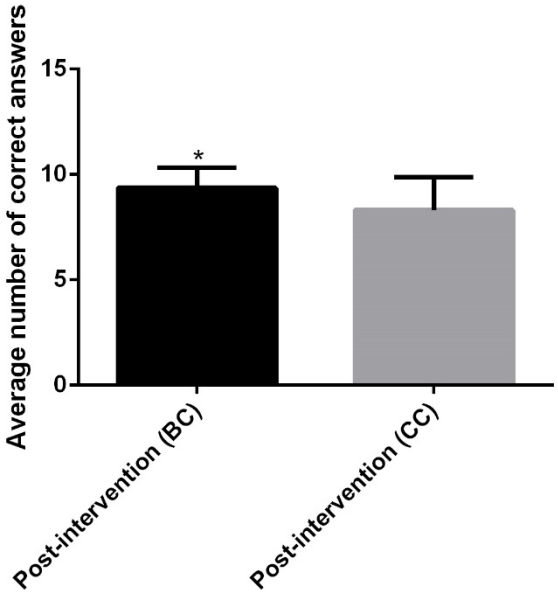

Figure 3. Comparison between the post-intervention averages of the Basic Cycle (BC) classes in relation to the Clinical Cycle (CC) classes. (Mann-Whitney), *($p<0.0001$).

As for the multiple comparison of performance between phases, there was no statistically significant difference in the pre-intervention questionnaire, showing that all phases had a similar level of prior knowledge. The results of the post-intervention questionnaire, however, showed statistically significant differences in the performances of the 1st vs 5th phase, 4th vs 5th, and 2nd vs 5th, 6th, 7th and 8th phases, as shown in Figure 4.

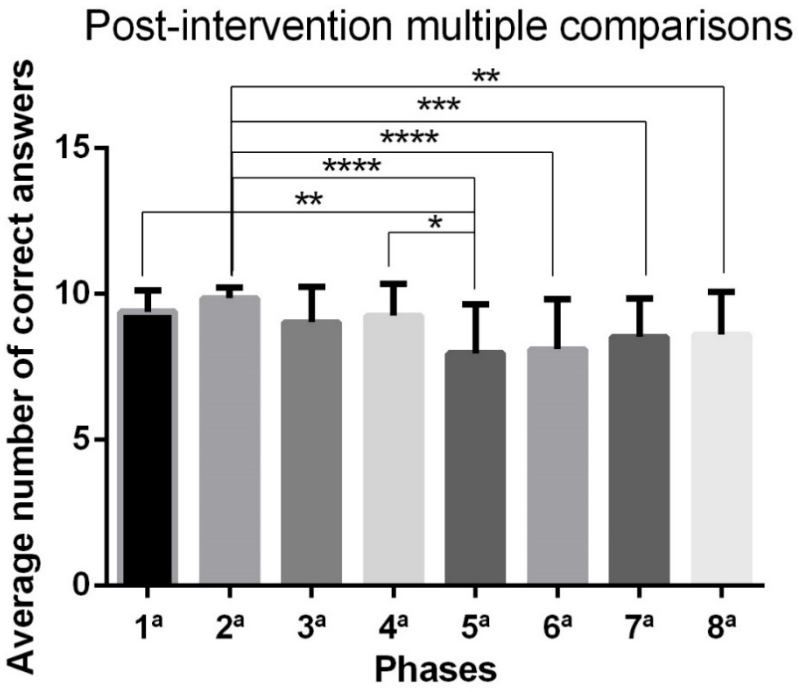

Figure 4. Analysis of the mean number of correct answers per phase during the post-intervention questionnaire (Kruskal-Wallis). Statistically significant differences were obtained 1st vs 5th phase **p<0.01, 4th vs 5th phases *p<0.05, 2nd vs 5th and 6th phases ****p<0.0001, 2nd vs 7th ***p<0.001, 2nd and 8th phase **p<0.01.

4. Discussion

The results suggest that students performed better after using the active method through the board game. According to the literature, this pedagogical resource serves not only to be used to break the monotony in the classroom, but as a teaching strategy to be integrated into the curriculum, thus seeking to promote meaningful learning (Tat, 2018). Meaningful learning is defined as learning that can encourage students to systematically expand, modify, and develop information so that the concepts being studied are relevant to the individual. Such a learning model assumes that the new knowledge offered is logically connected to other knowledge that the individual already possesses, and that there is a motivation for the individual to learn (Anwar, 2020).

Regarding the post-intervention results observed in the 5th phase, even though the result was not statistically significant, there was an increase in the absolute number. It is important to note that this phase had remote classes due to the pandemic period in 2020, when most of the content related to embryology was addressed. As well as the emergence of universities in continuing classes remotely, it made it difficult to develop active methods in the format of synchronous and asynchronous classes, opting for the traditional method in much of this period. The efficiency of the fully remote modality remains controversial, due to the lack of interpersonal interaction that the method imposes (Chang, 2022). Therefore, it is suggested

that this may eventually have been a determining factor for the presentation of the statistically non-significant result presented by that group.

Along with this, procrastination and anxiety were also harmful variables for student performance (Cormack, Eagle and Davies, 2020). It is believed that the period of social isolation demanded by the pandemic may have increased its relevance in academia. Studies suggest that the stress experienced by students and teachers increased during this period (Elmer, Mepham, & Stadtfeld, 2020; Son, Hegde, Smith, Wang, & Sasangohar, 2020). Such stress is closely related to anxiety, loneliness and depression (Misirlis, Zwaan, & Weber, 2020; Iglesias-Pradas, Santiago, 2021). This effect may be even more relevant in educational proposals based on active methodologies, since the habit of studying in groups in a collaborative and often integrated way is predominant for these students.

Regarding the analysis of the averages of the post-intervention questionnaire, these suggest a tendency towards lower performance of students in the clinical cycle (5th to 8th), when compared with the basic cycle (1st to 4th phases). Although most medical students perceive the importance of basic sciences for their education (Teshome, 2021), we theorize that this lower performance is due to the gradual loss of interest in the basic curriculum contents, on the part of students who find themselves at more advanced stages in the course.

According to D'Eon (2006), at his institution, students stated that their memory for subjects in the basic cycle was lower than expected, and that the content of these subjects did not seem so relevant when they reached the clinical cycle. The author also reports that a solid long-term memory is related to good initial learning, associated with periods of content reinforcement over time. It is also observed that there is a negative perception on the part of medical students in relation to basic sciences, as they progress in the course (Alam, 2011).

As for our most expressive results, in relation to the performance observed in the post-intervention questionnaire of the 2nd phase, we can theorize that the period in which this group participated in the research coincided with the end of the first year of the course, where the greatest amount of content referring to the areas of morphological sciences, specifically embryology, so it is likely that they felt more motivated and engaged to participate in the activity.

As previously discussed, the basic cycle is a preparation for the clinical cycle, and it is of paramount importance that the first is articulated with the second, bringing relevant and applicable aspects of basic sciences throughout medical training (Moura, 2018).

This research has a temporal limitation, since the post-intervention questionnaire was carried out right after the dynamics of the game. It is necessary in future studies to monitor how educational games can be favorable in the acquisition of knowledge in a more lasting way, and, in addition, to monitor the possible decay of the learning curve of the subjects of the basic cycle, when students enter the clinical cycle.

5. Conclusion

Considering the results presented, the use of a board game, as it was applied in this study,

proved to be a potentially favorable strategy for learning embryology content, promoting a better consolidation of knowledge on the subject.

As a future perspective, we believe it is important to run the post-intervention questionnaire at longer time intervals, after applying the game.

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