

Team-based learning in neurophysiology: performance and perception of medical students

Aprendizagem baseada em equipe em neurofisiologia: desempenho e percepção de estudantes de medicina

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ABSTRACT: *Introduction:* Fear of neural sciences was reported by many medical students and this is described in medical literature as neurophobia. This is mainly due to poor knowledge of basic concepts on the field. Active learning is a teaching method in which students are involved in knowledge construction as opposed to passive learning (PL). Team-based learning (TBL) is a teaching method that facilitates the learning process. *Aim:* Our aim was to investigate if TBL could improve academic performance in neurophysiology topics by Brazilian medical students and evaluate their perception about this teaching method. *Methods:* The study involved students from the School of Medicine from the Federal University of Ceará in Brazil. Peer tutoring activities were conducted on “Organization of the central nervous system” (OCNS) and “Autonomic nervous system” (ANS). Students had peer tutoring activity about one topic in TBL format and the other in passive PL format. A test was applied to compare performances and evaluate perception about the teaching methods. *Results:* Students that had peer tutoring activities of OCNS using TBL had a significantly higher score (7.5 ± 0.1 , vs. PL: 6.2 ± 0.2) compared to PL. In the ANS, TBL also provided greater score (6.5 ± 0.3 , vs. PL: 5.3 ± 0.3). Significantly more students rated TBL as excellent or very good and considered that TBL promotes more interaction, increases performance, and encourages communication and discussion. *Conclusion:* These results suggest that TBL could be a useful teaching method to help medical students build a solid background knowledge on neural science and possibly conquer neurophobia.

Keywords: Neurophysiology; Teaching; Central nervous system; Medical students.

RESUMO: *Introdução:* Muitos estudantes de medicina têm medo das neurociências e isso é descrito na literatura médica como neurofobia. A neurofobia parece estar relacionada principalmente ao pouco conhecimento de conceitos básicos na área. A aprendizagem ativa é uma metodologia de ensino na qual os estudantes estão envolvidos na construção do conhecimento, em oposição à aprendizagem passiva (AP). A aprendizagem baseada em equipe (ABE) é uma metodologia que facilita o processo de aprendizagem. *Objetivo:* Nosso objetivo foi investigar se a ABE melhoraria o desempenho acadêmico em tópicos de neurofisiologia por estudantes brasileiros de medicina e avaliar a percepção desses sobre essa metodologia de ensino. *Métodos:* O estudo envolveu estudantes da Faculdade de Medicina da Universidade Federal do Ceará no Brasil. Foram conduzidas atividades de monitoria sobre “Organização do Sistema Nervoso Central” (OSNC) e “Sistema nervoso autônomo” (SNA). Os estudantes tiveram atividades de monitoria sobre um tópico no formato ABE e outro no formato AP. Um questionário foi aplicado para comparar desempenho e avaliar a percepção sobre as metodologias de ensino. *Resultados:* Os estudantes que tiveram atividade de monitoria sobre OSNC usando ABE tiveram uma pontuação significativamente maior ($7,5 \pm 0,1$, vs. AP: $6,2 \pm 0,2$) em comparação com AP. Para SNA, ABE também promoveu maior pontuação ($6,5 \pm 0,3$, vs. AP: $5,3 \pm 0,3$). Número significativamente maior de estudantes classificou ABE como excelente ou muito bom e considerou que ABE promove maior interação, melhora o desempenho e incentiva comunicação e discussão. *Conclusão:* Esses resultados sugerem que ABE é uma metodologia de ensino eficiente para auxiliar os estudantes de medicina a construir um conhecimento básico sólido sobre neurociências e possivelmente superar a neurofobia.

Descritores: Neurofisiologia; Ensino; Sistema nervoso central; Estudantes de medicina.

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INTRODUCTION

Twenty-five years ago, the American neurologist Ralph F. Jozefowicz described that half of the medical students have fear of the neural sciences and named this phenomenon as “neurophobia”¹. Neurophobia is most likely caused by a deficiency in primary subjects. The students enroll in neuroanatomy and neurophysiology courses with a preconception that the subjects are complex, abstract, and difficult to understand. Earlier studies demonstrated that a high state of anxiety is associated with poor academic achievements². On the other hand, high levels of anxiety have been shown to negatively influence academic results³. Therefore, the students could be entering in a vicious cycle, in which the fear of negative evaluation in neuroanatomy and neurophysiology could potentially be causing anxiety, dislike, and eventual intellectual block, resulting in poor achievements that leads again to more anxiety.

Active learning is a teaching method in which the students are actively engaged in activities that force them to gather information, think, and solve problems. Therefore, the students are actively constructing their own knowledge as opposed to passive learning (PL). There are several different types of active-learning techniques, including brainstorming, notetaking, boardgames, role playing, discussing, group work, and others. Team-based learning (TBL) is a relatively recent teaching method proposed by Michaelsen and colleagues at the University of Oklahoma⁴. This method combines direct instructions and collaborative learning in small groups and studies have revealed several advantages: increased engagement and responsibility for learning⁵⁻⁷, development of skills in communication and team work^{5,8}, and encouragement of critical thinking for problem solving⁹. Therefore, the use of TBL could be a good strategy at the neurophysiology teaching/learning process. As TBL encourages discussion and peer-instruction, and stimulates thinking about the physiological mechanisms, it could reduce the fear of performing poorly in the examinations and block the aforementioned vicious cycle.

Although previous studies have indicated that students could benefit from TBL, there are only a few reports about the application of this teaching method in Brazilian Universities. Thus, as active learning can have the potential to improve the way students learn, our objective was to investigate if TBL could improve academic performance in neurophysiology topics by Brazilian medical students and evaluate their perception about this teaching method.

MATERIAL AND METHODS

The study involved students from the first semester of the School of Medicine from the Federal University of

Ceará in Brazil. The peer tutoring activities were conducted by undergraduate teaching assistants (peer tutors) after the formal class with the professor.

Participants

The study involved students from the first semester of the School of Medicine enrolled in the course “Nervous system” and was approved by the Ethics Committee of the Federal University of Ceará (CAAE:73932117.6.0000.5054). The students were provided copies of the participant information sheets and invited to participate in the study. The consent form was signed by a total of 63 students that agreed to participate in any part of the study.

Methodology

The topics chosen for the peer tutoring activities were “Organization of the central nervous system” (OCNS) and “Autonomic nervous system” (ANS). The students were randomly assigned to two different groups. The group A studied OCNS using the TBL method and ANS using PL method. The group B studied OCNS using the PL method and ANS using TBL method.

The peer tutoring activity using TBL consisted of 4 different activities: 1) Study the provided material prior to the activity; 2) Filling the individual test in class before the explanation; 3) Random assignment into groups (5-7 students/group) and filling the group test; 4) Short explanation about the topic and discussion of clinical cases. Each phase lasted around 30 minutes.

The peer tutoring activity using PL consisted of a lecture about the same items covered by the TBL method. However, no text was indicated prior to the activity and no clinical cases were discussed.

Data collection

An identical test with 8 true/false questions was applied to the students on both groups after TBL or PL peer tutoring activities to compare performances. In addition, the students also evaluated the different teaching methods according to their preferences.

Statistical analysis

The result of the true/false questionnaire is reported as means \pm SEM. Student's t test was used for comparisons. The evaluation of the teaching methods was reported as number of occurrences and analyzed by Chi-square test or One-Sample Signed Rank Test. Differences were considered significant at $p < 0.05$.

RESULTS

Students that had peer tutoring activities of OCNS using TBL method had a significantly higher score (7.5 ± 0.1 , vs. PL: 6.2 ± 0.2) [$t(61) = 5.716$; $p < 0.05$] (Figure

1A) compared to PL. Moreover, in the ANS peer tutoring activities, TBL also provided greater score (6.5 ± 0.3 , vs. PL: 5.3 ± 0.3) [$t(54) = 2.990$; $p < 0.05$] (Figure 1B).

The evaluation of the teaching methods showed that

significantly more students rated the TBL as excellent or very good in comparison to the PL [$\text{Chi-square}(4) = 29.614$; $p < 0.05$] (Figure 2).

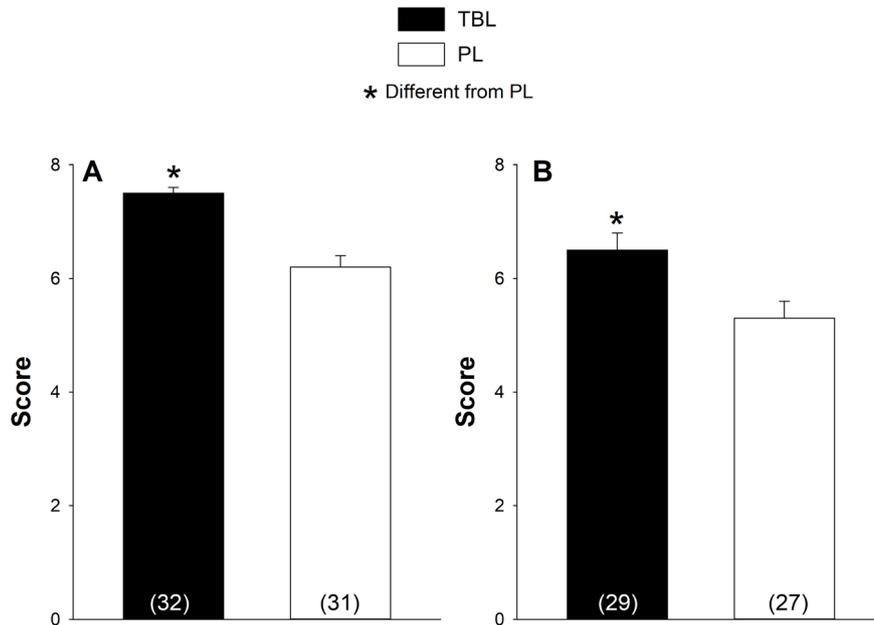


Figure 1: Score of students in the true/false questionnaire about (A) organization of the central nervous system and (B) autonomic nervous system after the peer tutoring activities using team-based learning (TBL) or passive learning (PL) methodology. Values are reported as means \pm SEM; number of students is given in parenthesis

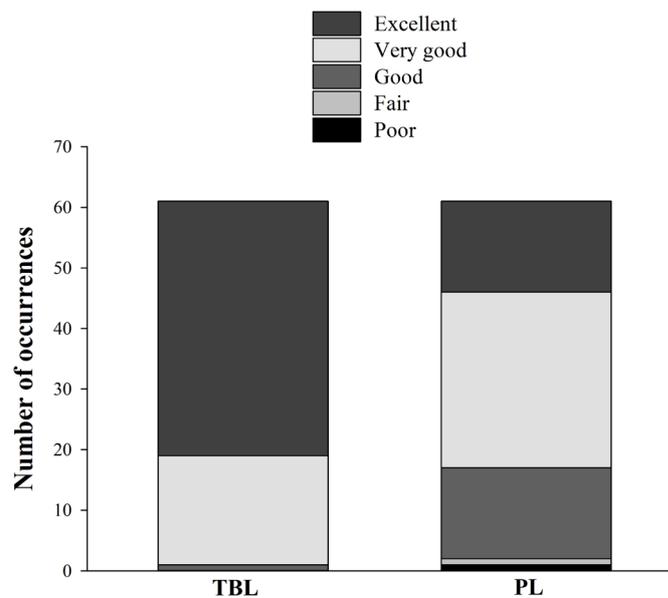


Figure 2: Evaluation of team-based learning (TBL) and passive learning (PL) methodology. Values are reported as number of occurrences; 61 students answered the questionnaire

The assessment of preference showed that only the minority of students were indifferent to the teaching methods. Significantly more students would prefer classes and peer tutoring activities about neurophysiology using the TBL teaching method in detriment of PL [Chi-square

(2) = 16.331; $p < 0.05$) (Figure 3). Additionally, the students agreed that the TBL promotes more interaction (Figure 4A; $Z = 7,141$; $p < 0.05$), increases performance (Figure 4B; $Z = 7,280$; $p < 0.05$), and encourage communication and discussion (Figure 4C; $Z = 6,928$; $p < 0.05$) compared to PL.

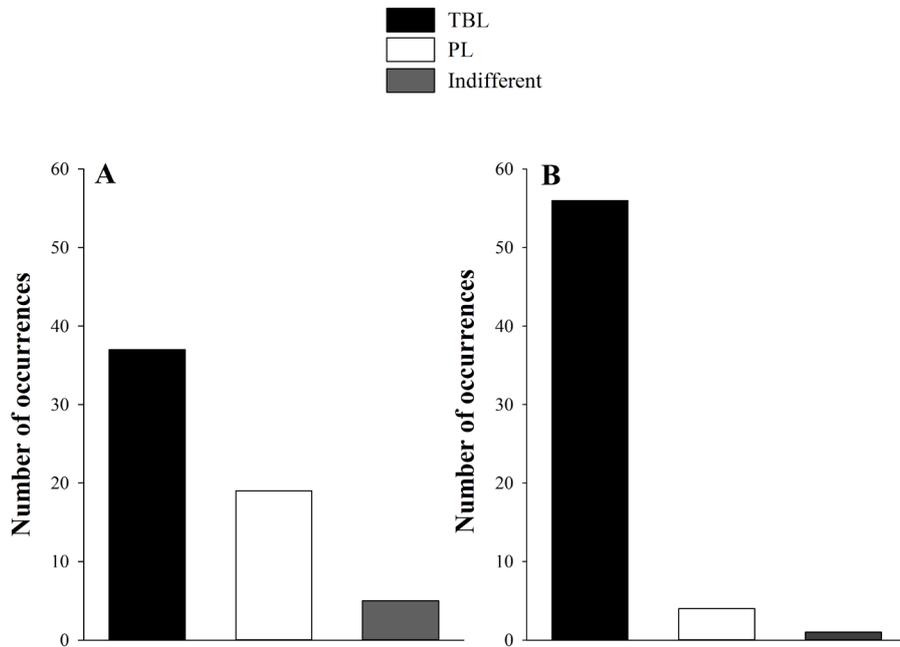


Figure 3: Preference for team-based learning (TBL) or passive learning (PL) teaching methods in (A) classes and (B) peer tutoring activities. Values are reported as number of occurrences; 61 students answered the questionnaire

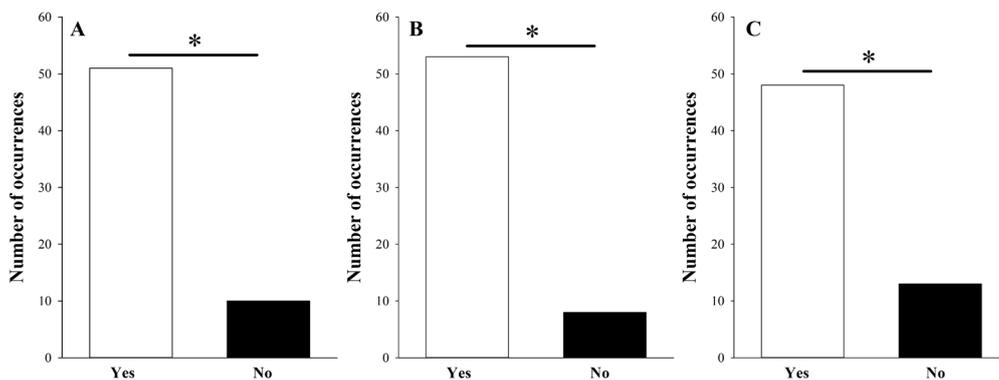


Figure 4: Evaluation of the team-based learning (TBL) in (A) promoting more interaction, (B) increasing performance, and (C) encouraging communication and discussion. Values are reported as number of occurrences; 61 students answered the questionnaire; * $p < 0.05$

DISCUSSION

The present results show that TBL significantly increases performance in neurophysiology topics and that students prefer this teaching methods, as it promotes more interaction and encourages communication and discussion.

A great number of recent studies have shown that neurology is perceived as the most difficult specialty and

medical students are having problems in dealing with patients with neurological problems¹⁰⁻¹³. This phenomenon had already been described and is known as neurophobia. Neurophobia is defined as a fear of the neural sciences and clinical neurology that is due to students' inability to apply their knowledge of basic sciences to clinical situations¹. This condition is mainly caused by a poor assimilation of the basic concepts on the field that leads

to inability to comprehend clinical problems. That is, to analyze a clinical case and propose a diagnose and adequate treatment/intervention, the medical student have to identify the affected structure and its morphology, the function of the system in which the structure is located, how it is regulated and the neuroendocrine mechanisms involved, how it interacts with other systems, and the most frequently observed pathologies. It is a complex process that requires analytical skills and the background knowledge built during the first years of the graduation course.

TBL is a teaching method of small groups in which students work individually and subsequently in groups and at all stages students receive a feedback¹⁴. When first conceived the aim of this method was that students could apply concepts to real future situations that they would encounter in their carriers rather than simply learning about them⁴. Nowadays, many Health Care Schools are using TBL as teaching method in their graduation courses^{15,16}. Tan et al.¹⁶ have shown that TBL results in greater improvement in knowledge scores, especially in students considered academically weaker. Interestingly, they also tested the students 48 hours after the intervention and it was observed that there was a decrease in the scores of students in the PL group, while students in the TBL group had even higher scores compared to the test taken immediately after the intervention¹⁶.

In our study we have also demonstrated that the score after TBL peer tutoring activities were significantly higher compared to score after PL. To prevent any possible biased data, the study was conducted in a counterbalanced design. The students that had OCNS peer tutoring activity in TBL and had a greater score in the first intervention, were the same students that studied ANS in PL and had

a significantly lower score in the second intervention. Therefore, we can assume that the results were not due to any uneven distribution of academically strong or weak students. Yet, according to the students' perception on our study, the TBL promotes more interaction and encourages communication and discussion. This could explain the greater scores observed by Tan et al.¹⁶ 48 hours after the intervention. TBL most likely creates a more welcoming group environment that is propitious for debate and informal conversations about academic topics that ultimately contributes to improve knowledge of the entire group.

Another interesting fact that we observed during our study is that students were more eager to participate in the peer tutoring activities comparing to previous activities not related to the present study. We believe that this greater engagement was because the students were from the first semester of the graduate program and had no previous experience with other teaching methods, so the TBL was attractive and considered by them as an innovative method. Thus, using TBL could promote a more appealing class which also contribute to the improvement of knowledge of the students.

CONCLUSION

Our results show that TBL is positively evaluated and effective in improving academic performance in neurophysiology topics of medical students. These results suggest that TBL could be a useful teaching method to help medical students build a solid background knowledge on neural science and possibly conquer neurophobia.

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Author contributions: *Teixeira AAR* – conceived and designed research, performed experiments, analyzed data, interpreted results of experiments, drafted manuscript, edited and revised manuscript, and approved final version of manuscript. *Botelho CV* – performed experiments, analyzed data, interpreted results of experiments, drafted manuscript, edited and revised manuscript, approved final version of manuscript. *Roncari CF* – conceived and designed research, analyzed data, interpreted results of experiments, prepared figures, edited and revised manuscript, approved final version of manuscript.

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