

# Peer-Assisted and Team-Based Learning: A new hybrid strategy for Medical Education

## Monitoria e Aprendizagem Baseada em Equipes: Uma nova estratégia híbrida para Educação Médica

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### ABSTRACT

Medical education has been significantly changing in the last years, mainly due to new conceptions of the teaching-learning processes that advocate the employment of active methods of learning, such as Team-Based Learning (TBL). Peer-Assisted Learning (PAL) is a long-established strategy that has been used in several undergraduate courses. This study describes a pilot test of a new model of PAL developed with an adapted TBL strategy, that was called "PAL-TBL method". The test occurred during Human Physiology classes with first-year Medical undergraduate students from Universidade de Pernambuco - Garanhuns Campus, Brazil. The PAL-TBL was designed as a teaching-learning methodology to improve academic education. Here, the organizational dynamics and the design of the activities carried out from 2016 to 2017 are reported. The resulting PAL-TBL methodology is characterized as the following: (i) timing I or material preparation (context/scenario) and study/analysis of the material by the participants; (ii) timing II or verification of prior knowledge (individual and team test), questioning and feedback and (iii) timing III or applying the concepts learned. It is worth mentioning that the end of timing II consisted of a moment for evaluating the team's work and the materials used. Material production happened through the interaction between student-tutors and the (supervising) professor, aiming to share experiences as well as to elucidate the importance of using active methods during the academic development of useful competencies for medical practice. The methodology developed allowed students to reflect extensively on the problems presented in the class discussions, allowing for a richer learning experience. Further applications of PAL-TBL in advanced years of the course will be done to confirm the benefits of this hybrid strategy for medical education.

### KEY-WORDS

- Peer-Assisted Learning;
- Team-Based learning;
- Teamwork;
- Educational competency.

## PALAVRAS-CHAVE

- Monitoria;
- Aprendizagem Baseada em Equipes;
- Trabalho em equipe;
- Competência educacional.

## RESUMO

*A educação médica tem mudado bastante nos últimos anos, principalmente pelo surgimento de novos conceitos relacionados aos processos de ensino-aprendizagem que preconizam o emprego de métodos ativos, tais como a Aprendizagem Baseada em Equipes (ABE), do inglês Team-Based Learning (TBL). A monitoria é uma estratégia bem estabelecida para atividades de ensino que tem sido utilizada em vários cursos de graduação. Esse artigo descreve o teste piloto de um novo modelo de monitoria desenvolvido por meio da adaptação do ABE, então denominado método "PAL-TBL". O método foi aplicado durante as aulas de Fisiologia Humana com os estudantes do primeiro ano do curso de Medicina da Universidade de Pernambuco – campus Garanhuns, Brasil. O método PAL-TBL foi delineado como uma modalidade de ensino-aprendizagem para contribuir para a formação acadêmica dos estudantes de Medicina. Nesse sentido, a dinâmica organizacional e o desenvolvimento das atividades deram-se durante os anos de 2016 e 2017. A metodologia utilizada foi a seguinte: (i) momento I ou de preparação de material (contexto/cenário) e estudo/análise desse material pelos participantes; (ii) momento II de verificação do conhecimento prévio (teste individual e em equipe), levantamento de dúvidas e feedback e (iii) momento III de aplicação dos conceitos. Vale ressaltar que o momento II contou com momento avaliativo do trabalho das equipes e do material preparado. A produção do material, contexto, questões e devolutiva, foi realizada por meio da interação entre os estudantes monitores e o professor, com o intuito de inserir as experiências vividas previamente, bem como elucidar a importância do uso de métodos ativos durante a formação acadêmica para o desenvolvimento de competências úteis para a prática médica. O desenvolvimento da metodologia proposta levou os estudantes a refletirem mais sobre os problemas apresentados durante as discussões em sala de aula, permitindo uma rica experiência de aprendizagem. Aplicações futuras do PAL-TBL com estudantes de anos mais avançados do curso serão realizadas para ampliar os benefícios da estratégia desenvolvida para a formação médica.*

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## INTRODUCTION

Medical education has been changing in the last decades with the purpose of selecting the best ways to offer a better education<sup>1</sup>. These changes aim mainly to develop professional profiles that include abilities beyond the well-established technical skills, to prepare students for the real world<sup>2,3</sup>. One example of such change is the current medical curricula of Brazilian universities that encompass professional competencies in three areas: health attention, education and management. For each area, there are skills, attitudes and cognitive aspects to be developed<sup>4</sup>. In order to support the progression of these competencies, faculty staff must be capable of selecting educational strategies that fit the purpose of medical education. However, this task is not simple because there are various educational strategies, new and old, available for medical education<sup>1</sup>, but none of which is a "magic method" that could be considered the best and unique. In addition, new perspectives show that choosing educational strategies involves taking into account the expected outcomes or the joint use of these strategies<sup>5</sup>.

Peer-Assisted Learning (PAL) is a learning method that has been informally used for some time and which recently was formally applied in medical education to further benefit student-tutors engaged in their development of professional attributes and understanding of content knowledge<sup>6</sup>. PAL is defined as "the acquisition of knowledge and skill through active helping and supporting among status equals or matched companions, where both tutees and tutors benefit from the transaction"<sup>7</sup>. It is noted that this process involves people from similar social groupings, but not professors who learn as they help one another to learn as well. PAL terminology is not standardized in the literature<sup>8</sup> therefore, "tutor" and "tutees" are used to define students who act as assistant and assisted in the learning/teaching situations, respectively.

PAL has been widely adopted in higher education courses as a teaching-learning strategy<sup>9,10</sup>, and its importance for the students involved goes beyond obtaining credits. It encompasses both the personal aspect of intellectual gain, as they help the tutees, and the exchange of knowledge between teacher and tutor during the execution of the PAL project<sup>11</sup>.

In other words, PAL aims to develop the tutors' pedagogical competencies concurrent with the construction of knowledge by tutees in the teaching-learning processes. Therefore, this strategy may be useful to meet the expected competencies of the Educational area present in medical curricula such as the Brazilian<sup>4</sup>, once it might present practical and effective ways for medical students to develop teaching experience<sup>12</sup>. Examples of areas in the medical curriculum that can be supported by PAL projects are Human Anatomy and Physiology<sup>10, 12-14</sup>.

Works previously published on Physiology PAL in medical education presented training programs focused basically on the principles of teaching, which included theoretical studying and practical training<sup>12,13</sup>. Thus, tutors developed teaching skills that involved the interplay of three processes: metacognitive awareness; deliberate practice, and self-explanation<sup>12</sup>. These are valuable gains, but PAL can serve further experimentation. Here, we described a new strategy for Physiology PAL in medical education, based on Team-based learning (TBL). TBL was created in the 70's by Larry Michaelsen, with the aim of decentralizing the teaching-learning process from the teacher to the students, allowing students to become co-responsible in the conduction of their own academic education.

This method improves students' academic performance by stimulating critical thinking, team development, motivation and cooperativism<sup>15,16</sup>. The learning process is based on dialogue and interaction among students, which includes communication skills and collaborative work in teams, necessary for their professional future and abiding by the Brazilian national curricular guidelines<sup>17</sup>. The present paper describes one application of TBL in the Physiology PAL in a Medical undergraduate class, here named PAL-TBL method. There were no reports in the literature on the combination of these two teaching-learning strategies in any academic area. The paper discusses how the method was arranged and experienced by tutors, tutees and teacher.

## METHODS

### Local and subjects of the study

PAL-TBL was used as a teaching-learning strategy for Human Physiology classes during 4 semesters in a Medical school, in 2016 and 2017. The strategy was applied on 111 medical students from University of Pernambuco, campus Garanhuns, Brazil. The Medical school was created in 2011 and the undergrad program lasts six years presenting a hybrid curriculum of both conventional instruction (lectures, demonstrations) and modern approaches, such as Problem-Base Learning (PBL). Since its creation, PAL has been quite explored from the first

to the eighth semester. In order to expand and improve the use of active methodologies, a pilot study was proposed by combining TBL methodologies with PAL for Physiology classes.

### Planning for PAL-TBL

PAL-TBL was planned according to Topping and Ehly<sup>18</sup>, whose 13 dimensions were organized as follows: (1) curricular content: Human Physiology with the selected systems and issues demonstrated in Table 1; (2) tutoring teams: in both years, teams were composed of eight students, seven of whom were volunteers and one student was awarded a scholarship. They were divided into pairs to prepare the TBL material and to practice the execution of the activities with a group of 40 tutees, divided into eight groups; (3) year of the class: tutors were from more advanced classes than the tutees with the minimum interval of one year (two academic terms); (4) abilities: tutors were expected to develop the following educational competencies (a) knowing how to identify both individual and collective learning needs; (b) promoting construction of knowledge and socialization; and (c) promoting scientific and critical thinking and supporting the construction of new knowledge; meanwhile, tutees were proposed the construction of Physiology-specific knowledge and non-technical skills for group work; (5) time: PAL-TBL was performed during regular Physiology classes, once a month, with 4 hours of interaction time; (6) place: each PAL-TBL was developed in a wide room with round tables that accommodated all groups; (7) tutor characteristics: students were admitted by a selection process that evaluated their Physiology knowledge, intrinsic motivations and affinity to the project, as well as willingness to be trained for the methodology. They should already have attended the first year of Medical school; (8) tutees characteristics: PAL-TBL was designed for the first and second semesters of Medical school attending regular Physiology classes; (9) PAL-TBL objectives: developing peer-assisted activities with the TBL method to construct knowledge on Human Physiology and foster argumentative abilities thus improving speaking and listening skills, as well as harboring affective, attitudinal, social and emotional gains.

### PAL-TBL methodology

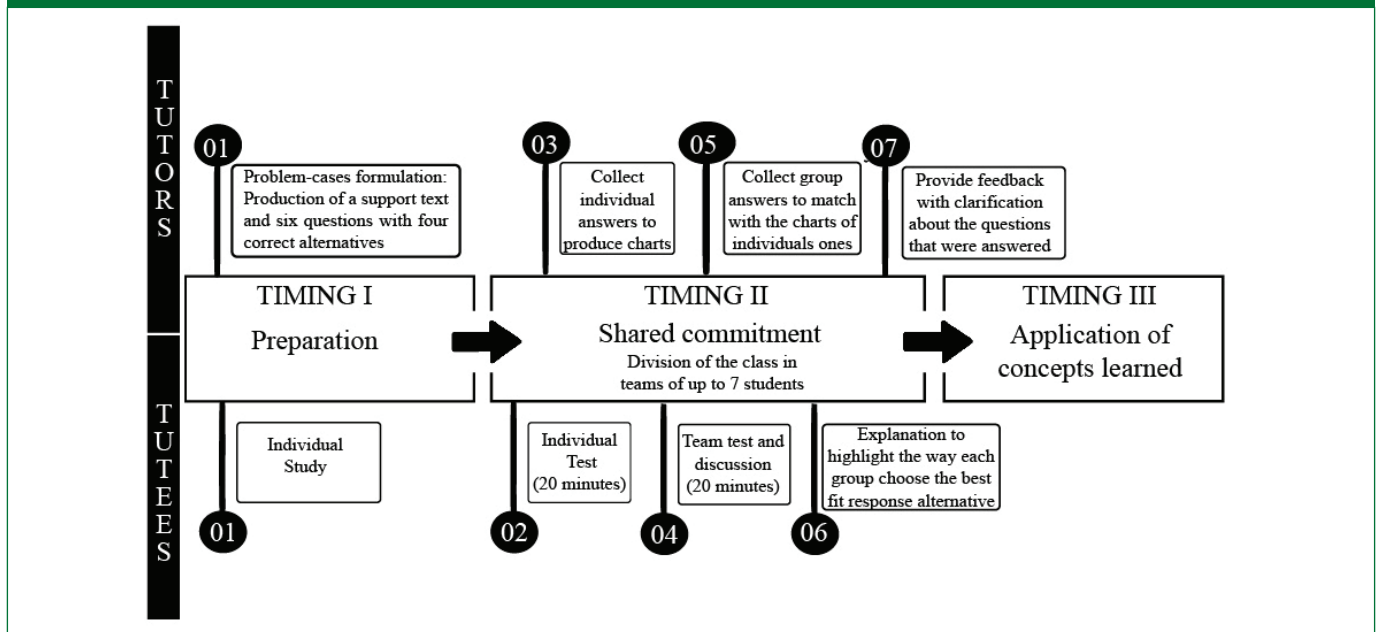
The TBL was designed based on the Parmelee and Michaelsen's twelve tips<sup>19</sup> adapted for PAL situations. The resulting PAL-TBL method was the following: (i) timing I or material preparation (context/scenario) and study/analysis of the material by the participants; (ii) timing II also named as shared commitment, is the verification of prior knowledge (individual and team test), questioning and feedback and (iii) timing III

or application of the concepts learned. It's worth mentioning that timing II ended with a moment for evaluating the team's work and the materials used.

During timing I, the pairs of tutors formulated problem-cases regarding the selected physiological system, producing a support text of up to one page containing the basic physiopathology of the subject, and six questions about the case, each question with four correct alternatives. During timing II or shared commitment, there was the application of the context and following tests, always in accordance to the protocol: (a) division of the class in teams of up to 7 students; (b) students were given 20 minutes for the individual reading of the problem-cases and support text as well as answering the questions. Afterwards, monitors collected the individual answers for each question to produce charts; (c) group discus-

sion for 20 minutes, in which a consensus for the answer of each question had to be achieved generating a unique feedback. Afterwards, each team's answers were collected by the tutors to be compared to the charts of individuals ones; (d) After individual and team responses, the class started with the explanation of how each team constructed the consensus for their answers, highlighting the way in which each group chose the most suitable alternative; in the last step (e) of timing II, tutors provided feedback with clarification of the answered questions. During timing III, the teacher advisor and the tutors recollected the aspects experienced in the TBL in the form of practical classes and further exercises as means of proposing challenging tasks to the teams, such as the application of the contents to other situations. Figure 1 represents the PAL-TBL method developed.

FIGURE 1  
PAL-TBL method



## RESULTS

At the beginning of each semester, the first activity carried out between tutors and teacher advisor was a discussion to instructing the former on the PAL-TBL method, elucidating its characteristics and defining the conduction and preparation of the material to be used during the semester. The pairs of tutors, supervised by the teacher, were responsible for the development of the problem-situations used in the PAL-TBL

sessions. It is worth mentioning that the teams of tutors were formed by students from more advanced semesters. Therefore, developing problem cases for the discussions was facilitated by practices from advanced stages of the course, even the contact with patients in real scenarios. This way, tutors were able to bring cases similar to those found in the community, from Primary Health Care to the hospital scenario. In this aspect, the development of tutors' abilities to understand

Human Physiology in dealing with various pathologies was outstanding.

**TABLE 1**  
**Themes selected for the development of TBL during the year 2017 for the Medicine school.**

Physiological system	TBL issues
Cardiovascular	Heart attack
Respiratory	Chronic obstructive pulmonary disease (COPD)
Digestive	Gastroesophageal reflux disease
Renal	Nephrotic syndrome
Action potential	Hypokalaemia
Neurotransmitter	Botulism

After selecting the themes, tutors prepared the context and exercises that should contain stimulating problems for student's previous knowledge and their teamwork capacity of analyzing, interpreting and then committing themselves with a choice or decision. Furthermore, they were allowed to work together to fully comprehend the concepts and findings and internalize their relations during the process of reaching a conclusion. The first challenge found by the tutors was the initial contact with the teaching experience. As tutors, students become responsible for the teaching-learning process with other students. Thus, the understanding of the area knowledge was not enough. It was necessary for them to develop strategies that allowed for an easier learning process for the other students.

Another challenge faced by the group of tutors was creating problem-cases for the PAL-TBLs. These problems from professional practice should demanded the application of Human Physiology corresponding to those explored throughout the semester. Additionally, the alternatives for each question were not created according to the classical form in which one answer is right while the others are wrong. Instead, the model in which all options were true assertions about the theme was used. This characteristic allowed the development of the ability to choose the most adequate option to each situation, even if all options were possible. After training and answering the proposed questions, tutors developed as expected by the teacher advisor, the ability to elaborate the material for tutoring according to the methodology. Examples of questions made by the tutors for the TBL experience, as well as individual and team answers from the tutored classes according to each theme, are presented in Table 2. Each question or group of questions is related to a problem-case such as the following botulism example:

*"E. M. S., 39 years, male, born and coming from Lajedo (PE), presented clinical condition of vomit, diarrhea and visual cloudiness. Two days later, he was admitted in Dom Moura Regional Hospital with abrupt onset of bilateral ptosis, dysphagia, respiratory distress, myasthenia and cervical pain that radiated to the thorax. On the day before the onset of symptoms, the patient travelled and ingested heart of palm, sausage and mozzarella. Symptoms began approximately 12 hours after the ingestion of these foods. The patient presented vomiting, apnea and cardiac arrest. Resuscitation maneuvers were immediately initiated with quick reversion of the condition. Diagnosis of botulism was confirmed by the finding of the toxin in patient's blood samples. The patient received clinical support and specific treatment and recovered without any complications. Foodborne botulism is caused by the bacteria Clostridium botulinum that produces toxins that attack the synaptic transmission in the neuromuscular junction".*

As observed in Table 2, for each question, there was only one most suitable answer since all alternatives were correct. This characteristic allowed for a rich discussion in each group and among groups in the classroom. Although students showed feelings of doubt, in the first TBL, as they assumed that only one alternative was correct while the others were supposed to be wrong, after understanding the TBL dynamics, students broadened their critical view on each question, improving the quality of the debate.

The tutored classes were committed to the method of execution, respecting the established time for resolving the questions and participating in the group discussions to achieve a specific answer. Therefore, the fact that the TBL model requires students to agree on a specific choice encourages them to work in a critical-reflexive manner. Activities developed during the semester of tutoring for post-PAL-TBL application sought to recollect the themes already explored in class. This application intended to deepen the knowledge constructed in the PAL-TBL. For example, after the Neuron Action Potential TBL, reflexive and sensitivity practices were developed for students to apply and analyze their achievements on the subject. It should be noted that all activities involved the same tutors and were systematically planned for the semester. Consequently, all activities were connected during the advising that took place in the monitoring.

## DISCUSSION

Medical teachers have been challenged to propose teaching-learning methods that allow the development of their students' competencies. For a long time, it was believed that the

**TABLE 2**  
**Examples of questions applied in the TBLs for problem situations of COPD, Hyponatremia and Botulism.**

TBL issue	Question	Alternatives	Answers	
			Individual	Group
COPD*	The likely explanation for the diminution of the vesicular murmur and the vocal fremitus that occur in COPD is:	A constant inflammation, the lung loses functional parts of the bronchial tree, thus the air that no longer circulates through these portions causes the diminution of the murmur and of the fremitus.	0%	16%
		Fibrosis caused by constant inflammation and by pulmonary hyperinflation.	48%	16%
		Residual capacity increase.	45%	52%
		Airway obstruction that allows a smaller amount of air per second.	7%	16%
Hyponatremia**	Serum samples show the patient with 134mEq/L of sodium. How the reduction of extracellular sodium would explain the weakness reported by the patient?	As sodium is an important ion for homeostasis and present in the whole body, changes in its values trigger systemic symptoms.	40%	50%
		For being associated to a clinical condition of infection, sodium loss caused the weakness felt by the patient.	0%	0%
		Sodium helps to establish the membrane potential. Its loss makes it easier to reach the depolarization threshold, making it easier for depolarization to happen and generating fatigue.	52%	34%
		Dehydration caused by infection decreases the total blood volume. This leads to a smaller cardiac output and smaller muscle perfusion, that can generate the fatigue sensation.	8%	16%
Botulism***	Regarding the principles of the chemical synapse transmission, mark the alternative that is more related to this pathology:	With an increase of Ca <sup>2+</sup> concentration, proteins alter its conformation in a way that the lipid bilayer of the vesicle membranes and presynaptic merge forming a point that allows the release of neurotransmitters in the synaptic cleft. Alterations in the Ca <sup>2+</sup> concentration can impair the release of neurotransmitters.	18%	0%
		Once synthesized in the axon terminal cytosol, the amino acids and amines must be taken to the synaptic vesicles. Concentrating these neurotransmitters inside the vesicle is the work of special proteins embedded in the membrane vesicle called transporters. Defects in these transporters are responsible for the appearance of neurological diseases.	15%	0%
		The speed of neurotransmitters' release suggests that involved vesicles have already been "attacked" in their active zones. It is believed that this "docking" involves interactions between proteins from the membrane vesicle and from the active zones. Some substances can destroy proteins involved in this process, like the SNARE protein which is essential for the neurotransmitters release.	28%	33%
		An uninterrupted exposition to high acetylcholine concentrations leads, after several seconds, to a process called desensitization, in which the ion channels activated by the neurotransmitter close; although the acetylcholine is continuously present, what generates a muscular mechanism failure.	39%	67%

The most suitable alternative for the each question is: \*second alternative; \*\*Third alternative ; \*\*\*Third alternative.

teacher was the only source of knowledge in a classroom, from whom students should passively receive what was transmitted to them<sup>20</sup>. In the face of historical transformations, several strategies for the construction of knowledge were developed and added to older ones turning the process of teaching and learning into a more interactive and participative one, adding creativity and critical sense to academic education<sup>21</sup>. Human Physiology is an example of area knowledge that has been significantly transformed in higher education<sup>22</sup>. Studying Physiology requires selecting or creating teaching strate-

gies that helps students to learn, thus being indispensable for the teacher to become a mediator of the process of knowledge construction, stimulating participation and understanding the uniqueness of those involved in the process. New ways of learning help to create new possible settings of professional training in superior education aiming at the development of creative professionals with better-reasoned practice<sup>16</sup>.

Here, a new strategy for the teaching-learning of Human Physiology in Medical school was designed by joining PAL and TBL methods. Employing an active teaching-learning

method, TBL-PAL, to Physiology was discussed and proved to be successful. The teacher advisor proposed the method and developed it along with the tutoring team. Tutors are students interested in self-development through different approaches of area knowledge, carrying out tasks that add to teaching, research or extension activities of a particular professor's group of courses<sup>23</sup>. Traditionally, PAL tutoring activities are based on out-of-class activities focused on classroom difficulties, with a selection of methods that mitigate them. From this perspective, tutoring can be understood as an activity in which the student supports the teaching-learning process<sup>24</sup>. However, from a teamwork perspective as adopted in the PAL-TBL project, the work of the tutor can be extended to different models from the one presented as an activity carried out concurrent to the teacher's work in the classroom, thus requiring a more active and collaborative participation from the tutors on the entire teaching-learning process<sup>25</sup>.

This type of teamwork was intended with the selection of the TBL strategy for the PAL activities. In the developed method, the TBL was planned for PAL Physiology sessions by tutors and teacher collaboratively. During the planning of the TBL session and the moment of dispersion, all the proposed activities included the elaboration of pedagogical objectives, content, on-site tasks (tests, dialogues, workshops, dramatizations, discussion sessions, etc.) and extra class tasks, in addition to evaluative techniques. The most expected response from the participants during classes was expressed in their engagement in the activities, their responsibility and interest in seeking out information as well as in their willingness to collaborate with their team.

Literature results corroborate the effects of using TBL in PAL tutoring for Human Physiology, since it has been used as a method for the education of health professionals in areas such as Embryology and Ophthalmology. According to Nieder *et al.*<sup>26</sup> more than 80% of the 280 students who experienced the TBL method agreed that learning was more consistent, and it also stimulated interaction and clinical discussion to solve the problems proposed. In another study, over 70% of the 169 people who participated in the TBL agreed that this method is more effective than traditional methods, since it requires more effort and participation from the students<sup>15</sup>. More recently, Burgess *et al.*<sup>6</sup> demonstrated that medical students preferred TBL over PBL as the optimal teaching strategy due to its qualities.

The application of PAL-TBL method extends the benefits of TBL characteristics to the tutoring teams. At each stage of the PAL-TBL (Figure 1), the tutors identified their own personal and professional gains and those of the tutee stu-

dents. During timing I, it was possible to identify individual autonomy and recovery of the tutees' previous knowledge in line with the performance of practical tasks by the tutors. During timing II, it was possible to observe the development of arguments, quality listening and joint decision making. In the making of the questions and the promotion of teamwork, it was noted that professional performance demanded more than the memorization of facts or theories and that individuals must motivate themselves to solve the presented problems.

Another important characteristic evidenced by the use of PAL-TBL was the exchange of experience between the participants which favored the recognition of individual potentialities and needs, so that each participant would find in this analysis a way to expand their participation and contribution to the team. According to Jost *et al.*<sup>27</sup> this recognition enhances students' motivation to learn specific components, improves communication and the ability to work in groups making TBL an attractive method, easy to learn and to apply. Thus, PAL-TBL benefited every learner (tutees) in some way as it was organized to benefit every helper (tutor) in some way, too. This is true both for the student helper and the student who is nominally helped<sup>7</sup>.

Therefore, PAL demands from the tutor a sense of commitment, seriousness and responsibility, as the method is considered by the students involved as an important instrument for studying specific knowledge areas and to an integrated professional education. For tutees, the tutor is a link between the teacher and the assimilation of the contents covered in class. For this reason, this strategy should employ mediation as a tool for the development of the proposed activities, since the tutor is seen by the tutees as an important facilitator in professional training<sup>29,30</sup>.

Finally, in the feedback phase for the tutored groups, during the confrontation between the results of individual and collective tests, it was possible to work on the valuation of one's knowledge, on the possibility of collective knowledge construction and the addition of results by sharing of information by every individual on the team. In addition, the discussion in small groups made the students feel more comfortable, allowing the content to be deepened and fixed for more time<sup>31,32</sup>.

## CONCLUSION

The experiences of the pilot study of PAL-TBL for Human Physiology corroborated the well-established importance of tutoring for personal and academic development of students. The differential of PAL in this project was the application of

a TBL strategy. The method enabled the development of the following educational competencies in the tutors: (a) identifying individual and group learning needs; (b) Promoting the construction of knowledge and socialization; and (c) promoting scientific and critical thinking and supporting the construction of new knowledge. Meanwhile for the tutees it was proposed the construction of Physiology-specific knowledge and non-technical teamwork skills. We intend to expand this experience in future applications.

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### Disclosers

No conflicts of interest are declared by the authors.

### Authors Collaboration

The number of seven authors are justified since all of them participated as tutors during the project execution under the supervision of Sinara Mônica Vitalino de Almeida

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