Using team-based learning for post-graduate training: challenges and solutions

Luan Nhut Au[*], My Thi Ngoc Do, and Hien Dang Phuoc Nguyen

Department of Obstetrics and Gynecology, Faculty of Medicine, University of Medicine and Pharmacy at Ho Chi Minh City, Ho Chi Minh City, Vietnam

Abstract

Introduction: Available evidence demonstrates that team-based learning (TBL) enhances teacher-learner interactions, solves cognitive gaps, connects concepts, and builds critical thinking. Nowadays, TBL has become a popular approach in undergraduate training (UGT). Surprisingly, only a few institutions implemented TBL into their post-graduate training (PGT) programs. UGT and PGT differ in their educational ecosystem, learning goals, and learner characteristics. Attempting to use TBL in PGT (TBL-PGT) requires adaptations to these differences. There are few conducted studies on TBL-PGT. Most discuss the possibility of using TBL in specific courses and do not discuss technical issues. We also experience challenges during our experiential TBL-PGT course. This paper aims to clarify TBL-PGT characteristics, identify potential challenges and discuss suitable solutions.

Methods: We search papers on TBL-PGT, identify technical issues and discuss potential solutions.

Results: To date, no systematic use of TBL in any post-graduate programs. All TBL-PGT attempts were experiential. The authors agreed that TBL could be part of the PGT program and that implementing TBL-PGT requires suitable adaptations. Experiences from experiential TBL-PGT affirm the crucial role of adapting course design to the particular PGT educational ecosystem, the complexity of knowledge, and the ability to link new concepts to real-life activities. We identify factors that might influence the TBL-PGT program outcomes, which include involving experts, enhancing learner accountability, building teams, determining educational goals, configuring assessments, preparing learning material, formulating authentic applications, training facilitators, and organizing in-class activities.

Conclusions: TBL is suitable for PGT. It promotes certain advantages. However, curriculum developers should consider adaptations while implementing TBL-PGT.

Keywords: team-based learning; post-graduate training; transdisciplinary approach; educational ecosystem; workplace-based learning

1. INTRODUCTION

In the early 1980s, Larry Michaelsen developed a new approach to teaching-learning that allowed the benefits of small-group learning within large classes. This educational approach was very close to the structure that team-based learning (TBL) classrooms use today [1]. Decades later, several U.S institutions implemented TBL as part of their core curriculums. In the early 2010s, TBL became a popular educational approach. Several educational settings worldwide,

including high schools and universities, introduced TBL into their training programs [2].

Nowadays, the TBL TM Collaborative (TBLC) defines TBL as "an evidence-based collaborative learning teaching strategy designed around units of instruction, known as "modules," that are taught in a three-step cycle: preparation, in-class readiness assurance testing (RAT), and application-focused exercise (APP). A class typically includes one module" [1] (Fig. 1).

By flipping the classrooms, TBL allows beneficiaries to avoid wasting time on in-class speech, so it promotes gaining time. This precious time gained is crucial for ensuring active learning [3]. According to available evidence, TBL effectively enhances teacher-learner interactions. Published works also demonstrate that TBL helps learners effectively solve cognitive gaps, connect learned concepts, and think critically [4].

Unlike the case of undergraduate training (UGT), only a few institutions implemented TBL into their post-graduate training (PGT) programs. The number of publications concerning the use of TBL in post-graduate training (PGT) is quite limited. There are few conducted studies on the use of TBL in PGT (TBL-PGT). Those papers mainly discuss the possibility of using TBL in specific courses rather than its potential technical issues.

Therefore, this paper clarifies findings that concern the use of TBL in PGT, identifies potential challenges, and discusses suitable strategies for solving them.

2. METHODS

We searched affiliated journals of the BEME, the IAMSE and the AMEE for published works on using TBL in PGT, using "team-based learning" and "post-graduate training" as keywords.

Found papers were retrieved and reviewed. The revision focused on the type of implementation, potential challenges, and the author's suggestions. These potential challenges and propositions were retrieved and used as subjects of discussion.

Because of the limited number of published works, we could not apply any statistical methodology for analyzing data. Consequently, we decided to perform direct analysis and comparison instead of quantitative or qualitative analysis.

Retrieved issues were also compared with UMP's current practices.

3. RESULTS

3.1. Searching results

We found only five papers which directly discuss issues related to the implementation of TBL in PGT. These five are published by McMullen et al. (Medical Teacher, 2014) [5]; Travis & Hudson (Teaching of Psychology, 2016) [6]; Graham et al. (Medical Science Educator, 2020) [7]; Xue et al. (Nurse Education Today, 2021) [8]; Nandamudi et al. (Journal of Interprofessional Education & Practice, 2023) [9] (Table 1).

3.2. Reviewing papers

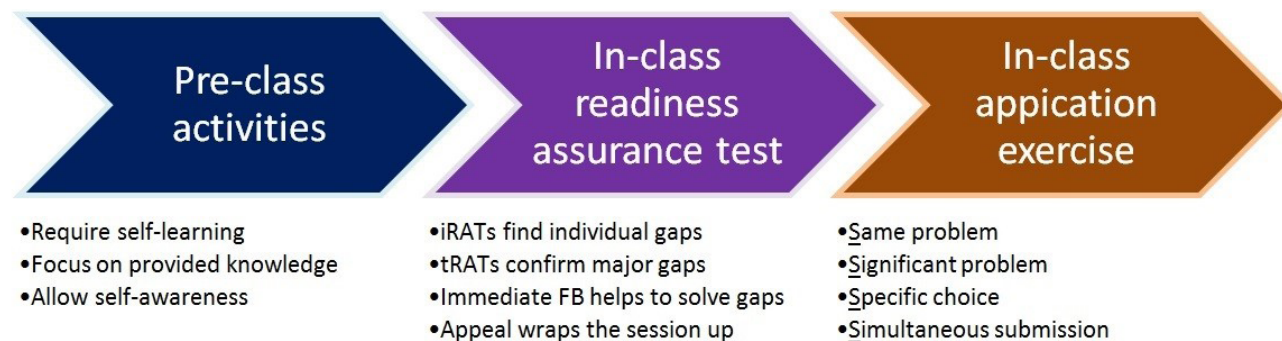The revision of these papers found that, to date, only a few

Fig. 1. The three steps of team-based learning.

Table 1. Brief description of published papers on PGT-TBL

		Disciplines	Implementing type
McMullen et al. [5]	2014	Psychiatric	Experiential use
Travis & Hudson [6]	2016	Introductory psychology	Experiential use
Graham et al. [7]	2020	Transfusion medicine	Experiential use
Xue et al. [8]	2021	Nursing	Comparative study
Nandamudi et al. [9]	2023	Dysphagia interprofessional collaborative	Pilot study

PGT, post-graduate training; TBL, team-based learning

institutions implemented TBL in their PGT curriculums. All of these uses of TBL in PGT were experiential and partial. There was no systematic use of TBL in any post-graduate programs.

Preliminary works on the experiential use of TBL in PGT have shown controversial opinions.

Graham ran three transfusion medicine sessions adhering to TBL principles. She demonstrated that TBL is effective and enjoyable. She also mentioned that preparation should be adequate, and team continuity is poor despite 'compulsory' education sessions [7].

McMullen converted a didactic module of lectures into a TBL module for psychiatric residency training. She concluded that her attempt to introduce TBL into her residency training program was successful. She considered involving TBL experts, reinforcing pre-class preparation and avoiding excessive pre-session assignments as keys to making TBL more relevant [5].

Travis studied the influence of TBL methods on exam performance and student satisfaction in her PGT class on introductory psychology. She demonstrated that students in the TBL sections performed significantly better on items that tested the content covered in the TBL modules. She concluded that TBL is more effective than lecture in contributing to learning among introductory psychology students without negatively impacting course satisfaction [6].

Xue compared the effect of TBL on post-graduate nursing students with lecture-based teaching with small group discussion and aimed to clarify potential factors that promote the effectiveness of TBL. Xue concluded that TBL effectively improved self-learning ability and classroom engagement. Xue also mentioned the importance of clear and definite reading assignments in TBL. Quality RAT helped students

obtain effective teacher feedback and ensured the effectiveness of discussion and communication [8].

Nandamudi studied the impact of the effectiveness of TBL on teaching collaborative practice (in dysphagia intervention) by conducting a TBL-based training in interprofessional education (IPE). She concluded that there was a strong positive influence on achieving the four core competencies [9].

In brief, these five authors agreed that TBL could be part of a residency and/or post-graduate training program. On the other hand, McMullen, Graham and Xue shared that appropriate adaptations are the key to implementing TBL in PGT [5],[7,8].

3.3. Experiential use of team-based learning (TBL) for post-graduate training (PGT) at UMP

In 2017, we built up and started a reproductive medicine PGT course based on TBL. The integrated course included biology, physiology, biochemistry, embryology, endocrinology and gynecology. At the end of this course, we invited learners to give us feedback. Learners provided positive feedback that concerns the teaching-learning approach. They also shared positive individual perspectives.

In the two following academic years, we ran the same PGT credit but applied some modifications to the RAT.

To date, we experienced the impacts of the PGT educational ecosystem on TBL course outcomes. We also found that involving experts, preparing learning materials, defining RAT goals, composing authentic application situations and selecting facilitators should be considered for applying TBL for PGT.

4. DISCUSSION

4.1. General perspectives

PGT is different from UGT in several particularities. The three main differences are the educational ecosystem, outcomes of learning and characteristics of learners (Table 2).

In PGT, simulation-based activities become less important. Various workplace activities replace simulation and then feature PGT. Graduates learn by practicing in real-life conditions. Several factors might impact learners' activities and efficacy of learning such as facing real-life beings, interprofessional relationships and social responsibilities.

PGT focuses on Entrustable Professional Activities (EPA) and targets professional competencies. This approach aims to help learners reach the top three levels of the educational pyramid (shows, does, trusts). Through PGT, learners follow a process of metamorphosis from novice to competent via milestones. While in PGT, students bring theory into daily practice, face real issues, move from knowledge-centered to human-centered.

In general, PGT courses involve learners who come from different backgrounds. It makes the PGT learner population heterogeneous. This heterogeneity includes learner competencies and practical experiences. Learner characteristic also concerns their social status, learning accountability and learning dynamics.

The above particularities of PGT require suitable teaching-learning configurations. In TBL-PGT, the technical issue to be solved is how to adapt the practice of TBL to PGT while still keeping the TBL principles?. Therefore, measures for implementing TBL-PGT should adapt to the PGT educational ecosystem, the complexity of knowledge and the ability to link new concepts to real-life practices (Fig. 2).

**Table 2. Characteristics of uundergraduate training and post-graduate training**

	Undergraduate training (UGT)	Post-graduate training (PGT)
Targets	Knows; knows how; shows	Shows; does; trusts
Educational environment	Simulation-based training	Workplace-based training
Learning materials	Tailored applications	Real life events
	Standardized subjects	Real-life beings
Knowledge complexity	Simple, separate	Complex, linked
Outcome measurement	Pre-defined end-points	Milestone complex system
Validating criterion	Pass-fail criterion	Judgement and decision

4.2. Adapting to the particular post-graduate training (PGT) educational ecosystem

Three issues may relate to this subject. Those issues are expert involvement, learner accountability and building teams.

4.2.1. Expert involvement

McMullen emphasized the importance of expert involvement in TBL course success [5]. UMP's practices reaffirmed
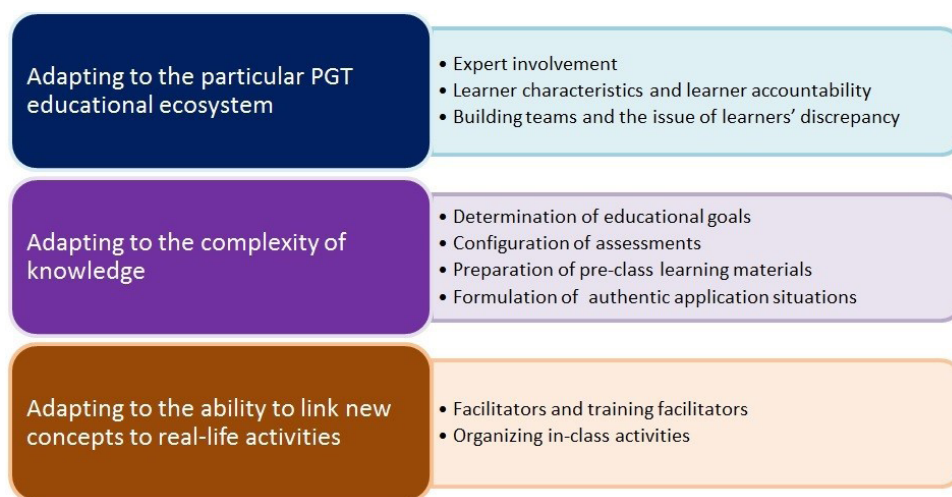
Fig. 2. The three measures for implementing TBL-PGT. TBL, team-based learning; PGT, post-graduate training.

this statement.

In UGT, the participation of experts in the teaching process is not mandatory. Their primary roles are curriculum developers, course managers and learning material editors [1],[3]. Inversely, involving experts is a primary prerequisite for implementing TBL-PGT. Experienced experts are critical resources for implementing the TBL curriculum in PGT.

Practicing in a real-life environment requires learners' competencies; therefore, PGT trainers should be experienced practitioners. The top priority in implementing TBL-PGT is to recruit experienced trainers from various domains.

Moreover, experienced trainers should work together in the expert committees. The committees are responsible for designing course syllabi, preparing course agenda, composing learning materials, approving these materials, developing and ensuring assessments, and facilitating the TBL classrooms.

4.2.2. Learner characteristics and learner accountability

McMullen emphasized that learner accountability should be reinforced [5]. UMP experienced the impacts of the lack of learner accountability on course outcomes and has made efforts to improve it.

Learner accountability includes a learning attitude and taking responsibility. In PGT, each learner may have unique social status, learning accountability and learning dynamics. These particularities may impact the TBL-PGT program outcomes. TBL-PGT course organizers must address learner accountability and uniqueness during the pre-course discussion.

Lack of accountability hinders the quality of TBL classrooms. TBL practitioners should recognize the importance of this issue and develop strategies for accurately assessing learner accountability. Additionally, the TBL process holds students accountable for coming to class prepared and working together as a team [1],[3].

4.2.3. Building teams and the issue of learners' discrepancy

EPA and IPE are key features of PGT. Varieties of workplace activities dominate EPA's teaching-learning processes. In the workplace environment, learners should perform their tasks in team setting rather than individually. Their ability to work in teams becomes a mandatory requirement.

Nandamudi considered that TBL-based training enhanced learners' ability to work together in IPE [9]. Travis confirmed this statement and showed empirical evidence, which suggested that TBL is a suitable pedagogical approach that enhances learners' ability to work in teams [6].

The authors in these papers did not discuss learners' discrepancies. Learners' discrepancies include discipline, performance and experience. Graham found that the team after-class continuity was poor, but she did not adequately explain potential hidden causes [7]. Learners' discrepancies include discipline, performance and experience. The UMP had faced the same discrepancy issue and had to solve it.

The balance among teams in learner characteristics is one of the four principles of TBL. Different learner backgrounds lead to team heterogeneity that may influence the accuracy and effectiveness of team performance. Consequently, course organizers should build teams with similar characteristics by placing learners who have various learning experiences equally in each team.

Once it meets the above requirement, TBL allows learners to improve their ability to work effectively together.

4.3. Adapting to the complexity of knowledge

There are four issues being discussed in this section, include: educational goal determination, assessment configuration, pre-class learning material preparation and formulation of authentic application situations.

4.3.1. Determination of educational goals

Conventionally, TBL is an approach which aims to teach theory basis in a single-disciplinary/multidisciplinary course. Undergraduates learn through understanding concepts and connecting them.

In PGT, the teaching theory basis targets wide-ranging knowledge. In recent decades, PGT began shifting its pedagogical approach, leaving multidisciplinary strategies and redirecting toward the universal implementation of interdisciplinary/transdisciplinary courses. The pre-existed boundary between subjects in multidisciplinary approaches becomes

less indistinct in the interdisciplinary/transdisciplinary course. The learning contents usually have higher complexity and should be practice-oriented. Graduates often feel challenged while connecting wide-ranging concepts relating to various disciplines.

Therefore, conventional TBL might lose the ability to ensure its effectiveness in PGT. Changing the TBL course syllabi becomes crucial. TBL course ELOs should target the ability to link ideas rather than focus on the ability to understand separate concepts or the ideas themselves. This approach contributes to putting learners at ease while simultaneously working on several topics.

The above-discussed adaptations were subjects to explore in experiential uses of TBL interdisciplinary courses. Nandamudi demonstrated that her TBL-based integrated module positively influenced helping learners achieve the four core competencies [9]. The UMP's experiential TBL-integrated course confirmed this statement.

4.3.2. Configuration of assessments

The TBLC considers the RATs as double-purpose activities targeting assessment-of-learning and assessment-for-learning [1]. PGT-RAT is different from UGT-RAT in its aims. UGT-RAT aims to identify cognitive gaps, while PGT-RAT focuses on more complex competencies (connecting, applying, synthesizing, summarizing). As a formative assessment, PGT-RAT requires adapted changes to help graduates reach their learning goals.

Bringing concepts together is one of the primary assessment goals in PGT. Moreover, graduates should be able to link ideas concerning different disciplines (integrating). Low-order thinking MCQs seem likely unable to meet PGT test blueprint requirements.

PGT-RAT should target a higher level of knowledge, such as the ability to analyze/synthesize complex issues. Therefore, PGT-RATs require the replacement of low-order thinking MCQs with high-order thinking MCQs. Crafting high-order thinking MCQs needs writing experiences, both educational and professional [1],[3].

On the other hand, irrelevant PGT-RAT might "kill" in-class activities without helping learners find the right way to connect separate issues. Technically, composing relevant PGT-RAT is challenging. Ideally, TBL trainers should work in an expert committee. To ensure the relevance of the PGT-RAT, this committee should identify the most common misunderstood reasoning, professional mistakes, and potential cognitive gaps and put it all into the PGT-RAT [1],[3].

Xue emphasized the need for relevant MCQs for teaching and assessing purposes in TBL-based PGT [8]. The UMP experienced several difficulties when composing MCQs for PGT-integrated courses.

4.3.3. Preparation of pre-class learning materials

Implementing TBL-PGT requires adapted learning materials to cover all key concepts which help learners build interdisciplinary connections. Those materials should consistently develop ideas throughout several disciplines, directly target idea linking, and constructively align (both vertically and horizontally) with designed ELOs. On the other hand, in the workplace environment, even though learners are graduates, textbooks are not the first choice as practicable materials. Simplified, structured, oriented and learner-centered documents should be the key features of TBL materials.

Avoiding potential learners' overload is also important Pre-class workload should not exceed the minimum required.

Quality materials help learners to think critically throughout the learning process. McMullen [5], Travis [6] and Graham [7] shared the same idea on the importance of targeted learning materials. They emphasized that ensuring the constructive alignment between ELOs, assessments, and learning materials is a prerequisite to success in TBL-PGT. Students in the TBL-PGT program at UMP receive targeted learning materials.

4.3.4 Formulation of authentic application situations

The 4S principles are the cornerstones of TBL. They include: : working in teams, solving the Same assignment on Significant problems, selecting Specific solutions, and Simultaneous reporting (of team solution) [1],[3].

Application exercises for UGT-APP differ from application situations for post-graduate training (PGT-APP) in their learning goals.

Most UGT-APPs are simulated exercises. The 4S-based application exercises help students connect separate learned elements and apply knowledge in simulated situations [3].

In PGT, the weighting of practical activities is high. Graduates learn through specialized, oriented training courses. Consequently, PGT-APPs should focus on more complex and authentic subjects while still respect for the 4S principles. Replacement of solving simulated exercises with managing real-life situations features those courses.

Application situations should not include invalid details. Removing them from the original issue is crucial, which ensures reaching ELOs.

In her research, Graham demonstrated that PGT-APPs did not reach the same degrees of effectiveness throughout different abilities [7]. UMP's experiential TBL-PGT suggested that the PGT-APP should focus on initial acquisitions rather than advanced competencies.

4.4. Adapting to the ability to link new concepts to real-life activities

wo issues are discussed in this section: the facilitators and the organization of in-class activities.

4.4.1. Facilitators and training facilitators

As conventionally described, there is neither a lecturer nor a lecture in TBL classrooms.

In UGT, TBL facilitators are in charge of facilitating in-class discussions. They are not being responsible for delivering a course. Consequently, the in-class presence of experts is not a mandatory requirement [10].

Unlike UGT, the PGT in-class activities concern the highest degree of thinking also the ability to link concepts to real-life practices. McMullen suggested that the in-class presence of a proficient practitioner seems likely a primary requirement [5]. To date, the UMP has consistently followed this strategy.

Skilled facilitators are a prerequisite in all TBL classrooms. Facilitators should be familiarized with TBL's philosophy, regardless of UGT-TBL or PGT-TBL. Unskilled facilitators might shoot the in-class discussion down [10]. Future trainers (even experts) should equip themselves with skills

for preparing and conducting TBL. They should regularly attend specific ToT on the ability to facilitate so that they can improve the trainer-trainee interactions and enhance the effectiveness of discussion in PGT. McMullen considered training facilitators as a crucial part of preparation [5]. The UMP has consistently supported this consideration. To date, we conducted several ToT workshops. to continuously train our facilitators.

4.4.2. Organizing in-class activities

Even though TBL is one of the various kinds of flipped classrooms, the TBL approach is very different from the other flipped classrooms. A typical TBL flow includes three consecutive steps: preparation before class, in-class RAT and in-class APP [1],[3].

The preparation phase includes all learner must-do activities before a class which mainly focus on self-studying provided materials. This phase aims to provide essential knowledge to learners and does not aim to find or solve their cognitive gaps. Even though the fact that PGT graduates have more advanced background, self-learning is still critical in PGT-TBL. McMullen and Graham experienced the impact of inadequate learner preparation on TBL-course outcomes [5],[7]. Graham emphasized the significance of the preparation phase in the TBL-based training and suggested conducting an opening talk for each course. The UMP emphasizes the importance of self-learning to all of our students.

The in-class RAT is the key of TBL. PGT-RAT focuses on high-order thinking. On-target focused discussions and experienced trainers are the two factors that ensure the effectiveness of PGT-RAT. Discussions should address interdisciplinary/transdisciplinary issues and not focus on individual subjects. Even though the in-class presence of experts is mandatory, experts should maintain their roles as facilitators and not lecturers to promote open discussions. Delivering speeches shot discussion down. Technically, we consider that facilitating is the most challenging TBL-PGT issue.

The in-class APP is also the cornerstone of TBL. PGT-APP concerns transdisciplinary linked concepts. Experienced trainers are crucial to ensure the relevance of PGT-APP. On the other hand, evidence-based solutions support graduates

in enhancing critical thinking. Voting via colored clickers, as classically described, allows graduates to express complex solutions. Using various ways for reporting encourages learners to discuss more complex options. A poster gallery walk seems likely helpful for expressing complex solutions [1].

5. CONCLUSION

Several studies have confirmed the effectiveness of TBL. Furthermore, evidences also support the use of TBL in PGT. Experiential works demonstrate that it is possible to introduce TBL into PGT. However, implementing TBL in PGT requires several adaptations to achieve more complex educational goals. The difference in the educational ecosystem also requires appropriate changes. Paying attention to the impact of an educational ecosystem, involving experts in professional committees, carefully designing course syllabi, preparing appropriate learning materials, changing the way of writing RAT and applications, and involving trainers in ToT workshops are the most common issues which relate to the success of implementation TBL in PGT.

Conflict of interest
No potential conflict of interest relevant to this article was reported.

ORCID
Luan Nhut Au
https://orcid.org/0009-0007-3844-9240
My Thi Ngoc Do
https://orcid.org/0000-0001-6867-4798
Hien Dang Phuoc Nguyen
https://orcid.org/0000-0002-6841-1127

Authors' contributions
Conceptualization: LN Au.
Methodology: LN Au, MTN Do.
Validation: LN Au.
Investigation: LN Au.
Writing - original draft: LN Au, MTN Do, HDP Nguyen.
Writing - review & editing: LN Au, MTN Do, HDP Nguyen.

Availability of data and material
Upon reasonable request, the datasets of this study can be available from the corresponding author.

Ethics approval
Not applicable.

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