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Journal

Medical Science Educator, 29(4)

Authors

Tulloch, Luis
Relan, Anju
Curello, Jennifer
et al.

Publication Date

2019-12-01

DOI

10.1007/s40670-019-00804-3

Peer reviewed

Medical Science Educator (2019) 29:1179–1185
https://doi.org/10.1007/s40670-019-00804-3

ORIGINAL RESEARCH

Using Modified Team-Based Learning to Teach Antimicrobial Stewardship to Medical Students: One Institution's Approach

Luis Gonzaga Tulloch[1] · Anju Relan[2] · Jennifer Curello[2] · Elise Martin[3] · Roma Patel[2] · Tara Vijayan[2]

Published online: 28 August 2019

Abstract

Educational interventions are a critical feature of antimicrobial stewardship programs. Most of these interventions target practicing physicians whose prescribing habits are usually difficult to influence. Consequently, there has been increasing interest in familiarizing early learners with the principles of antimicrobial stewardship. However, there is limited data regarding the utility of active learning interventions, such as team-based learning (TBL), for this purpose. In this article, we report the results of a post-course survey eliciting the opinions of the 168 second year medical students who completed the first implementation of a modified TBL course on antimicrobial stewardship. The course consisted of two 120-min modules, each of which guided participant students through most of the characteristic stages of TBL. The post-course survey was analyzed using qualitative and quantitative methodologies. In general, students found the readiness assurance testing, application activity, and team dynamics of TBL effective and the webcasts, used for pre-class preparation, ineffective. This study offers a first glimpse into the attitudes of pre-clinical medical students toward TBL as a strategy for introducing antimicrobial stewardship. It can serve as a roadmap for educators contemplating the implementation of a similar program at their institution and as a launching pad for research on the effects of this type of intervention on physician prescribing habits.

Keywords Team-based learning · Antimicrobial stewardship

Introduction

Educational interventions are critical for strengthening antimicrobial stewardship programs [1]. Traditionally, these interventions have targeted practicing physicians in order to influence their prescribing habits. However, effecting behavioral change among experienced physicians is a difficult enterprise [2, 3]. There is increasing interest in introducing antimicrobial stewardship early in medical training, but few studies have analyzed which pedagogies are best suited for doing so [3]. Specifically, there is a dearth of data on the efficacy of active learning interventions to teach antimicrobial stewardship.

✉ Luis Gonzaga Tulloch
luistulloch@gmail.com

[1] Puget Sound Veterans Affairs Healthcare System, Hospital and Specialty Medicine, 1660 S. Columbian Way, S-111-MED, Seattle, WA, USA

[2] David Geffen School of Medicine, University of California Los Angeles, Los Angeles, CA, USA

[3] University of Pittsburg Medical Center, Pittsburg, PA, USA

Team-based learning (TBL) is an active learning strategy that gives students the opportunity to apply independently learned concepts through a series of small group activities designed to foster accountability, critical thinking, and teamwork. Team-based learning has been used widely to train students in the health sciences [4–6]. We designed and implemented an antimicrobial stewardship course for second year medical students consisting of two modified TBL modules. In this article, we report the results of the post-course survey eliciting the opinions of the learners who completed the first implementation of this course.

Methods

Setting and Participants

The setting for this intervention was the David Geffen School of Medicine at the University of California in Los Angeles (UCLA), a 4-year, non-profit, public medical school located in a major metropolitan area. We included a convenience sample of 168 second year medical students from the graduating

class of 2020 enrolled in the required microbiology and antimicrobial pharmacology course between August and September of 2017. Fifty-three percent of the students in this class are female and 76% are residents of the state of California [7]. The course is taught primarily through a combination of traditional lectures, problem-based learning (PBL) modules, and "hands-on" clinical activities. Prior to our intervention, antimicrobial stewardship had just been introduced to the curriculum in the previous year. In addition, webcasts and TBL had only been used on one occasion each before our intervention: the webcasts were used as part of three question-and-answer sessions regarding antimicrobial stewardship for students in the graduating class of 2019 and TBL had been used as an activity in a different discipline for students in the graduating class of 2020.

Intervention

The antimicrobial stewardship course consisted of two 120-min modules, each of which guided the entire class in randomly selected groups of six to eight students through most of the characteristic phases of TBL (Fig. 1). Pre-class preparation consisted of assigned readings, traditional lectures on microbiology, and nine newly developed webcasts on antimicrobial pharmacology. The webcasts lasted up to 30 min and were narrated by a multidisciplinary team of infectious disease physicians and pharmacists. The first two webcasts introduced basic principles of antimicrobial pharmacology and optimization including bioavailability, distribution, minimum inhibitory concentration, and pharmacokinetic-pharmacodynamic relationships. The remaining seven webcasts detailed the mechanism, spectrum of activity, and adverse effects of different antibiotic classes. The webcasts were assigned at the start of the course, and students had protected time to complete them at home. In-class individual and team readiness assurance testing (IRAT and TRAT, respectively) consisted of a ten-question multiple-choice quiz which students completed individually, and then again in their randomly assigned groups. The first module used paper-based Immediate Assessment Feedback Technique cards for the two assessments. The second module used the Inte-Dashboard ™ software platform to administer and monitor the readiness assurance testing. Students had 15 min to complete the IRAT and 25 min to complete the TRAT. The answers to the ten-question multiple-choice quiz were discussed after the TRAT. Lastly, for the application activity, students were guided through a real-life clinical scenario punctuated by a series of multiple-choice questions, which mirrored real clinical conundrums and frequently had multiple correct answers. Groups of students had to simultaneously reveal the answer to each of the questions and were encouraged to defend their answers and ask clarifying questions of the supervising faculty (Fig. 1). Our intervention did not include peer evaluation due to the 120-min per module time limit.

Post-Course Survey

After completing the entire microbiology and antimicrobial pharmacology course, students were asked to answer an anonymous 16-question online perception survey. The survey was a modified version of the standard post-course that included questions pertaining specifically to the TBL modules. It contained 12 Likert-scale questions, two multiple-choice questions, and two short-answer questions eliciting what students liked and disliked about TBL as a strategy to teach antimicrobial stewardship (Fig. 2). Responses to the Likert-scale and multiple-choice questions were analyzed using descriptive statistics. The short-answer responses were analyzed using conventional content analysis. Responses were read independently by two of the authors (TV and LT) to identify underlying themes. The authors then created response categories based on these underlying themes. Each individual student's response was allocated to one or more categories depending on the number of underlying themes that emerged from it [8]. The authors communicated regularly to resolve disagreements and reach consensus regarding the nature of the underlying themes and their allocation to the response categories [9]. The UCLA institutional review board exempted this study.

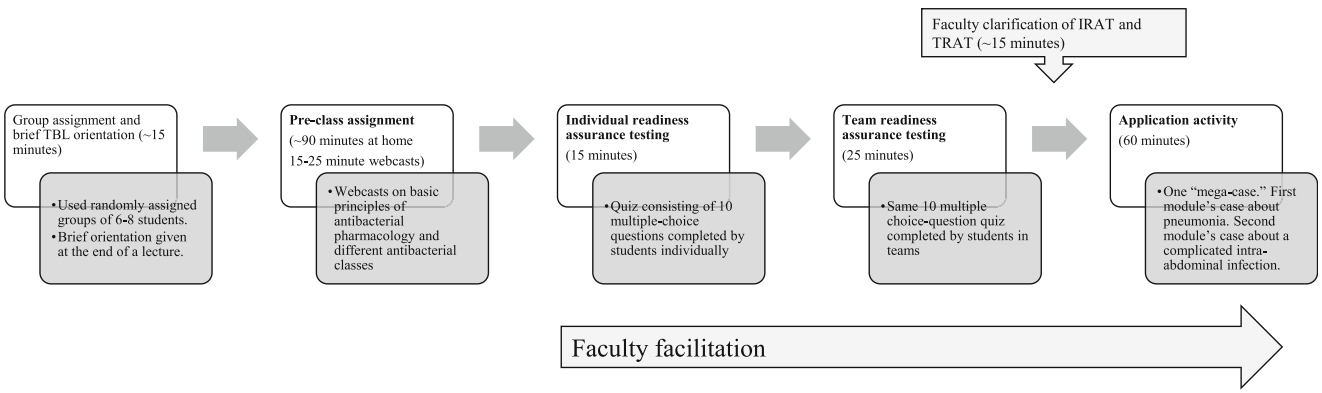

Fig. 1 Structure of an antimicrobial stewardship team-based learning module

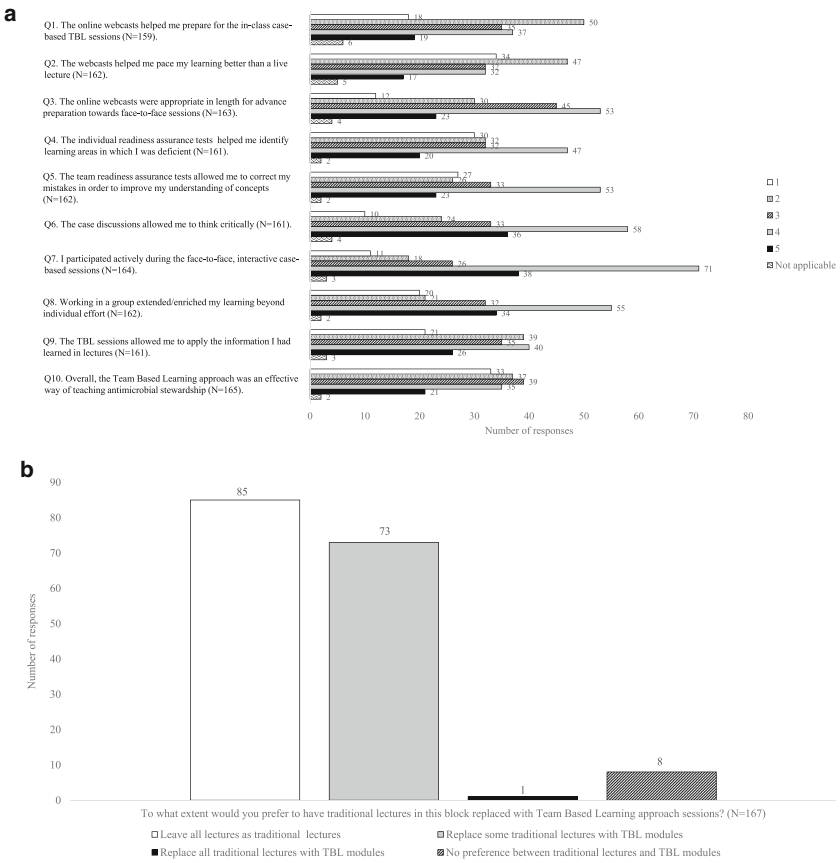

Fig. 2 **a** Results of Likert-scale questions. **b** Results of multiple-choice question; TBL team-based learning; *N* number of responses. For Likert-scale questions: 1 Strongly disagree; 2 Disagree; 3 Neither agree nor disagree; 4 Agree; 5 strongly agree. For multiple-choice questions: LAL leave all lectures as traditional lectures; RST replace some traditional lectures with TBL modules; RAT replace all traditional lectures with TBL modules; NPB no preference between traditional lectures and TBL modules

Results

Student responses are presented according to the four stages of TBL (Fig. 1), team dynamics, and overall effectiveness of TBL to teach antimicrobial stewardship. Students' consolidated perceptions on both qualitative and quantitative components of the survey are highlighted within each of these sections.

Participation in the Post-Course Survey

One hundred and sixty-seven (99.4%) of the students who completed the course responded to the Likert-scale and multiple-choice questions. Responses to the two short-answer questions were variable: on the first question pertaining to reasons for liking TBL, 66 (39.3%) students responded, with 54 (32.1%) providing 67 categorizable units. Seven (4.2%) students erroneously answered the second short-answer question instead and five (3%) provided no response. On the second question pertaining to reasons for disliking TBL, 91(54.2%) students responded (including the seven students who had answered the first question erroneously), with 88 (52.4%) providing 133 categorizable units and three (1.8%) providing no response.

Pre-Class Preparation

Regarding the efficacy of the webcasts for advance preparation, 76/163 (47%) students found the length of the webcasts to be appropriate (Fig. 2a). However, 68/159 students (42.8%) reported that the webcasts did not help them prepare for the in-class TBL sessions. Furthermore, 61/162 students (50%) reported a preference for the pacing of live lectures over webcasts. Twenty-one short-answer responses were supportive of this finding, noting that webcasts were not as interactive or structured as a live lecture.

Readiness Assurance Testing (IRAT and TRAT)

Sixty-seven of 161 students (41.6%) agreed or strongly agreed that the IRAT helped them identify gaps in their understanding. Furthermore, 76 of 162 students (46.9%) agreed or strongly agreed that the TRAT allowed them to correct their misperceptions and improve their understanding of certain concepts (Fig. 2a).

Application Activity

In probing one of the most sought-after attributes of TBL, critical thinking, most participants (94/161, 58.4%) agreed

or strongly agreed that the case discussions made them think critically. In addition, most students (109/164, 66.5%) agreed or strongly agreed that they participated actively in the case discussions (Fig. 2a). Twelve students indicated that the application activity allowed them to apply learned material to real-life scenarios, and seven felt that it allowed them to consolidate their understanding of the material (Table 1).

Team Dynamics

The majority of students (89/162, 54.9%) agreed or strongly agreed that working in a team enriched their learning (Fig. 2a). Thirty-four students appreciated the opportunity to discuss concepts with their peers. However, 15 learners felt that their peers did not appear interested in, or prepared for, the in-class sessions. Three students reported anxiety about interacting with peers outside of their usual social circle (Table 1).

Efficacy of TBL as a Strategy to Teach Antimicrobial Stewardship

Sixty participants (37.3%) agreed or strongly agreed that the TBL sessions allowed them to apply the information that they had learned in lectures, while 66 (41%) disagreed or strongly disagreed with this finding. Student perceptions on the effectiveness of TBL as a strategy for teaching antimicrobial

Table 1 Conventional content analysis of post-course survey short-answer responses. *PBL* problem-based learning; *TBL* team-based learning

TBL component	Response category	Sample response	Number of short-answer responses
Pre-class preparation (webcasts)	*Disliked* that webcasts were not as interactive as live lectures or PBL/preferred more structured pre-class didactics	"Students [cannot] learn drugs by reviewing podcasts in which [they] cannot ask clarifying questions and the entire process is inherently a passive learning experience."	21
	Liked that pre-class assignments increased accountability and engagement	"The required prep work made me put in more study time than I would for a normal lecture."	3
	Liked that webcasts were more efficient than lectures/granted the ability to self-pace	"The podcasts were good in the sense that information was delivered very efficiently and concisely."	2
Application activity	*Liked* opportunity to apply learned material to a real-life scenario	"I could appreciate that the discussions we were having are the kind of discussions that occur every day in the hospital for patient care and antimicrobial stewardship. This required critically (sic) thinking and it was refreshing."	12
	Liked opportunity to consolidate understanding of material	"The cases were really helpful and did help solidify a lot of the information that was presented to us."	7
Team dynamics	*Liked* opportunity to discuss concepts with peers	"I liked being able to discuss the answer choices with my group and reasoning through why each answer was wrong or right."	34
	Disliked that some peers did not appear prepared or interested	"It's hard to make sure everyone is on the same page… despite trying to prepare thoroughly beforehand, there was still a knowledge gap among the members of the group."	15
	Disliked that class/group size felt too large	"Having the entire class of 180 people in the big room gets a bit out of hand. It's hard to focus and to feel like we are having constructive conversations in such a distracting environment."	13
	Disliked feeling anxious about working with peers outside usual social circle	"Being placed in a group with other students we either do not know or know of and do not prefer to associate with completely ruins the experience."	3
General effectiveness of TBL	*Disliked* insufficient "knowledge scaffolding"/Questions appeared to be beyond the level of a second year medical student class	"Many of us are learning these drugs for the first time and we need to build a strong foundation before we can apply what we know."	29
	Disliked the overwhelming breadth and depth of the material	"Antimicrobials are very difficult to learn/understand. There is not just one antibiotic per bug. Instead there are numerous drugs that can be used and a spectrum that the drugs cover."	20
	Liked that the TBL module granted the opportunity to identify important concepts and gaps in understanding	"It gave me an opportunity to solidify information with my classmates and compare information we each deemed as salient."	9
Other	*Disliked* that the pacing of the module felt too slow	"The use of time during the session could have been more efficient."	14
	Disliked the delays due to technical difficulties	"A large portion of the time was spent dealing with technical issues"	4
	Disliked that the module was too early in the course of the day	"Asking students to think critically and to take a quiz at 8 am is asking quite a lot."	1

stewardship were mixed: 56 (33.9%) agreed or strongly agreed that TBL was an effective strategy for teaching antimicrobial stewardship, 39 (23.5%) neither agreed nor disagreed, and 70 (42.4%) either disagreed or strongly disagreed. However, approximately half of the participants (85/167, 51%) indicated that they preferred to leave all lectures as traditional lectures rather than replacing some (73/167, 44%) or all (1/167, 1%) of them with TBL modules (Fig. 2b). Twenty-nine students mentioned that a lack of "knowledge scaffolding" contributed to their dislike of the course, stating that the difficulty of the questions was beyond their level of training. Similarly, 20 participants reported that the breadth and depth of course material was overwhelming. However, nine students reiterated that the TBL course allowed them to identify gaps in their understanding (Table 1).

Discussion

The value of TBL as a strategy to boost student participation and academic performance has been shown repeatedly across a variety of settings [4, 10, 11]. In this study, we sought to investigate the perceptions of second year medical students regarding the use of TBL as a strategy for teaching antimicrobial stewardship early in their training. Our study did not establish uniformly positive perceptions regarding the use of this iteration of TBL for this purpose. Nonetheless, the use of quantitative and qualitative methodologies to thoroughly probe student responses unfurled a nuanced picture of the strengths and limitations of the use of this much advocated, active learning intervention in this setting. The data analysis showed that a modest majority of students found the readiness assurance testing, application activity, and team dynamics to be effective. The only component that students consistently found to be lacking in usefulness was the webcasts. Finally, students were widely dispersed on the overall effectiveness of this version of TBL to teach antimicrobial stewardship, reflecting the heterogeneity and ambiguity of their beliefs.

Decisions regarding antimicrobial selection and subsequent de-escalation require not only an understanding of microbiology and antimicrobial pharmacology but also the ability to critically appraise a range of therapeutic options while considering the pros and cons of each option. Additionally, students need to understand and embrace the complexity of these scenarios, in which there are often multiple "right" answers. This can be a challenging task for early learners accustomed to standardized testing, in which questions usually have only one correct answer. In TBL, readiness assurance testing is designed to solidify a student's knowledge of core concepts, whereas the application activity is an opportunity to critically analyze and apply these concepts to a real-life scenario in a way that goes beyond simply reciting the information [4, 10, 11]. So, it is encouraging that, in general, our students rated these aspects of TBL favorably, agreeing that they contributed to their learning (Fig. 2a). The short-answer responses regarding these portions of TBL were also favorable (Table 1). There are very few studies that analyze medical student perceptions of each individual phase of TBL. In a qualitative study of fourth year medical students learning pharmacology, a "few" learners found the readiness assurance questions "inappropriate," and several disliked portions of the application activity. However, several environmental factors may have affected these attitudes [12].

The favorable perception of the team dynamics of TBL in our study is consistent with previous studies [6, 13]. For the pertinent Likert-scale question, most students either agreed or strongly agreed that the group environment enriched their learning (Fig. 2a). Further, "enjoyed the opportunity to discuss concepts with peers" was the most common short-answer response category (34/200, 17%). However, there appears to be room for improvement. Some learners felt that not all their peers prepared equally for the in-class activities. This may be partly because the teams were assigned randomly and changed from the first to the second module. In its ideal implementation, TBL teams should be static and balanced in terms of academic strength, background (cultural, professional, etc.), and inclination to participate [14]. In addition, most of our students had limited experience with TBL before our course. In a meta-analysis of TBL use in health profession education, Reimschisel et al. found that several iterations of TBL are typically needed for learners to accept it as a viable learning strategy [6]. More recently, Chen et al. found a similar pattern in a meta-analysis of perceptions of TBL among medical students in China [15].

On a similar vein, webcasts were a relatively new addition to our curriculum at the time of this course's implementation. As a teaching tool, webcasts have been found to be as effective as, if not more than, traditional lectures [16]; however, learners are not always satisfied with them. In a randomized study of third year medical students learning otolaryngology concepts either through webcasts or traditional lectures, the students in the webcast group outperformed the students in the traditional lecture group [17]. In that same study, however, 37% of students in the webcast group felt that they could not get their questions answered in a timely manner, and 45% rejected the idea of replacing most traditional lectures with webcasts. In our case, students indicated that they may have responded more favorably to webcasts with more structure and more interactive material, such as case-based questions. Student ratings also increase if the material in the pre-class assignment leads directly into the IRAT and TRAT [4].

Student opinions regarding the general efficacy of this iteration of TBL as a strategy to teach antimicrobial stewardship were split. Most responses to the Likert-scale questions related to this topic fell in the disagree, neither agree or disagree, and agree categories (Fig. 2b). Students were also divided

regarding the future role of TBL in the curriculum. Eighty-five (51%) preferred no TBL at all, and 73 (43.7%) felt that some of the traditional lectures and PBL modules could be replaced with TBL modules. However, the short-answer responses indicated a less favorable opinion. Forty-nine students indicated that the material itself or the way the material was delivered was overwhelming and that the cases were too difficult for their level of training (Table 1). In and of itself, the material covered in the modules has been taught for many years through traditional lectures. So, as previously stated, the participants' dissatisfaction with our antimicrobial stewardship modules may have largely stemmed from their lack of familiarity with TBL and webcasts. In addition, the concept of "knowledge scaffolding" was brought up by some of the respondents. This idea of gradually increasing a learner's understanding of a subject is not widely discussed in the TBL or antimicrobial stewardship literature. However, it is a known necessity for courses employing active learning interventions as it compensates for the limitations of working memory that may prevent learners from retaining newly learned concepts [18]. Indeed, scaffolding is felt to be a key part in instructional learning and PBL based courses [19].

There are several limitations to this study. It is important to note that our modules did not use "classic" TBL but rather a modified version of it. This is not uncommon but important to note [10]. First, our TBL orientation was very brief, and not all students attended. Second, students were randomly assigned to teams, and the composition of each team changed between modules. Third, we did not use peer evaluation due to time constraints. In addition, parts of our survey may have been limited by selection bias as students with strong opinions may have been more likely to respond to the short-answer questions. Furthermore, the 12 students who did not attend the initial sessions and instead attended replacement sessions with significantly improved instructor-to-student ratios consistently rated TBL more favorably. Many of the responses contributing to the learners' perception of TBL focused on factors that may not be specific to TBL (i.e., technical difficulties, course too early in the day). Our approach to conventional content analysis was also prone to personal bias as disagreements in underlying theme identification and categorization were settled through consensus rather than randomization [9]. Finally, the focus of this study on a single class of students at a single medical school limits its generalizability.

Future iterations of these antimicrobial stewardship modules can meet the need for increased scaffolding by adding case-based questions to the webcasts. In addition, situating the modules later in the course may increase the participants' preparation for the course. Increased participation can be accomplished by balancing groups based on academic performance, demographic characteristics, and participation in previous courses. Adding a peer evaluation component to the course is also likely to increase participation in addition to accountability.

Despite its limitations, this study offers a first glimpse into the attitudes of pre-clinical medical students toward TBL as a strategy for learning the basic principles of antimicrobial stewardship. Therefore, it can serve as a roadmap for educators contemplating the implementation of a similar program at their institution and as a launching pad for research on the effects of this type of intervention on physician prescribing habits.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval The UCLA institutional review board exempted this study.

Informed Consent Not applicable.

References

1. Barlam TF, Cosgrove SE, Abbo LM, MacDougall C, Schuetz AN, Septimus EJ, et al. Implementing an antibiotic stewardship program: guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America. Clin Infect Dis. 2016;62(10):e51–77.
2. Davey P, Brown E, Fenelon L, Finch R, Gould I, Hartman G, Holmes A, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. Cochrane Database Syst Rev 2005;4:1–117
3. Silverberg SL, Zannella VE, Countryman D, Ayala AP, Lenton E, Friesen F, et al. A review of antimicrobial stewardship training in medical education. Int J Med Educ. 2017;8:353–74.
4. Parmelee D, Michaelsen LK, Cook S, Hudes PD. Team-based learning: a practical guide: AMEE guide no. 65. Med Teach. 2012;34(5):e275–87.
5. Poeppelman RS, Liebert CA, Vegas DB, Germann CA, Volerman A. A narrative review and novel framework for application of team-based learning in graduate medical education. J Grad Med Educ. 2016;8(4):510–7.
6. Reimschisel T, Herring AL, Huang J, Minor TJ. A systematic review of the published literature on team-based learning in health professions education. Med Teach. 2017;39(12):1227–37.
7. Applicants and Matriculants data - FACTS: applicants, Matriculants, enrollment, graduates, MD/PhD, and residency applicants data - data and analysis - AAMC. https://www.aamc.org/data/facts/applicantmatriculant/. Accessed 6 Aug 2019
8. Hsieh H-F, Shannon SE. Three approaches to qualitative content analysis. Qual Health Res. 2005;15(9):1277–88.
9. Lacy S, Watson B, Riffe D, Lovejoy J. Issues and best practices in content analysis. J Mass Commun Q, 2015;1–21.
10. Kibble JD, Bellew C, Asmar A, Barkley L. Team-based learning in large enrollment classes. Adv Physiol Educ. 2016;40(4):435–42.
11. Whitley HP, Bell E, Eng M, Fuentes DG, Helms KL, Maki ED, et al. Practical team-based learning from planning to implementation. Am J Pharm Educ. 2015;79(10):149.
12. Zgheib NK, Simaan JA, Sabra R. Using team-based learning to teach clinical pharmacology in medical school: student satisfaction

and improved performance. J Clin Pharmacol. 2010;51(51):1101–11.
13. Parmelee DX, DeStephen D, Borges NJ. Medical students' attitudes about team-based learning in a pre-clinical curriculum. Medical Education Online 14. 2009.
14. Haidet P, Levine R, Parmelee D, Crow S, Kennedy F, Kelly P, et al. Perspective: guidelines for reporting team-based learning activities in the medical and health sciences education literature. Acad Med. March 1, 2012;87(3):292–9.
15. Chen M, Ni C, Hu Y, Wang M, Liu L, Ji X, et al. Meta-analysis on the effectiveness of team-based learning on medical education in China. BMC Med Educ. 2018;18:77.
16. Dong C, Goh PS. Twelve tips for the effective use of videos in medical education. Med Teach. 2015;37(2):140–5.
17. Vaccani J-P, Javidnia H, Humphrey-Murto S. The effectiveness of webcast compared to live lectures as a teaching tool in medical school. Med Teach. 2016;38(1):59–63.
18. Kirschner PA, Sweller J, Clark RE. Why minimal guidance during instruction does not work: an analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. Educ Psychol. 2006;41(2):75–86.
19. Hmelo-Silver C, Duncan RG, Chinn CA. Scaffolding and achievement in problem-based learning and inquiry learning: a response to Kirschner, Sweller, and Clark. Educ Psychol. 2007;42(2):99–107.