

ORIGINAL RESEARCH ARTICLE

The outcomes of team-based learning vs small group interactive learning in the obstetrics and gynecology course for undergraduate students

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Abstract

Introduction: Team-based learning (TBL) is a well-established active teaching method which has been shown to have pedagogical advantages in some areas such as business education and preclinical disciplines in undergraduate medical education. Increasingly, it has been adapted to clinical disciplines. However, its superiority over conventional learning methods used in clinical years of medical school remains unclear. The aim of this study was to compare TBL with traditional seminars delivered in small group interactive learning (SIL) format in terms of knowledge acquisition and retention, satisfaction and engagement of undergraduate medical students during the 6-week obstetrics and gynecology clerkship.

Material and methods: The study was conducted at Karolinska Institutet, a medical university in Sweden, and had a prospective, crossover design. All fifth-year medical students attending the obstetrics and gynecology clerkship, at four different teaching hospitals in Stockholm (approximately 40 students per site), in the Autumn semester of 2022 were invited to participate. Two seminars (one in obstetrics and one in gynecology) were designed and delivered in two different formats, ie TBL and SIL. The student:teacher ratio was approximately 10:1 in the traditional SIL seminars and 20:1 in the TBL. All TBL seminars were facilitated by a single teacher who had been trained and certified in TBL. Student knowledge acquisition and retention were assessed by final examination scores, and the engagement and satisfaction were assessed by questionnaires. For the TBL seminars, individual and team readiness assurance tests were also performed and evaluated.

Results: Of 148 students participating in the classrooms, 132 answered the questionnaires. No statistically significant differences were observed between TBL and SIL methods with regard to student knowledge acquisition and retention, engagement and satisfaction.

Conclusions: We found no differences in student learning outcomes or satisfaction using TBL or SIL methods. However, as TBL had a double the student to teacher ratio

Abbreviations: iRAT, individual readiness assurance test.; SIL, small group interactive learning.; TBL, team-based learning.; tRAT, team readiness assurance test.

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as compared with SIL, in settings where teachers are scarce and suitable rooms are available for TBL sessions, the method may be beneficial in reducing faculty workload without compromising students' learning outcomes.

KEYWORDS

active learning, medical education, team-based learning, undergraduate

1 | INTRODUCTION

Team-based learning (TBL) was introduced into medical education in 2001 and was adapted from a business school environment.¹ TBL promotes teamwork, communication skills and the efficient use of faculty resources. In comparison with traditional learning methods, TBL is learner-centered and focuses on group interactions, group work and knowledge application, using effective pedagogical principles such as pre-class preparation, active learning, peer learning and instant feedback.^{2,3}

Although TBL is well-established as an active teaching method, with some documented benefits for students, such as enhanced student engagement, and knowledge acquisition in a variety of disciplines including pharmacy, engineering, business, nursing, and preclinical medical disciplines,⁴⁻⁸ it has not been as widely adopted in clinical disciplines in undergraduate medical education. However, the context of learning in clinical disciplines is complex and findings from non-medical and preclinical disciplines may not be directly applicable.

One of the challenges of using TBL in clinical disciplines is the short-term clerkships, which do not allow teams to work together for a longer time and mature. In contrast with the preclinical disciplines where the main method of teaching has been cathedral lectures, the clinical disciplines traditionally use a variety of methods such as bedside teaching, apprenticeship, simulations, small group interactive seminars, problem-based seminars and case studies. Thus, it is challenging to draw firm conclusions about the benefits of implementing TBL in clinical disciplines due to the range of other teaching methodologies used simultaneously.

A scoping review of published literature by our research group showed that most of the studies (90%) on implementing TBL in clinical disciplines adopted a modified version where one or more steps of TBL were missing. Furthermore, the methodological quality of the studies varied substantially, making it difficult to synthesize evidence and draw reliable conclusions.⁹ Most of the previously published studies use traditional lectures as a comparator, with only a few comparing TBL with seminars in clinical disciplines.¹⁰⁻¹³

Therefore, the primary aim of the current study was to compare TBL with traditional small group interactive learning (SIL) in a prospective cross-over trial with randomized allocation of seminars to student groups to investigate knowledge acquisition and retention by undergraduate medical students during the obstetrics and gynecology clerkship. We also investigated student engagement and satisfaction with the learning process.

Key message

Student performance in final examination and their satisfaction with the course in clinical obstetrics and gynecology was not significantly different using team-based learning or small group interactive learning method. However, a reduced teacher:student ratio could be an advantage of team-based learning.

2 | MATERIAL AND METHODS

2.1 | Study setting and population

The study was conducted at Karolinska Institutet, a medical university in Stockholm, Sweden. All students attending the obstetrics and gynecology clerkships during the Autumn semester of 2022 were invited to participate. The obstetrics and gynecology (Ob/Gyn) clerkships are 6 weeks long in the 5th year curriculum. Students attend clinical clerkship in two different batches consecutively during one semester. All students attending the course are divided by the administrative staff of the university into four groups consisting of approximately 40 students, and each group is assigned to one of the four large teaching hospitals in Stockholm affiliated to Karolinska Institutet (ie Karolinska University Hospital Huddinge, Karolinska University Hospital Solna, Stockholm South Hospital and Danderyd Hospital). During this clerkship a combination of teaching methods are used, eg lectures, seminars and clinical rotation, where students participate alongside obstetrician gynecologists in their everyday clinical work.

Most of our participants had only had one previous TBL session and were not very familiar with TBL, since this model of active learning was adopted by the Karolinska Institutet recently in 2021 with its initial implementation starting in preclinical disciplines followed by gradual introduction into clinical disciplines.

2.2 | Design of the study

We performed a prospective crossover study to compare the TBL seminars with SIL seminars. Two seminars – “Bleeding during pregnancy” and “Abnormal uterine bleeding” – were chosen from the curriculum to be delivered as TBL and traditional SIL. As

students attended clinical clerkship in two consecutive groups during the same semester, the seminars were randomly allocated to the groups using a simple randomization procedure of drawing sealed opaque envelopes. The first group were allocated to the seminar on “Bleeding during pregnancy” in TBL format and the seminar on “Abnormal uterine bleeding” in SIL format, whereas the second group was allocated to the same seminars in the opposite format. The student:teacher ratio was approximately 10:1 in the traditional SIL seminars and 20:1 in the TBL seminars.

2.3 | Team-based learning seminars (intervention)

For the TBL sessions we used InteDashboard^R Inc., Singapore, an all-in-one TBL electronic platform for digital individual readiness assurance test (iRAT), team readiness assurance test (tRAT) and application exercises. The students were informed about the process of creating the teams and randomly assigned to teams using a computer-generated sequence, a feature available in the InteDashboard. Each team had the recommended ideal group size of five to seven students and each TBL session had 17 to 22 students.³ Each TBL seminar started with a short introduction to the TBL concept and learning objectives for the seminar. All TBL seminars were led by the same instructor (IS) who was trained in teaching TBL and has a Team-Based Learning Collaborative certification and several years of general teaching experience.

The TBL sessions consisted of four steps in accordance with the classic TBL approach.³ The structure of each step and time slots are summarized in Table 1. The first step was the pre-class preparation phase where the students had to read certain predefined materials in their recommended textbooks and watch video lectures covering the two subject areas: bleeding during pregnancy and abnormal uterine bleeding.

The second step was the readiness assurance process, which was accomplished by using iRAT and tRAT. Both iRAT and tRAT were closed-book assessments. The iRAT was taken by each student individually. The tRAT was completed by the teams after discussing the questions and their responses among the team members to arrive at

a consensus. Immediate feedback was provided from Intedashboard, which displayed whether the correct answer had been chosen.

An inter-team discussion followed the tRAT and all questions were discussed thoroughly. The discussion was led by the facilitator (IS). The teams could also appeal and ask questions during this part of the discussion if they did not agree with the answers provided.

The third TBL step was the application exercises. To create them we adhered to the “4S” principle: (1) Significant problem, (2) Same problem, (3) Specific choice and (4) Simultaneous reporting. The application exercises were realistic clinical scenarios posing a *significant problem*. All groups then had 25 minutes to discuss the *same problem* and to write down their *specific choice* of answer. The answers were *reported* in Intedashboard *simultaneously* for the facilitator who moderated the discussion, clarified concepts, and discussed all questions with the groups.

The fourth TBL step, the peer-evaluation, was performed at the end of the TBL session on paper sheets. The students rated their team members' contribution to the discussion by distributing a total of 100 points to their team members according to Fink's (“Divide up the Money”) method.¹⁴ The students were not forced to assign different point values to their team members. They could also provide written feedback.

The results of the sub-components of the TBL were not taken into account in the students' final grade.

2.4 | Traditional small group interactive learning seminars (control)

The traditional SIL seminars in the obstetrics and gynecology clerkship were 3 hours long and based on clinical scenarios. In each seminar, approximately 10 medical students (in three of the four hospitals) and 20 (in the fourth hospital) participated. As in TBL, the students had a preparation phase where they had to prepare four to five predefined clinical scenarios regarding history taking, clinical exam and investigations, differential diagnosis and treatment. The cases were then discussed between students and with the facilitator of the seminar.

TABLE 1 Overview of team-based learning steps and their structure with respective time slots.

Step	Description	Time
1. Pre-class assignment	Independent study and completion of preparatory work to understand basic concepts of the topic before classroom session.	4 hours
2. Readiness assurance process	• Individual Readiness Assurance Test (iRAT): An individual quiz to assess understanding and learning of the pre-class material using 10 multiple choice questions each with five options and a single best answer.	15 minutes
	• Team Readiness Assurance Test (tRAT): The same quiz taken by the teams after group discussion to ensure team preparedness.	25 minutes
	• Inter-team discussions, appeals and tutor clarifications	35 minutes
3. Application exercises	• Collaborative problem-solving exercises that apply course concepts.	30 minutes
	• Inter-team discussions and clarifications	35 minutes
4. Peer review and evaluation	Feedback provided by students on their peers' contribution to team activities.	10 minutes

2.5 | Outcomes and the measurement tools

The primary outcome was knowledge acquisition and retention assessed through final examination scores. The final examination for the course was a theoretical test which combined single best answer questions (10 items) with short answer questions (11 items) and had a maximum score of 52.5 points. In the final exam, there were questions related to both types of seminars (7.5 points for the Bleeding during pregnancy seminar and 14 points for the Abnormal uterine bleeding seminar).

The secondary outcomes were student satisfaction and engagement. For all teaching sessions the students completed a self-reported 15-item questionnaire on satisfaction and engagement (Appendix S1). "A Scoring Guide for the Student Self-report of Engagement Measure", which is a validated tool,¹⁵ was used to measure engagement. Student satisfaction with the specific two seminars was assessed using Student Satisfaction Subscale – part of the validated tool.¹⁶ All the questions were answered anonymously using a five-point Likert scale (1=strongly disagree, 5=strongly agree).

A subanalysis of the iRAT and tRAT results was performed to better understand the students' learning process in TBL sessions.

2.6 | Statistical analyses

Frequencies and proportions were used for the description of sample characteristics. For continuous numerical variables, mean and standard deviations (SD) or median and quartiles were calculated. Mann-Whitney *U*-test was used to compare differences between the outcomes of TBL and SIL. A two-sided *P*-value <0.05 was considered significant. All analyses were performed using IBM SPSS Statistics software version 24.0 (IBM Corp. Armonk, NY, USA).

3 | RESULTS

A total of 157 students rotated through the obstetrics and gynecology clerkship during Autumn 2022. The mean age of the students was 27.4 years (SD 4.3) and 65.5% (103/157) were females. A total of 148 students attended the TBL and SIL seminars, and 132 of them answered the questionnaires regarding student engagement and satisfaction.

3.1 | Knowledge acquisition and retention

There were no statistically significant differences between TBL and SIL seminars regarding student knowledge acquisition and retention when comparing final exam scores of the respective item. The median value of the exam items from TBL seminar was 6.5 (4.0–12.5) and the median value of item from the SIL seminar was 6.5 (4.5–11.5).

3.2 | Student satisfaction

Table 2 shows the median scores for the participating students' satisfaction for TBL seminars and for the SIL seminars. No significant differences were found between the two teaching methods, except for "The way the facilitator led the seminar is suitable for the way I learn", with the students preferring SIL.

3.3 | Student engagement

Table 3 shows the median scores for the participating students' engagement for TBL seminars and for the SIL seminars. There was a significant difference in favor of the TBL regarding "I talked in class with other students about teaching material". No other significant differences between the two teaching methods were found.

3.4 | Learning process in TBL session

The median scores for iRAT were 60% (40%–70%) and the median scores for tRAT were 80% (70%–90%). The tRAT scores were significantly higher than the iRAT scores (*P*<0.01). Nineteen of the 24 teams had total team scores that were higher than, or equal to, the score of the team's best member.

4 | DISCUSSION

In this study we wanted to evaluate the impact of introducing TBL, an increasingly popular pedagogical method in medical education, for teaching clinical disciplines in medical school. We could not show superiority of TBL over SIL in student knowledge acquisition and retention methods during the obstetrics and gynecology clerkship for undergraduate medical students. Neither could we observe statistically significant differences in student self-reported satisfaction and engagement. Of the 15-item questionnaire only "The way the facilitator led the seminar is suitable for the way I learn" was favored in SIL and "I talked in class with other students about teaching material" was favored in TBL. Due to multiple testing, these results should be interpreted with caution.

Most of the previously published literature compares TBL with traditional lectures. Only a few studies have compared the benefits of TBL with seminars in clinical disciplines, but their results show no differences in knowledge acquisition between groups^{10,12} or any significantly improved performance in the key feature problem examination.¹⁷ One study showed significantly improved knowledge acquisition, but no difference in long term knowledge retention between these teaching methods.¹¹ In obstetrics and gynecology, the implementation of TBL has so far been studied only in comparison with traditional lectures or no comparator at all.^{18–20} The research findings are also inconsistent with one study reporting no

TABLE 2 Satisfaction ratings for the team-based learning (TBL) seminar compared with the small group interactive learning (SIL) seminars (5-point Likert scale).

Questions	TBL	SIL	P-value
	Median (Q1–Q3)	Median (Q1–Q3)	
The teaching methods used in the seminar were helpful and effective	4 (4–5)	4 (4–5)	0.19
The seminar provided me with knowledge to promote my learning in obgyn	4 (4–5)	4 (4–5)	0.18
I enjoyed how the facilitator led the seminar	4 (4–5)	4 (4–5)	0.05
The teaching materials used for this seminar were motivating and helped me to learn	4 (3–4)	4 (3–4)	0.89
The way the facilitator led the seminar is suitable for the way I learn	4 (3–5)	4 (4–5)	0.01
Overall, I was satisfied with the quality of this seminar	4 (4–5)	4 (4–5)	0.12

Abbreviations: Q1, 25th percentile; Q3, 75th percentile; SIL, small group interactive learning; TBL, team-based learning.

TABLE 3 Engagement ratings for the team-based learning (TBL) seminar compared with the small group interactive learning (SIL) seminars (5-point Likert scale).

Questions	TBL	SIL	P-value
	Median (Q1–Q3)	Median (Q1–Q3)	
I contributed meaningfully to class discussion today	4 (4–5)	4 (4–4)	0.07
I was not paying attention most of the time in class	2 (1–2)	2 (1–2)	0.88
I contributed my fair share to class discussions	4 (4–5)	4 (4–5)	0.95
I talked in class with other students about teaching material	4 (4–5)	4 (3–4)	<0.01
I was mostly a passive learner in class today	2 (1–3)	2 (2–3)	0.34
Most students were actively involved in class today	4 (4–5)	4 (3–4)	0.11

Abbreviations: Q1, 25th percentile; Q3, 75th percentile; SIL, small group interactive learning; TBL, team-based learning.

differences in knowledge acquisition¹⁸ and one finding improvements in national board test performance but not in knowledge retention.²⁰ To our knowledge, no studies have compared TBL with SIL in this medical specialty.

The methods used to assess knowledge acquisition and retention vary considerably across different studies from final exam scores to national board exam scores.⁹ Although many studies show improvement in knowledge acquisition and retention with TBL, there are some that are in concordance with our results.^{10,18,21} The group discussions in TBL allow both intra-team and inter-team debating. Immediate feedback provided during readiness assessment process is expected to enhance individual learning as well as team communication process. We examined whether students benefit from the team interactions in TBL, which is represented by the gain in scores from iRAT to tRAT. The tRAT scores were significantly higher than iRAT scores. The average group scores were 23% higher than the individual scores, which suggests that peer-learning is an efficient method of learning. However, the overall team scores surpassed the score of the team's best member in only 50% of the cases. This can be explained by the short duration of the obstetrics and gynecology clerkship, which is only 6 weeks long, and mostly relies on bedside learning, not allowing enough time for the teams to mature and become the highly functional teams as described by Michaelsen et al.²²

Our students were relatively new to TBL as a teaching method and had limited experiences with TBL sessions, which may explain the relatively low iRAT scores. A study by Carasco et al. showed that prior experience with TBL improves both iRAT and tRAT scores especially among weaker students.²³

Although there are several studies reporting increased students' satisfaction with TBL, these results could not be replicated in our study. That could be partially explained by having different comparators^{24–26} or no comparators at all^{21,27,28} in previous studies.

There was one item that was statistically significantly favored by students in SIL seminars compared with TBL seminars. This was: "The way the facilitator led the seminar is suitable for the way I learn". Due to multiple testing these results should be interpreted with caution. However, we can speculate that students would discuss clinical cases with their peers during clinical clerkships rather than taking a more theoretical approach. Furthermore, TBL relies on the ambiguity of the application exercises, which are meant to stimulate intra-team and inter-team discussions. Medical students may find this confusing, especially if they are used to get answers from clinical experts during seminars in previous clerkships.

Previous studies show a higher level of student engagement in TBL seminars in clinical disciplines when compared with traditional teaching methods, such as lectures and case-based discussion seminars.^{26,29,30} Our results showed no statistically significant difference

in student engagement between TBL and SIL. This may be explained by a high level of engagement in the discussions already present in the SIL seminars.³¹ However, in contrast to other small group interactive learning methods, in TBL a single qualified expert can facilitate several small groups of students in a relatively large lecture room.³²

In our study, the benefit of TBL was mainly limited to higher student to teacher ratio compared with SIL. Our findings are not in concordance with what has been reported previously from pre-clinical disciplines in medical schools^{33,34} or other nonmedical subject areas.^{6,8} This suggests that the findings from such studies may not be directly applicable to clinical disciplines due to their inherent complexity in learning context that includes use of a variety of teaching methods.

Our study showed that an increased students to teacher ratio could be accommodated in TBL without compromising learning outcomes and student satisfaction. Therefore, TBL can be particularly advantageous in decreasing faculty workload, since it can be extended to larger groups without losing its effectiveness provided there are suitable rooms available for TBL sessions.³⁵

The main strength of this study is its crossover design with randomized allocation of the seminars ensuring similar demography of the groups for both teaching methods. Another strength is that the TBL concept was applied as recommended by Haidet et al.³⁶ with no modifications, so that our results can be compared with results from other clinical disciplines.

Our study has some limitations. First, a priori sample size/power calculation was not performed, since we intended to include all eligible students that attended the obstetrics and gynecology clerkships during one semester. However, our sample size compares favorably with previous studies with a similar design in clinical clerkships.^{10,37-39} Secondly, the limited number of exam questions in the final exam and the different weightage of scores in the two seminars could impact the results. However, that would be expected to impact both TBL and SIL equally. Thirdly, the cross-over design could have a carry-on effect on the groups that had the TBL seminars first.

5 | CONCLUSION

In this study, TBL was not superior to SIL in terms of undergraduate medical students' knowledge acquisition and retention as well as their satisfaction and engagement in the obstetrics and gynecology course. However, as TBL had a higher student to teacher ratio (double) than SIL, its implementation might decrease the faculty workload without adversely affecting the students' knowledge acquisition/retention and satisfaction.

AUTHOR CONTRIBUTIONS

Irene Sterpu, Lotta Herling, Ganesh Acharya and Jonas Nordquist designed the protocol for the study. All authors planned the TBL seminars together. The data analysis was performed by Irene Sterpu. All authors contributed to article revision and approved the submitted version.

CONFLICT OF INTEREST STATEMENT

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

ETHICS STATEMENT

The study protocol was reviewed by the Swedish Ethical Review Authority and granted exempt status on June 6, 2022 (Ref. Dnr: 2022-02891-01). All students participating in the study provided written informed consent.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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