*Original article*

# Using Team-Based Learning to Teach Evidence-Based Medicine to First-Year Residents

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## SUMMARY

Team-based learning (TBL) is a well-established instructional strategy that provides students with the chance to apply conceptual knowledge through a series of actions, including pre-class, individual, team class activity, and immediate feedback. The purpose of the present study was to introduce a course of teaching the evidence-based medicine (EBM) to all first-year medical residents in different disciplines at Shiraz Medical School in Iran country using the TBL instructional strategy.

The sample included 86 medical residents at Shiraz Medical School. This study had a quasi-experimental design and was conducted in 12 sessions of evidence-based medicine (EBM) based on team-based learning (TBL) strategy. The obtained data were analyzed using SPSS software. In all sections, the results of Individual Readiness Assurance Tests (IRATs) and Group Readiness Assurance Tests (GRATs) were added and calculated. Cronbach's alpha test was implemented to evaluate the reliability of the questionnaires. For the descriptive analysis of data, descriptive statistics were used. ANOVA and T-test were used for analytic analysis.

There was a significant difference in answering the questions between individual ($3.73 \pm 2.33$) and group ($4.71 \pm 2.29$) stages. Residents gained higher average grades on working in the team (P-value < 0.02). Results of residents' response about satisfaction questionnaire are shown that the best scores belong to group activities in TBL.

The results of this study showed that TBL could be used as an effective method for residents' education in different disciplines.

*Key words:* team-based learning, medical residents, medical education, evidence-based medicine

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## INTRODUCTION

Team-based learning (TBL) is a well-established instructional strategy that provides students with the chance to apply conceptual knowledge through a series of actions, including pre-class activity, individual class activity, team class activity, and immediate feedback. TBL emphasizes the key role of teams as the active mechanism for teaching and learning in class, thereby actively strengthening the concepts studied prior to class. At each stage, students undergo evaluation of their understanding with a test (1).

TBL was first designed and introduced by Dr. Larry Michaelsen at the University of Oklahoma Business School. Since then, it has been used with considerable interest by medical schools (2).

For decision-making, a doctor needs the cooperation of the patient, family members, seniors, and other medical team professionals (3). TBL, as a learning method, can help medical students to use all visual, hearing, writing, and driving forces of learning and collaboration to gain more knowledge and preserve it for a long time (4).

Several studies have been done on the effectiveness of TBL for undergraduate students in different courses. In a comparison between lecture-based learning and TBL, the students who participated in TBL sections had higher grades than those in lecture-based sections. The students spoke freely about therapeutic recommendations. Critical thought and diagnosis increased among the TBL students (5). At the American University of Beirut, 90 TBL sessions were conducted in two years for medical students. The results showed that the students had more powerful critical thought and better individual study skills. They also showed that team-working is improved; during these two years, students developed better learning, problem-solving, and communication skills at professional and individual levels (6).

TBL is used in various fields of medical education (7-10); however, there are a few studies on the practice of TBL among residents. In a study on the teaching of internal medicine residents in a TBL course, residents and faculties reported the interactive format, the content of course, and competitive environment of sessions as the strengths of TBL (11). Another study on using TBL for psychiatry residents showed that four domains are important in TBL - team learning, the effect on learner, the relationship between students and teachers, and efficiency of the teaching and learning process (12). Fallon and Strout used TBL in emergency medicine for developing a structured educational intervention (13). Schy-

noll et al. developed a comprehensive medical knowledge of TBL curriculum for an internal medicine residency; their result showed that implementing this curriculum is feasible and lead to learner's satisfaction and faculty acceptance (14).

The purpose of the present study was to introduce a course of teaching evidence-based medicine (EBM) to all first-year medical residents in different disciplines at Shiraz Medical School using the TBL instructional strategy. EBM is one of the important topics in medical education and is considered an important subject in the curriculum of undergraduate and postgraduate medical students (15). Residents from different disciplines should learn how to communicate effectively in a collaborative way in the first days of their training. To our knowledge, this is the first study conducted on all specialty residents using the TBL instructional strategy.

## METHODS

This study was a quasi-experimental study that was performed at Medical School of Shiraz University of Medical Sciences.

### Participants

The population included all first-year medical residents participating in the EBM courses at Shiraz Education Development Center in south Iran; we used the census method for sampling. A total of 86 medical residents from different disciplines such as internal medicine, pediatrics, general surgery, radiology, radiotherapy, etc. participated in this study.

### Design of TBL

The designing of TBL consists of three different phases (7, 16). Phase 1 is an individual readiness or preparing assignments before the individual session, such as reading a scenario or watching a video (17). The second phase is readiness assurance through Individual Readiness Assurance Tests (IRATs) and Group Readiness Assurance Tests (GRATs), consisting of multiple choice questions based on the content of the preparation assignment (11-17). In IRATs, the students answer the questions on studied subjects individually to ensure their readiness for using studied subjects and problem-solving. Then, in GRATs, students are divided into different groups and answer the same questions in groups (16). The third phase involves a group application activity that requires students to apply material from the

preparation assignment to a "real-world" scenario (17). Therefore, the students should use their knowledge as a team to resolve their problems and make decisions. The problem and the answers should be completely significant, and students should answer the questions simultaneously (using flashcards). The last phase includes individual student and faculty evaluation (10-16).

This study was conducted in 12 sessions of EBM based on TBL strategy. The goal and specific objective of the course were designed based on our previous research on teaching EBM to undergraduate students (18).The residents were asked to study the predefined topics before the session and attend the session readily. Then, in an IRAT, a questionnaire was distributed among medical residents, including five multiple-choice questions on the same topic; respondents had to answer within a specific time limit. After questionnaires were completed and collected, the residents were split into 10–15-member groups. Then, the groups discussed the same questions and answered them for the GRAT. Every group was given a chance to answer the questions and to discuss and defend its answers. The faculty also helped the students to consolidate the learning. In the third stage of TBL, an article about different aspects of EBM was distributed to the residents. Residents were asked to read the article and then tutors and residents discussed it. This stage was not scored, because this stage aims to encourage discussion and improves residents' skills in managing the problems presented in each article. In the last section of TBL, the tutor gave a small lecture and answered the questions. At the end of the final session, satisfaction survey forms on TBL were distributed among the residents and were collected at the end of the workshop session. For each session, we created tutoring guides for the tutors, which contained the session's objectives, presession studying material, IRATs and GRATs, and articles for the third part of TBL.

## Data collection tool

IRATs and GRATs were prepared for each 12 sessions. For each session the students' scores were calculated from 5. The means score for IRATs and GRATs for every 12 sections was also calculated from 5. The faculty and medical education experts approved the face and content validity of the questionnaires. To confirm the reliability, a pilot study was done on 37 residents. The result shows acceptable reliability using Cronbach's alpha ($\alpha = 0.91$).

Satisfaction forms were distributed among the residents at the end of the TBL-based course. This satis-

faction questionnaire was prepared based on previous studies on TBL (12). It contains 10 questions based on the 5 points Likert scale from 1 to 5. For each question in the satisfaction questionnaire, the mean students' scores were calculated from 5. Medical education experts determined the validity of the satisfaction questionnaire and the reliability was established after a pilot study on 37 residents using Cronbach's alpha ($\alpha = 0.83$). We used CVR and CVI for determining of content validity by using ten expert opinions; they were higher than .62 and .79, respectively, for all questions related to satisfaction.

## Ethical considerations

This study was approved by the Ethics Committee of Shiraz University of Medical Sciences with proposal number 10484. Before the course, the author described the study and its applicability to the residents and stated that this information is only to be used for research purposes and participant information will be kept confidential.

## Statistical analysis

Kolmogorov-Smirnov test was used for checking normality that showed that data was normal. (p >.05).The obtained data were analyzed using SPSS software. In all sections, the results of IRATs and GRATs were added and calculated. The mean score for IRATs and GRATs was calculated from 5. Cronbach's alpha test was implemented to evaluate the reliability of the questionnaires. For the descriptive analysis of data, descriptive statistics were used. ANOVA was used to examine differences in group-learning in terms of residents' specialty. Independent sample T-test was used for the comparison between IRATs and GRATs.

## RESULTS

The study population consisted of 38 (44.1%) male and 48 (55.9%) female residents. All of the residents answered the questions and participated in IRATs and GRATs. In completing the satisfaction survey, 81 residents returned the questionnaires, so response rate was 95 %.

ANOVA test was done to assess the differences between IRAT scores and residents' specialty. There was no difference (p < 0.05) between the score of this test and residents' specialty as a whole. Post hoc tests were not

used due to the small number of residents in some specialties (Table 1).

In all TBL sections, the GRAT scores are higher than IRAT scores and this difference was statistically significant (Table 2).

Results of residents' response about satisfaction questionnaire are shown in Table 3.

It can be seen that the best scores belong to group activities in TBL (Item Number 10).

*Table 1.* **The results of IRAT score based on residents' specialty**

| Field of Study | Number | Average | Standard Deviation | Standard Error |
|---|---|---|---|---|
| Surgery | 5 | 4.00 | 3.16 | 1.58 |
| Psychiatry | 4 | 3.00 | 0.00 | 0.000 |
| Radiology | 5 | 3.00 | 0.707 | 0.316 |
| Physiotherapy | 5 | 4.25 | 2.63 | 1.31 |
| Dermatology | 4 | 4.50 | 3.51 | 1.75 |
| Urology | 5 | 4.00 | 2.24 | 1.00 |
| Pediatrics | 4 | 3.00 | 1.41 | 0.707 |
| Ophthalmology | 5 | 4.00 | 2.45 | 1.22 |
| Cardiovascular | 5 | 3.00 | 2.00 | 1.00 |
| Anesthesia | 7 | 4.43 | 2.57 | 0.972 |
| Neurology | 5 | 4.00 | 3.46 | 2.00 |
| Nuclear Medicine | 6 | 4.00 | 3.16 | 1.29 |
| Orthopedics | 6 | 4.17 | 2.63 | 1.07 |
| Internal Medicine | 5 | 3.25 | 0.500 | 0.250 |
| Pathology | 6 | 2.50 | 1.64 | 0.670 |
| Community Medicine | 4 | 5.00 | 2.00 | 1.00 |
| Radiotherapy | 5 | 3.33 | 0.577 | 0.333 |
| Total | 86 | 3.73 | 2.43 | 0.276 |

*Table 2.* **Comparison of GRAT and IRAT scores in all TBL sections**

| Learning | Number of sessions | Average (from 5) | Standard deviation | T | Significance |
|---|---|---|---|---|---|
| Individual | 12 | 3.73 | 2.33 | -4.148 | 0.002 |
| Group | 12 | 4.71 | 2.29 | | |

*Table 3.* **Students' satisfaction about TBL in EBM course**

| | Item | Mean ±SD (from 5) |
|---|---|---|
| 1 | TBL assisted me in increasing my knowledge of EBM. | 03.41 ± 0.46 |
| 2 | I found the pre-class studying helpful. | 2.25 ± 0.34 |
| 3 | IRATs were beneficial learning activities. | 4.32 ± 0.32 |
| 4 | The GRAT discussions allowed me to improve my understanding of EBM concepts. | 4.61 ± 0.20 |
| 5 | Problem-solving in a group is a real way to learn. | 4.53 ± 0.39 |
| 6 | I paid attention most of the time to TBL sessions. | 4.42 ± 0.49 |
| 7 | I have a positive attitude toward working with others as a team. | 4.13 ± 0.72 |
| 8 | The ability to work in a team is essential for me to be successful as a specialist. | 04.01 ± 1.11 |
| 9 | Most residents were cooperative during TBL sessions. | 03.21 ± 1.74 |
| 10 | My total score for TBL classes | 4.12 ± 0.69 |

## DISCUSSION

Nowadays, the best medical schools all over the world have changed their teaching methods from teacher-centered to student-centered (1). TBL is a student-centered and teacher-directed strategy for entire classes of students, who are divided into small teams to solve problems (2). Medical residents are adult learners who need to learn teamwork due to the unique character of each medical specialty.

The results of the present study show that residents had greater scores in GRATs than in IRATs. These findings are also reported in other studies about TBL (17). Parmelee and Michaelsen, based on data from 1,115 teams of 6,161 students, report that in most of TBL sessions, the lowest team score will be higher than the highest individual score in the whole class. This is certainly due to the high ability of teams to achieve the educational objectives. Our previous study about TBL shows similar results (19).

There is no significant difference between the specialty of residents and the IRAT scores. In a topic like EBM, the knowledge levels of residents do not differ significantly.

The results of the satisfaction of residents show that they are satisfied with TBL sessions and especially group dynamics and problem-solving. They reported that this activity helped them to work better in teams. The TBL process is intended to develop teamwork, communication skills, collaboration, leadership skills, negotiation, and respect for other team members (12). These skills are necessary for the course of training of a medical resident. In Iran, the integration of the health system and medical education prepares a good environment for medical students and residents to communicate with each other and with other healthcare personnel (20). Activities like TBL offer a chance to develop this communication skill early in the training course.

The worst score in satisfaction questionnaires was reported about the pre-class activity. This may be due to residents' working hours and their fatigue. This challenge is also reported in another article about TBL in residents. The authors conclude that sensitizing residents to study pre-class materials is much more difficult than sensitizing students because students are motivated by grades (12). They prefer to learn the whole material in class. Another item that attained a low score in comparison with other items was cooperation by most residents in group activities. It seems that some residents cooperate well while others do not cooperate effectively. This may be because the residents who are familiar with the TBL process and group dynamics can contribute more effectively to the group discussion. These residents know the importance of the team as they assist the team

to fruitfully complete the assignments. One article about TBL reports that TBL instructional strategy is designed to encourage students' accountability over the actions inserted in the course structure. Students are estimated to commit to contributing to the group discussions (21).

This study had some strength. Working in the field of new teaching strategies is one of the priorities in medical education research in the Eastern Mediterranean Region and Iran (22). The other strength was that in this study, different residents participated and it was a good environment for team activities and collaboration.

There are some limitations to this study. One of the limitations is that it was not possible for us to have a control group. Another limitation is that IRAT and GRAT were done in the class and we did not measure the long-term effect of TBL sessions. Also, this study was done on first-year medical residents, who might not be a good representative for all residents. Moreover, the pre-class activity should be more structured. In future studies, long-term follow-up and more structured pre-class activities are required.

## CONCLUSION

The implementation of new teaching strategies like TBL for medical residents seems to be necessary. In our experience, TBL is a practical and crucial activity to educate medical residents about EBM.TBL was intended to develop better classroom engagement in a group of first-year residents in the present study. Better classroom engagement leads to better learning and understanding of residents and has a direct effect on improving patients' outcomes. In this study, residents' view about teamwork improved, which would help them to communicate well with each other for inter-department educational activities in the future years. We hope that the results offer more motivation for faculty and residents to implement this method.

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# *References*

1. Parmelee D, Michaelsen LK, Cook S, Hudes PD. Team-based learning: a practical guide: AMEE guide no. 65. Med Teach 2012;34:e275-e87. https://doi.org/10.3109/0142159X.2012.651179

2. Michaelsen LK, Parmelee DX, McMahon KK, et al. Team-based learning for health professions education: A guide to using small groups for improving learning. 2008.

3. Epstein B. Five heads are better than one: preliminary results of team-based learning in a communication disorders graduate course. Int J Lang Commun Disord 2016;51:44-60. https://doi.org/10.1111/1460-6984.12184

4. Ismail NAS. Effectiveness of team-based learning in teaching medical genetics to medical undergraduates. Malays Journal Medi Sci 2016;23:73.

5. Bleske BE, Remington TL, Wells TD, et al. A randomized crossover comparison of team-based learning and lecture format on learning outcomes. Am J Pharm Educ 2016;80:120.

6. Zgheib NK, Dimassi Z, Bou Akl I, et al. The long-term impact of team-based learning on medical students' team performance scores and on their peer evaluation scores. Med Teach 2016;38:1017-24. https://doi.org/10.3109/0142159X.2016.1147537

7. Koohestani HR, Baghcheghi N. The effects of team-based learning techniques on nursing students' perception of the psycho-social climate of the classroom. Med J Islam Repub Iran 2016;30:437.

8. Dearnley C, Rhodes C, Roberts P, et al.. Team based learning in nursing and midwifery higher education; a systematic review of the evidence for change. Nurse Educ Today 2018;60:75-83. https://doi.org/10.1016/j.nedt.2017.09.012

9. Freeman S, Parmar H, Pluen A. Integrated examinations: supporting students with team-based learning. Stroke 2018;13:57.

10. Ibrahim MSB, Hassan NG. The Structural Framework, Implementation Strategies and Students' Perception of Team Based Learning in Undergraduate Medical Education of a Medical School in Malaysia. EducMed J 2018;10(1).

11. Balwan S, Fornari A, DiMarzio P, et al. Use of team-based learning pedagogy for internal medicine ambulatory resident teaching. J Grad Med Educ 2015;7:643-8. https://doi.org/10.4300/JGME-D-14-00790.1

12. McMullen I, Cartledge J, Levine R, Iversen A. Team-based learning for psychiatry residents: a mixed methods study. BMC Med Educ 2013;13:124. https://doi.org/10.1186/1472-6920-13-124

13. Fallon T, Strout TD. Free Open Access Medical Education (FOAM) Resources in a Team-Based Learning Educational Series. West J Emerg Med 2018;19(1):142. https://doi.org/10.5811/westjem.2017.11.35091

14. Schynoll G, Irish E, Wayne J, Smith R. Feasibility of a Comprehensive Medical Knowledge Curriculum in Internal Medicine Using Team-Based Learning. J Grad Med Educ 2018. https://doi.org/10.4300/JGME-D-17-00465.1

15. Glasziou P, Burls A, Gilbert R. Evidence based medicine and the medical curriculum. Br Med J (Clin Res Ed) 2008;337(7672):704-5. https://doi.org/10.1136/bmj.a1253

16. Dent J, Harden RM, Hunt D. A practical guide for medical teachers: Elsevier Health Sciences; 2017.

17. 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. https://doi.org/10.1080/0142159X.2017.1340636

18. Sagheb MM, Amini M, Saber M, et al. Teaching Evidence-Based Medicine (EBM) to Undergraduate

Medical Students through Flipped Classroom Approach. Shiraz E Med J 2018, 19; e57150.
https://doi.org/10.5812/semj.57150

19. Amini M, Jafari S, Lotfi F, et al.. The Effect of team-based learning on study skill course of Nutrition Students of Shiraz University of Medical Sciences. Future of medical education journal 2011;1:3-7.

20. Salehi A, Harris N, Lotfi F, et al. Reform in medical and health sciences educational system: a Delphi study of faculty members' views at Shiraz University of Medical Sciences. East Mediterr Health J 2014;20:151-61.
https://doi.org/10.26719/2014.20.3.151

21. Stein RE, Colyer CJ, Manning J. Student accountability in team-based learning classes. Teaching Sociology 2016;44:28-38.
https://doi.org/10.1177/0092055X15603429

22. Amini M, Kojuri J, Lotfi F, et al.. Research priorities in medical education in the Eastern Mediterranean Region/Priorites de la recherche sur l'enseignement medical dans la Region de la Mediterranee orientale. East Mediterr Health J 2012;18:687.
https://doi.org/10.26719/2012.18.7.687

# Primena timskog učenja u nastavi o medicini zasnovanoj na dokazima specijalizantima prve godine

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## SAŽETAK

Timsko učenje je poznata nastavna strategija koja studentima pruža mogućnost primene konceptualnog znanja kroz seriju aktivnosti, uključujući i aktivnosti pre časa, individualne i timske aktivnosti, kao i dobijanje neposrednih povratnih informacija. Cilj ove studije bio je uvođenje kursa o medicini zasnovanoj na dokazima, specijalizantima prve godine različitih medicinskih disciplina, na Medicinskom fakultetu Širaz u Iranu, a primenom timskog učenja.

Uzorak je obuhvatio 86 specijalizanata na Medicinskom fakultetu u Širazu. Ova kvazi-eksperimentalna studija sprovedena je u 12 sesija o medicini zasnovanoj na dokazima primenom strategije timskog učenja. Dobijeni podaci su analizirani primenom SPSS programa. Rezultati Individual Readiness Assurance testa kao i Group Readiness Assurance testa su sabrani i izračunati. Primenjen je Cronbach alfa test kako bi se utvrdila pouzdanost upitnika. Za deskriptivnu analizu podataka korišćena je deskriptivna statistika. Za analitičku analizu korišćeni su ANOVA i T test.

Uočena je značajna razlika između odgovora na individualnom (3,73 ± 2,33) i grupnom (4,71 ± 2,29) nivou. Specijalizanti su dobili prosečno veće ocene kada su radili u timu (p < 0,02). Rezultati odgovora koji su pokazali koliko su specijalizanti bili zadovoljni, ukazali su da su najviše ocene date grupnim aktivnostima primenom timskog učenja.

Rezultati ove studije pokazali su da se timsko učenje može primeniti kao efikasna metoda za edukaciju specijalizanata u različitim disciplinama.

*Ključne reči:* timsko učenje, specijalizanti, medicinska edukacija, medicina zasnovana na dokazima