



Taibah University

Journal of Taibah University Medical Sciences

www.sciencedirect.com



Student Article

Team-based learning in an undergraduate pathology curriculum and its effects on student performance



Ahmed Alwahab^{a,*}, Saud Abdulqader^a, Assmaa Nugud^b, Shomous Nugud, MD^a, Farhan Cyprian, PhD^c, Abdul Ahad Shaikh, PhD^d and Khurshid Anwar, PhD^e

^a Department of Clinical sciences, College of Medicine, University of Sharjah, Sharjah, United Arab Emirates

^b College of Medicine, Ras AlKhaimah Medical and Health Sciences University, RAK, United Arab Emirates

^c Department of Basic Sciences, College of Medicine, University of Sharjah, Sharjah, United Arab Emirates

^d Department of Physiology, Alfaisal University, KSA

^e Department of Pathology, Alfaisal University, KSA

Received 8 February 2018; revised 18 March 2018; accepted 20 March 2018; Available online 27 June 2018

المخلص

أهداف البحث: يمثل التعلم المبني على فريق استراتيجية تعليمية مستحدثة مثيرة للاهتمام. حيث يتم جمع الطلاب المتفوقين مع غيرهم في مجموعات تعليمية مما يساعد على تعزيز الكفاءات المهنية للطلاب، ويعتج بشكل كبير على قابلية الطلبة للتعلم من بعضهم البعض. الهدف من هذه الدراسة هو تقييم فاعلية التعلم المبني على فريق كاستراتيجية تعليمية، وتأثيره على الدرجة النهائية أيضاً. استكشاف آراء الطلاب عن هذه الاستراتيجية كطريقة تعليم حديثة في العالم العربي.

طرق البحث: أجريت دراسة مقطعية من خلال استبانة ذاتية التصميم. شُيد الاستبانة لفحص جوانب من التعلم المبني على فريق، بما في ذلك الإدراك، والمهارات الاجتماعية، ونوعية الأسئلة خلال محاضرات التعليم المبني على فريق. تمت دعوة 101 طالباً للمشاركة في الدراسة وأكمل 101 منهم الاستبانة. تم جمع نتائج كل من اختبارات ضمان استعداد الفرد واختبارات ضمان استعداد المجموعة كما تم تحليل البيانات ومقارنتها بنتائج التقييم النهائي باستخدام البرنامج الإحصائي للعلوم الاجتماعية.

النتائج: درجات الطلاب خلال محاضرات التعليم المبني على فريق كانت دائماً أعلى من درجات التعليم المبني على الفرد. لوحظ وجود علاقة إيجابية بين درجة التعليم المبني على الفرد ودرجة الامتحان النهائي. 57% من الطلاب وافقوا على التعليم المبني على فريق ساعد في فهم المادة المطروحة في المحاضرة. 45% و

جودوا أن التعليم المبني على فريق كان مفيد و 67% من الطلاب وجدوا أن التعليم المبني على فريق ساعد في تحسين مهارات الاتصال والعمل الجماعي.

الاستنتاجات: كان التصور العام وموقف الطلاب تجاه نظام التعلم المبني على فريق إيجابياً وواعداً. ومع ذلك، فإن هناك بعض الملحوظات ومجالات للقلق يجب إعادة النظر فيها ومعالجتها لتحسين التعلم المبني على فريق كإداة تعليمية.

الكلمات المفتاحية: التعلم المبني على فريق؛ التعليم؛ الطبي؛ التعلم المبني على؛ مشكلة؛ اختبارات ضمان استعداد؛ الفرد؛ اختبارات ضمان استعداد المجموعة

Abstract

Objectives: Team-based learning (TBL) is a student-centered learning modality in which high and low achievers are organized in groups where students learn from each other at their own pace. The purpose of this study was to explore the correlations between TBL scores and final examination scores and student perceptions of a TBL system.

Methods: A cross-sectional survey was conducted on a sample obtained using quota sampling of a population of second-year students enrolled in the College of Medicine, University of Sharjah, Sharjah, United Arab Emirates. A self-administered questionnaire was employed to collect data on the students' perceptions and opinions, TBL scores, and final examination scores. The data were processed and analyzed using SPSS Version 22.

Results: A sample of 101 students participated in the study. The Team Readiness Assurance Test scores were consistently higher than the mean Individual Readiness Assurance Test (IRAT) scores. The results found a

* Corresponding address: Dubai Health Authority, Dubai, UAE; Sharjah Institute for Medical Research, Sharjah, United Arab Emirates.

E-mail: a7md13@gmail.com (A. Alwahab)

Peer review under responsibility of Taibah University.



Production and hosting by Elsevier

statistically significant correlation between the IRAT and the final examination scores ($r = 0.46, p < 0.001$). About 57% of the sample agreed that TBL increased the understanding of course content, 45% reported that TBL was a useful learning activity, and 67% indicated that TBL enhanced interpersonal and communication skills.

Conclusion: The findings imply that TBL is an effective tool to facilitate inter-professional and team-based learning outcomes. Collaborations among TBL group members help learners to develop communication and interpersonal skills and to gain knowledge.

Keywords: Communication skills; Interpersonal skills; Medical students; Student-centered learning; Team-based learning

© 2018 The Authors.

Production and hosting by Elsevier Ltd on behalf of Taibah University. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Parmelee (2012) defined team-based learning (TBL) as a student-centered, subject-specific, directed instructional strategy that promotes active learning in small groups.¹ Larry Michaelsen introduced and integrated TBL into the medical field in 2001.^{2,3} This modality provides students with opportunities to apply their knowledge through a series of activities comprising individual work, teamwork, immediate feedback, and application to problem-solving task-based assignments. TBL has three stages: (1) student preparation based on generated and provided session objectives, (2) assessment of the preparation through the Individual Readiness Assurance Test (IRAT) and the Team Readiness Assurance Test (TRAT) followed by immediate feedback, and (3) problem-solving in groups in the context of a provided clinical scenario.^{2,3}

Many active learning strategies are currently being used, including case-based group discussion, workshop, and audience response. Although these learning techniques are effective for increasing student engagement, they also have been extremely resource intensive. In contrast, TBL strikes a balance among active learning, faculty teaching time, and resources.⁴ Its immediate feedback, self-reflection, meaningful peer evaluations, and peer-assisted learning process are cornerstones of the learner-centered educational strategy.¹

The first application of TBL in professional healthcare education occurred at Baylor College of Medicine in 2001.⁵ Currently, TBL is being implemented at schools of medicine, nursing, dentistry, pharmacy, and in residency programs worldwide, including Japan, Korea, Singapore, and the Middle East.⁶ Apparently, TBL has gained considerable popularity during the past two decades based on its perceived effectiveness. The goal of this study was to empirically determine the effects of TBL on students' independent and team-based learning by statistically

assessing the relationship of this active learning modality to performance on final examinations intended to assess learning outcomes. An alternative way to assess learning would be to compare student perceptions of TBL to their perceptions of problem-based learning (PBL).

Materials and Methods

A single-stage, cross-sectional survey without random sampling was conducted. All of the respondents ($n = 101$) completed a structured self-administered paper questionnaire comprising 24 multiple-choice questions with response options on a Likert-type scale. The questionnaire had five sections: (1) contents of the TBL, (2) opinions of the TBL process, (3) perspectives on the material covered during the TBL sessions, (4) perspectives on the TBL assessments, and (5) the effects of TBL on communication and interpersonal skills. Because instruction at the College of Medicine, University of Sharjah, is in English, the questionnaire, which was administered in academic year 2015–2016, was in English. All of the available respondents were interviewed, the questionnaire was explained to them, and the respondents' anonymity was assured. Before distributing the questionnaire, the administrators explained the study's objectives to the respondents, and they were informed that their participation was voluntary and based on their consent.

This study aimed to determine the effects of TBL for second-year students in an undergraduate pathology curriculum. The undergraduate curriculum at the College of Medicine, University of Sharjah, Sharjah, United Arab Emirates, is a six-year integrated hybrid PBL outcome-oriented curriculum in which the pathology courses that focus on basic medical science are spread throughout the first three years. All of the study's respondents were students in their second year undertaking the cardiology, respiratory, and endocrine blocks offered in the "first semester of the second year." The students were organized into 10 groups of about nine to 11 students per group. The three phases of the TBL process are described in Table 1.

During the study period, there was one TBL session per week, each of which lasted for at least 2 h, comprising of 12 multiple-choice questions (MCQs) and conducted by one faculty member. The objectives of the TBL sessions were posted on Black Board® one week before the TBL sessions. Before the sessions began, the faculty member made certain that the participants were correctly seated in an examination format. Then, the faculty member distributed the Scantron™ form used to complete the IRAT; the Scantron™ used for the TRAT was provided only to the group leader.

During the TBL sessions, the students were given 90 s to attempt each MCQ on the IRAT and TRAT. Topic experts had developed all of the MCQs, each of which included a short clinical vignette, laboratory data, imaging studies, and high-resolution photographs depicting gross and histopathological findings relevant to that week's learning objectives. The MCQs were displayed in timed PowerPoint™ presentations.

The students indicated their answers to the IRAT and TRAT MCQs on individual Scantrons™. The IRAT Scantrons™ were collected at the end of IRAT testing period. During the TRAT, the students worked in predefined

Table 1: The structure of the team-based learning (TBL) pathology curriculum.

TBL process in the pathology curriculum				
Phase 1: Preparation	Faculty posts the TBL objectives on Black Board®	Students prepare based on individual study		
Phase 2: Readiness Assurance	Administer IRAT to assess individual preparation	Administer TRAT to assess group preparation	Written group appeals	Faculty feedback
Phase 3: Application of course concepts	Group assignments and problem-solving	Faculty feedback		

groups, each of which was led by a group leader chosen through intragroup voting. To facilitate group discussions, seating during the TRAT was arranged in a circle with the students facing each other. The group leader's function was to mark the answers on the TRAT Scantron™ after the majority of the group reached an answer by show of hands, following the discussion.

After the IRAT and TRAT were administered, faculty moderated a simultaneous review of the MCQs of all the groups. When the groups' answers disagreed, the groups were encouraged to defend their answers with logical reasoning and arguments. At the end of the TRAT, at least 1 h was used for discussion and explanation of MCQs on epidemiology, etiology, clinical presentation, pathogenesis, and diagnosis of the clinical scenarios. The students were allowed to challenge the quality of the materials in the MCQs.

After the sessions, the Scantron™ sheets were input into the Scantron™ software and the results were exported to the SPSS statistical package (Version 22). Then, the data were manually verified and adjusted to reflect the number of sessions attended by the students.

Statistical analysis

Statistical analysis was performed using SPSS statistical package (Version 22). The significance levels of the associations between qualitative variables were analyzed using Chi-squared for contingency (χ^2). To quantify the respondents' opinions, a five-point Likert-type scale was used for the response options regarding limitations, satisfaction, and perspectives. The response categories were collapsed into three groups: (1) agree/satisfied, (2) neutral, and (3) disagree/dissatisfied. To assess the gender differences in IRAT scores and final examination scores, Pearson's correlation coefficient was used. The results are presented as numbers of cases and percentages, with a 95% confidence interval, and p -value of 0.05 was the statistical significance cutoff value (see Table 4).

Results

All of the second-year medical students ($n = 101$) attended the TBL sessions and completed the questionnaire (100% response rate). One TBL session was held in the cardiovascular, respiratory, and endocrine block every other week, totaling eight sessions over a 16-week period. Each TBL included 12 MCQs in the IRAT and in the TRAT. There were 10 groups ordered alphabetically (A–J). The results of the statistical analysis of the IRAT scores are shown in

Table 2 and the results of the analysis of the TRAT scores are provided in Table 3.

Discussion

As expected, the mean TRAT scores were greater than the mean IRAT scores in all of the groups, and the difference among groups was statistically significant ($p < .001$). Among the groups, the lowest mean TRAT score was higher than the mean IRAT score. This finding is consistent with previous studies by Weiner et al. (2009) and Nieder et al. (2004).^{7,8} The respondents scored an average of 50% on the IRAT, suggesting that the difficulty of the questions would sufficiently stimulate discussion. There was no statistically significant relationship between IRAT scores and the summed final examination scores. Nieder et al. (2004) previously studied TBL implemented in a gross anatomy and embryology course and found a similar trend in the relationship between IRAT and final examination scores (correlation = 0.7597, $p < 0.0001$). Other studies also have found this association, indicating that the IRAT is a reliable predictor of examination performance.^{8–10}

The analysis of the IRAT and TRAT scores by group (A–J) found differences by group (data not shown). Specifically, Group B's highest IRAT score was 60, whereas its mean TRAT score was 76.5. This difference of 16.5 points is likely the result of effective communication among the group members during the TRAT. Similar results were found for Group F. Just one member of Group D scored 74.1, while the other group members scored less than 60 points, but the group's combined TRAT score was 82.5. The results might indicate effective leadership in the high-achieving group or a skewed group score caused by one high-achieving student.

The analysis found a weak correlation between the students attending the sessions and their summed MCQ scores,

Table 2: Mean IRAT test results ($n = 101$).

Group ID	Number of students	Mean	Std. deviation	Std. error of mean
A	10	53.520	14.0074	4.4295
B	10	46.270	10.1619	3.2135
C	11	59.255	12.3651	3.7282
D	10	48.530	12.1193	3.8325
E	10	45.300	7.3482	2.3237
F	10	52.210	10.6451	3.3663
G	11	51.218	6.5113	1.9632
H	11	45.882	10.0907	3.0425
I	10	50.570	11.8661	3.7524
J	8	52.387	11.0970	3.9234
Total	101	50.525	11.1103	1.1055

Table 3: Mean TRAT test results ($n = 101$).

Group ID	Number of students	Mean
A	10	81.20
B	10	76.50
C	11	83.50
D	11	82.50
E	10	69.40
F	10	83.50
G	11	72.90
H	11	75.30
I	10	74.10
J	9	75.30
Total	103	77.48 (SD = 4.726) (SE = 0.465)

Table 4: The association (Pearson's correlation coefficient (r)) between IRAT and final examination scores for the entire sample ($n = 101$), which found no statistical significance.

Correlation results			
		IRAT score	Final examination score
IRAT score	Correlation Coefficient	1.00	-0.004
	(Two-tailed p-value)		0.970
	n	76	76
Final examination score	Correlation Coefficient	-0.004	1.00
	(Two-tailed p-value)	0.970	
	n	76	82

which is consistent with Anwar et al.'s (2015) results.¹⁰ These results also found a positive influence of attendance and engagement in problem solving during the TBL on the summed final examination scores.

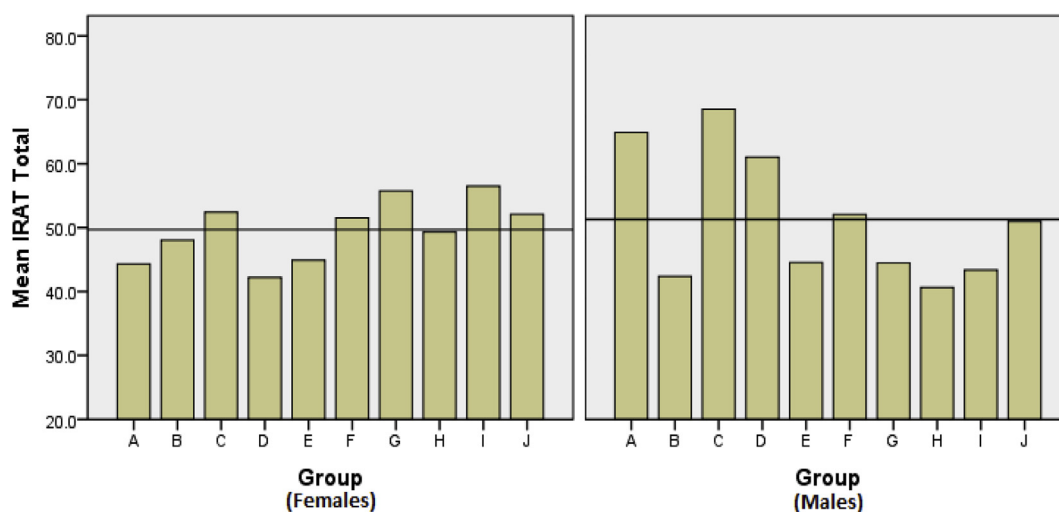
Over the 16-week study period, there was a general decline in mean IRAT scores in all of the groups. This change could have been caused by significant numbers of absentees in weeks six and seven and/or relatively less readiness for the TBL caused by students' diverted attention as the final examination period neared.

The analysis found a small gender difference in mean IRAT scores (Figures 1 and 2). However, Figure 2 shows no difference in the final examination scores. Moreover, there was no statistically significant correlation between males' and females' IRAT scores or final examination scores. However, Weiner et al. (2009) reported a favorable influence of TBL on males' summed examination scores compared to females.⁷ The observed differences might reflect the influence of an underlying cultural context that is beyond the scope of this study.

These results found that the males had a stronger positive correlation than the females between mean IRAT score and final examination score. Previous studies similarly reported a stronger IRAT effect on males' than on females' grades.⁷

Sixty-five percent of this study's respondents agreed that the content covered in the TBL sessions helped them to increase their understanding of the course material, and 43.4% agreed that the TBL sessions helped them to focus on the core information. Approximately 36% of the sample reported that they were well prepared for the IRAT, which is similar to Anwar et al.'s (2012) results.¹¹ The majority of the sample (56.6%) considered the IRAT a useful learning activity. Approximately 54% of the respondents reported that the TBL process helped them to generate information, understand the basic concepts of pathology, bridge the knowledge gap, and rectify misunderstandings through group discussions during the TRAT. Approximately 55% of the respondents reported that they enjoyed their group experiences and that the groups helped them to improve interpersonal and communication skills (see Figures 3 and 4).

Incorporating modern educational tools, such as social networking sites^{12,13} and clinical reasoning, into existing medical curricula holds great promise for enhancing the learning experience.¹⁴ Broadening the curricular scope and adding workplace-based education and assessment have

**Figure 1:** Bar charts illustrating mean IRAT scores of 10 groups by gender ($n = 101$).

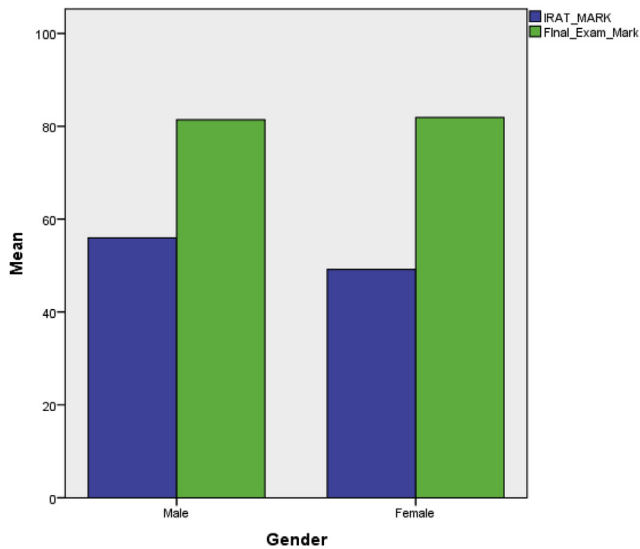


Figure 2: Bar chart illustrating mean final examination scores and IRAT scores by gender ($n = 101$).

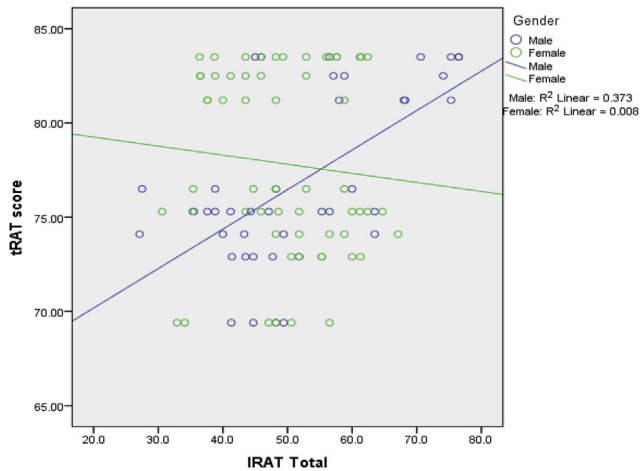


Figure 3: Scatterplot of the association between TRAT scores and IRAT scores ($n = 101$).

been found to strengthen lifelong learning in the healthcare field.^{15,16} Small group dynamics have a crucial role in the learning process, and appropriately conducted small group sessions could have major effects on active and interactive learning outcomes. In addition, knowledge of students' learning preferences facilitates educators' skillful modification of curricular delivery to match learners' preferred learning styles.¹⁷ Collectively, these curricular interventions could promote active learning and the goal of embedding lifelong learning in medical school students.

Conclusion

TBL is a tool that caters to the needs of the rapidly changing practice of medicine and that facilitates inter-professional and team-oriented skills. This approach directs attention to the student because it emphasizes a process that facilitates knowledge acquisition, which encourages students

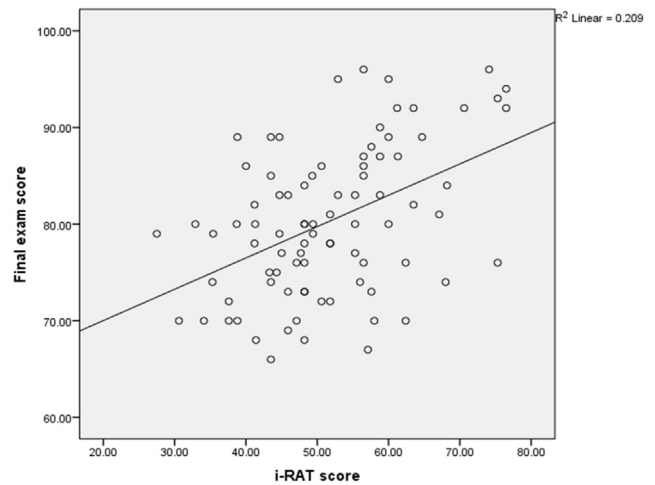


Figure 4: Scatterplot of the association between IRAT scores and summed MCQ scores ($r = 0.46$, $p < .001$, $n = 101$), indicating a moderately strong relationship.

to be actively responsible for their learning outcomes. TBL and PBL are similar because they focus on individual students, promote cooperation, and generate critical thinking. During TBL sessions and pre-session periods, students actively participated in the broad scope of the course. Moreover, they had opportunities to learn basic concepts in the context of actual clinical situations, maintaining high levels of motivation throughout the course.^{16–18}

The previous literature has strongly emphasized the importance of TBL for fostering problem solving and collaborative learning in feedback-rich small and large group learning environments, and the current study demonstrates and supports this point.¹ These results imply that the immediate feedback obtained during TBL sessions ensures that the students never doubt the content of the sessions. The combination of small and large group dynamics leads to a significant amount of interaction among learners, which creates ownership and enthusiasm, and this point was demonstrated by the within study.⁵

Study limitations

The sample of students analyzed for this study comprised students at the College of Medicine, University of Sharjah, which might be different in important and relevant ways from medical students at other educational institutions. In addition, the reliability and validity of the instrument were not tested. Furthermore, a longer study period might have strengthened the overall study design. Despite these limitations, the study's results provided an adequate answer to the research question.

Recommendations

Implementing TBL in cardiovascular and respiratory educational blocks increased students' sense of responsibility for their learning outcomes and improved their interpersonal and communication skills. A previous study also obtained this finding.¹⁹ The learning that happened in TBL sessions helped

this study's respondents to gain knowledge and bridge cognitive gaps. We recommend that future studies examine other types of academic outcomes, such as critical thinking skills and knowledge application. In addition, because preliminary evidence of the effectiveness of TBL for improving academic learning outcomes is an established learning objective, future studies should deeply investigate explanations of the effects of specific elements of TBL.

Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

Ethical approval obtained from the institutional review board before collecting the data. And a signed consent form was obtained before answering the questionnaire.

Authors' contributions

AAS and KAA conceived the idea and taught the TBL sessions. AAA, SIA, and AAN administered the questionnaire and performed the data entry, data analysis, and wrote the paper. SAN and FSC developed the questionnaire and reviewed the initial and final manuscript drafts. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

References

1. Parmelee D, Michaelsen L, Cook S, Hudes P. Team-based learning: a practical guide: AMEE Guide No. 65. *Med Teach* 2012; 34(5): e275–e287.
2. Michaelsen L, Watson W, Cragin J, Dee Fink L. Team learning: a potential solution to the problems of large classes. *Exchange Organ Behav Teach J* 1982; 7(1): 13–22.
3. Seidel C, Richards B. Application of team learning in a medical physiology course. *Acad Med* 2001; 76(5): 533–534.
4. Searle N, Haidet P, Kelly P, Schneider V, Seidel C, Richards B. Team learning in medical education: initial experiences at ten institutions. *Acad Med* 2003; 78(Supplement): S55–S58.
5. Haidet P, O'Malley K, Richards B. An initial experience with "team learning" in medical education. *Acad Med* 2002; 77(1): 40–44.
6. Parmelee D, Michaelsen L. Twelve tips for doing effective Team-Based Learning (TBL). *Med Teach* 2010; 32(2): 118–122.
7. Wiener H, Plass H, Marz R. Team-based learning in intensive course format for first-year medical students. *Croat Med J* 2009; 50(1): 69–76.
8. Nieder G, Parmelee D, Stolfi A, Hudes P. Team-based learning in a medical gross anatomy and embryology course. *Clin Anat* 2004; 18(1): 56–63.
9. Rawekar A. A. Team based learning: a controlled trial of active learning in large group setting. *IOSR J Dent Med Sci* 2013; 7(4): 42–48.
10. Anwar K, Shaikh A, Sajid M, Cahusac P, Alarifi N, Al Shedoukhy A. Tackling student neurophobia in neurosciences block with team-based learning. *Med Educ Online* 2015; 20(1): 28461.
11. Anwar K, Shaikh A, Dash N, Khurshid S. Comparing the efficacy of team based learning strategies in a problem based learning curriculum. *APMIS* 2012; 120(9): 718–723.
12. Guraya S. The usage of social networking sites by medical students for educational purposes: a meta-analysis and systematic review. *N Am J Med Sci* 2016; 8(7): 268.
13. Al Wahab A, Al-Hajo S, AlAhmdani G, Al-Mazroua N, Edan M, Nugud S, et al. The patterns of usage and perceived impact of social networking sites on medical students' education. *J Nursing Healthcare* 2016; 1(2).
14. Guraya S. The pedagogy of teaching and assessing clinical reasoning for enhancing the professional competence: a systematic review. *Biosci Biotech Res Asia* 2016; 13(3): 1859–1866.
15. Guraya S, Habib F, Khoshhal K, Guraya S. Learning styles of medical students at Taibah University: trends and implications. *J Res Med Sci* 2014; 19(12): 1155.
16. Kebodeaux C, Peters G, Stranges P, Woodyard J, Vouri S. Faculty perception of team-based learning over multiple semesters. *Curr Pharm Teach Learn* 2017; 9(6): 1010–1015.
17. Guraya S, Almaramhy H. Small group teaching improves students' acquisition of knowledge and skills. *Saudi Med J* 2012; 33(12): 1304–1309.
18. Williams B. The theoretical links between problem-based learning and self-directed learning for continuing professional nursing education. *Teach High Educ* 2001; 6(1): 85–98.
19. Conway S, Johnson J, Ripley T. Integration of team-based learning strategies into a cardiovascular module. *Am J Pharmaceut Educ* 2010; 74(2): 35.

How to cite this article: Alwahab A, Abdulqader S, Nugud A, Nugud S, Cyprian F, Shaikh AA, Anwar K. Team-based learning in an undergraduate pathology curriculum and its effects on student performance. *J Taibah Univ Med Sc* 2018;13(5):496–501.