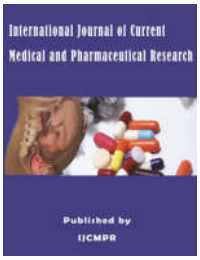
Research Article

INTERNATIONAL JOURNAL OF CURRENT MEDICAL AND PHARMACEUTICAL RESEARCH

ISSN: 2395-6429, Impact Factor: SJIF: 4.656
Available Online at www.journalcmpr.com
Volume 4; Issue 1(A); January 2018; Page No. 2868-2871
DOI: http://dx.doi.org/10.24327/ 23956429.ijcmpr20180356



ASSESSING THE BENEFITS OF TEAM BASED LEARNING IN THE CONTEXT OF A CLINICAL PATHOLOGY COURSE

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ARTICLE INFO

Article History:
Received 18th October, 2017
Received in revised form 14th November, 2017
Accepted 08th December, 2017
Published online 28th January, 2018

Key words:
Team-based learning, active learning, pathology course, evaluation

ABSTRACT

Team Based Learning (TBL) can help students to better develop problem solving skills and strong critical thinking in an integrative course like Pathology. Medical students were divided into small teams based on their academic performance, gender, and ethnicity. The results of tests administered individually and to the TBL groups were evaluated using the Mann-Whitney U statistical test for group differences. At the end of the course, and at the end of their basic science education the same students were asked to complete a survey to assess their perception of TBL compared to traditional lecture. *t*-Test and one-way analysis of variance (ANOVA) were used to analyze this data.TBL group exam results were consistently and significantly higher compared with individual student exam results. The benefits of TBL were experienced by both stronger and weaker students; exam results were higher in both groups. Descriptive statistics for three outcome measurements, (learning environment, student interaction, and group structure) were assessed by group. The one-way ANOVA yielded significant results for group structure by term: Term4 students were .25 points significantly ($p < .05$) higher than Term 5 students on the group structure construct. TBL was well received by the students that participated in our study. We found that Term4 students who had more recently participated in TBL rated group structure significantly higher than Term5 students, indicating a more positive perception than that of Term5 students. TBL is a promising educational method and was effective at improving learning outcomes in a Clinical Pathology course.

INTRODUCTION

Trinity School of Medicine (TSOM) opened in 2008 and has an offshore American Faculty of Medicine located on the Caribbean island of St Vincent and The Grenadines. After finishing five semesters of preclinical, basic science training in St Vincent, TSOM students continue with clinical rotations in US and Canadian hospitals. In Term 3, students complete the General Pathology course. This is followed in Term 4 by a more focused, Clinical Pathology course. TSOM students have diverse academic backgrounds and possess varying funds of knowledge in the biological sciences. Consequently, when students finish the General Pathology course in their third term, their academic outcomes in pathology are highly variable. TSOM started with traditional lecture-based instructions in 2008 and two years ago introduced Team Based Learning (TBL) in the Clinical Pathology course for Term 4 classes. Research has demonstrated that TBL may benefit students who are less able to learn and need to be helped by other team members [1,2], but there are also reports that it improves student performance in both academically weak as well as academically strong students [3, 4]. Traditional lecture may therefore not be the optimal teaching strategy to help students learn and apply therapeutic or scientific content to clinical scenarios [5] or to other real-world situations.

TBL is a well-documented and accepted teaching method, validated through its adoption by many disciplines and across many countries around the world [6]. Among the biggest adopters of TBL are health professionals, who are particularly concerned with producing graduates who can think critically and apply concepts in practice [7]. Several graduate medical education departments and some residency programs that have already incorporated TBL into their curricula [8]. Active-learning strategies such as the "flipped classroom" used in problem-based learning (PBL) and TBL are becoming more prevalent in higher education to improve traditional lectures. Traditional education, reflecting passive transfer of information from lecturer to students in a large group, has been shown to be inferior to active learning [9]. In contrast, TBL, as one example of active learning, has been found to promote

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more thorough and lasting understanding [10]. Team-based learning is a collaborative, small-group process that occurs during class, utilizing individual preparation with a focus on application of learned materials. Unsurprisingly, students in lecture-based courses tend to interact more with their teachers, while students in problem-based learning courses tend to interact more with each other [11]. Consequently, learning and scholarship improved among all students, regardless of their prior academic performance or background [12]. In this study, we aimed to assess the effect of team work on exam results as well as the students' perception of TBL depending on their grades, prior contact with TBL and academic performance.

METHODS

The purpose of this study was to determine the effect of teamwork on exam results and to compare students' perception of this teaching method depending on their grades, prior contact with TBL and academic performance in their actual medical education. At the beginning of Term 4, teams of 6 to 7 students (n=105) were created randomly based on their academic performance, gender, and ethnicity. 4 to 5 days before their first TBL session, the students were directed to read the core content of the organ system to be studied. 6 TBL sessions per term were performed. At the beginning of TBL sessions, an individual readiness assurance test (IRAT), consisting of 10 multiple choice questions and lasting 12 minutes, was administered. After completing the IRAT, students retook the same test, but were given 30 minutes and were permitted to collaborate with the other members of their TBL group to find the single best answer. This second test was termed the group assurance test (GRAT). Following the GRAT, individual TBL groups were allocated another 30 minutes to discuss their answers with the other TBL groups. The IRAT results were subsequently compared with the GRAT results. At the end of Terms 4 and 5 and during clinical rotations, the students were asked to complete a survey to assess their perception of the TBL construct compared to traditional lecture. Three different student cohorts were compared. The first cohort included Term 4 students who participated in TBL during the semester. The second cohort included Term 5 students who participated in TBL during the previous semester, but were still in the basic science program. The third cohort included Term 6 and Term 7 students who were participating in clinical rotations. These three groups of students then completed an anonymous online survey that presented questions divided into three groups pertaining to the TBL construct. The answer to each question was selected from a 5-choice Likert scale: strongly disagree, disagree, agree, strongly agree and not sure. The first group of questions addressed the learning environment and had a research goal of defining a strategy to enhance dynamic learning in the classroom. The second group of questions addressed the students' interaction and had a research goal of better understanding the social aspects of TBL that improve learning. The third and final group of questions addressed group structure and had a research goal of identifying the optimal group structure to enhance the TBL learning experience. Student responses were analyzed and means and standard deviation were calculated. Descriptive statistics were produced and a one-way analysis of variance was conducted to evaluate mean differences of the TBL construct. The survey questions are provided in Appendix A.

RESULTS

Individual versus group exam performances obtained over five testing sessions were assessed using descriptive statistics (i.e., means and standard deviations). All comparisons were evaluated using the Mann-Whitney U statistical test for group differences, due to the small sample size and violation of normality assumption. The difference in outcomes of all testing sessions between individuals and groups demonstrated statistical significance.

Tables 1 and 2 present the descriptive and comparative statistical results, respectively.

Table 1 Means (Standard Deviations) for Individual versus Group Testing by Sessions

	Session 1	Session 2	Session 3	Session 4	Session 5
Individual	46.8 (19.0)	41.7 (18.2)	51.1 (12.2)	46.9 (18.4)	47.7 (16.2)
Group	70.8 (17.7)	69.6 (9.5)	73.6 (4.2)	65.6 (11.9)	76.1 (10.0)

Table 2 Mann-Whitney U values and Sum of Ranks by Testing Sessions

	Session 1	Session 2	Session 3	Session 4	Session 5
Σranks(Ind)	878.00	1166.00	706.00	578.00	1198.50
Σranks(Group)	298.00	364.00	329.00	242.00	397.50
U	58.00*	38.00	3.00	50.00*	22.50

Note: *p<.01;

In Table 3 are the descriptive statistics (i.e., means and standard deviations) and inferential statistics information for the individual versus group performance for both low and high performing individuals. Both tests were conducted using an independent-sample t-test, since the normality assumption was met with the larger sample size. The testing sessions between individuals and groups were significantly different. These results are presented graphically in Figure 2 below.

Table 3 Means (Standard Deviations) and Inferential Statistics Information for Individual versus Group Testing by Sessions

	Low-performance	High-performance
Individual	31.8 (9.0)	59.7 (10.7)
Group	71.1 (11.6)	71.1 (11.6)
t	21.38**	5.68**
df	134	146

Note: **p<.001

An overall score was created for each TBL construct surveyed (i.e., learning environment, student interaction, and group structure, as outlined in Appendix A). Additionally, students were grouped into terms according to their progress through medical school.

Table 4 Descriptive Statistics of Dependent Variables by Groups

		Learning Environment			Student Interaction			Group Structure		
Variable	Level	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
Term	4	3.00	0.49	55	2.91	0.39	55	1.95	0.28	55
	5	3.31	0.26	12	3.09	0.35	12	1.69	0.24	12
	6-10	3.03	0.42	11	2.98	0.40	11	1.76	0.33	11
Prior TBL	Yes	3.03	0.53	35	2.91	0.43	35	1.95	0.30	35
	No	3.07	0.40	43	2.97	0.35	43	1.83	0.29	43
Course Grade	A	3.05	0.39	20	2.95	0.31	20	1.90	0.29	20
	B	3.16	0.37	26	2.91	0.37	26	1.83	0.30	26

C	2.91	0.57	24	2.94	0.44	24	1.88	0.31	24
F	3.26	0.47	6	3.21	0.44	6	2.14	0.27	6

Table 4 displays descriptive statistics (the mean, standard deviation, and sample size) for the three assessed TBL constructs and associated group (i.e., disaggregated by term, course grade and prior TBL experience). Table 5 shows the one-way analysis of variance (ANOVA) representing that group structure was significantly different by term. The Tukey's post hoc analysis revealed that term 4 students were .25 points significantly ($p< .05$) higher than term 5 students on the group structure construct.

Table 5 ANOVA Summary Table(SS, sum of squares; df, degrees of freedom; MS, mean square; F, F-ratio.)

Source	*SS*	*df*	*MS*	*F*	*p*
Between	0.84	2	.42	5.14	< .05
Within	6.10	75	.08		
Total	6.94	77			

DISCUSSION

TBL is a small-group learning instructional method that can be implemented in a large class environment. It facilitates the application of conceptual knowledge by students through a recurring sequence of activities that involve individual work, teamwork, and immediate feedback[13]. There is accumulating evidence that active learning produces better educational outcomes than traditional lecture-based instruction[14]. Our results showed that in all testing sessions, the group's exam results were significantly higher compared with the individual's exam results (Figure 1).

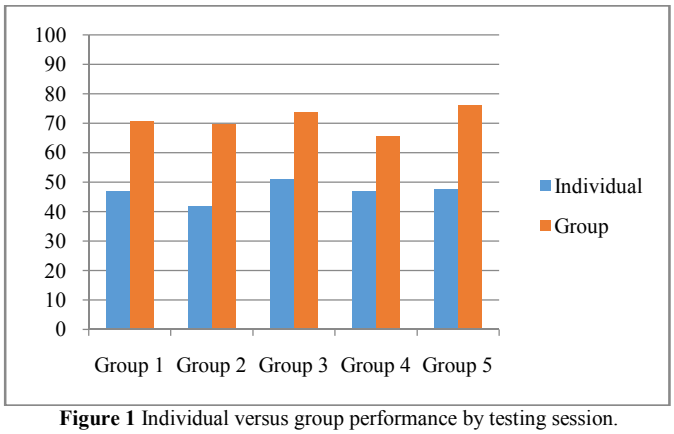

Figure 1 Individual versus group performance by testing session.

We wanted to know if this difference was significant for both academically stronger and weaker students. Indeed, for both groups our results showed a statistically significant benefit from learning as part of a team. This result is in accordance with a finding by Koles and others who showed that TBL increased overall academic performance, especially in weaker students [1,2,15]. However, some research found that TBL may benefit only students who are lessable to learn and need to be helped by other team members(16), or only those with excellent innovative thinking[17]. As demonstrated in Table 1, we found that weaker students working in a group increased their scores by 39.3% (from 31.8% to 71.1%, $p<.001$) while stronger students increased their scores by 11.4% (from 59.7 to 71.1%, $p<.001$). These results are depicted graphically in Figure 2 below.

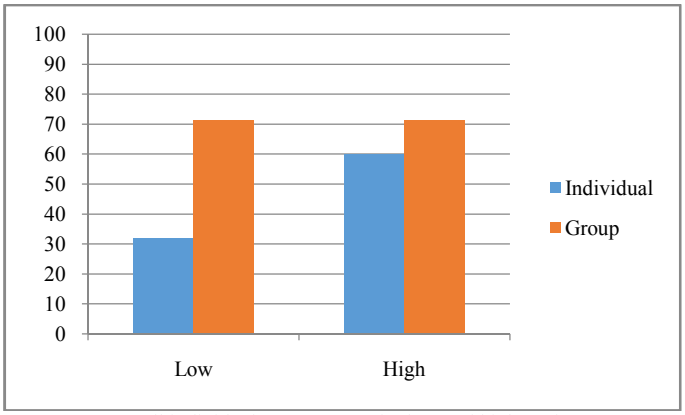

Figure 2 All individual test vs group for low and high performers.

In our school, TBL occurs as a part of a two-hour session at the start of the 'Systemic Pathology' unit in the fourth term Medical Pathology course. The success of TBL depends on high-functioning student teams [18]. "Wealth characteristics" such as higher degrees in pathology, prior experiences with TBL, sex and ethnicity, were balanced between the groups. That being said, it was interesting to observe in our findings that teams with lower-scoring individuals outperformed teams formed from higher-scoring individuals (Figure 1, group 2 and group 5) [13]. In TBL literature there are also reports addressing the learning outcomes question. When considering knowledge acquisition, TBL is on average superior to lecture-based programs [2,19], and tends to increase team skills and problem-solving abilities [20,21].

Overall, TBL was well received by the students enrolled in Medical Pathology at TSOM. Students were more active in the class and were often forced to defend their answers in front of their peers. More than passively attending lecture, this improved the students' ability to solve "higher order" and more complex questions and tended to encourage collaboration between students. Moreover, it provided an opportunity to learn new approaches to answering questions. Such benefits were reflected in their examination marks. We observed that academic improvements were the same in all terms, independent of prior TBL experience and independent of students' final course grades. However, students in Term 4 rated the TBL experience significantly higher than Term 5 students. That is, their perception was more positive than the Term 5 students'. Although both groups rated their perception of TBL highly, their satisfaction with the experience was mixed. Willett LR *et al.* [22] examined decreased student satisfaction depending on the group size while Parmelee *et al.* [23] reported considerable variation in student satisfaction with different aspects of the TBL process. The authors also showed that the ratings changed with time and that second-year students becoming less enthusiastic about peer evaluation or the sense that TBL aids their professional development compared with first-year students. Interestingly, Espey [24] found that students who were successful academically were more negative about TBL and preferred to learn on their own. Some papers reported that the students often resisted implementation because TBL or any type of active learning is a shift from the passive process of lecture-based settings [25,26]. In general, TBL is considered an efficient tool in the medical education system, where students' active participation is central to effective learning and where key factors are student satisfaction and a cooperative climate [27]. Our results demonstrated that the students who participated in TBL

sessions generally enjoyed the experience and benefited academically from them.

CONCLUSION

We found that working in a small group significantly improved student performance in both academically weak and academically strong students. Additionally, TBL enhanced students' understanding of concepts covered in the classroom, provided a new way to think about material presented in the class, improved the ability to solve "higher order" questions, and encouraged collaboration between peers.

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