doi: 10.3325/cmj.2009.50.69

Team-based Learning in Intensive Course Format for First-year Medical Students

Hubert Wiener, Herbert Plass, Richard Marz

Core Unit for Medical Education, Department of Science and International Relations, Medical University of Vienna, Vienna, Austria

Aim To examine the impact of team-based learning (TBL) on educational outcomes in the first year of the curriculum of the Medical University of Vienna.

Methods TBL was first offered to students as a single-group exercise to illustrate the value and dynamics of a learning team. In a second step, TBL was provided in an intensive course format with six 2-hour sessions over a 3-day period as an elective course covering the material of a critical teaching block. Students' responses to the program and the impact on the final exam were analyzed.

Results Out of 1417 eligible students, 386 participated in 8 parallel courses offered in the TBL block. The reaction of students to TBL was highly positive. Using the final exam as an outcome measure, 220 students who completed the intensive courses had a 25.3% higher score (non-TBL vs TBL students: 22 ± 9 vs 28 ± 9 points) in the TBL block. They also had a 16.5% higher score (non-TBL vs TBL students: 94 ± 29 vs 109 ± 26 points) in the remaining 5 non-TBL blocks of the year.

Conclusions TBL in an intensive course format seems to be especially attractive for the best students of the year, making them even more successful in the key exam. Even the students who usually learned alone highly appreciated learning in teams, thereby developing the understanding and skills needed to work productively in task-groups.

Received: July 10, 2008

Accepted: November 19, 2008

Correspondence to:
Hubert Wiener
Core Unit for Medical Education
Department of Science and International Relations
Medical University of Vienna
Spitalgasse 23 Bt 84/102
1090 Wien, Austria
hubert.wiener@meduniwien.ac.at

In 2001/02 academic year, an entirely revised 6-year medical curriculum was introduced at the Medical University of Vienna (1). According to the new curriculum, the first year consists of 2 semester modules, each divided into 3 successive blocks. Courses focusing on medical skills run parallel to these core blocks (2). The first year ends with a "summative integrative exam," a passing grade at which is a prerequisite for enrolling the second year. Until 2006/7 academic year, there were up to 1560 students enrolled yearly in the first semester and the graduation from Gymnasium was the only entrance requirement. In the second year, there were only 600 students enrolled yearly (720 after 2006/7).

The Functional Systems and Biological Regulation, a 5-week block in the second semester, is critical for the success in the first year of study, as indicated by low grades at the first year final examinations and the results of the student evaluations. This block consists of didactic lectures and laboratory sessions covering material from the traditional disciplines of physiology and biochemistry plus contributions from immunology, pharmacology, medical physics, and cybernetics, with some elements of clinical medicine. Due to very large number of students in the first year, coupled with limited faculty resources, this block required a lecture-based educational approach. Students often complained of having considerable problems in mastering the complex material of the block and of understanding the fundamental medical concepts presented in the lectures. As a result, some ended up rather dissatisfied and demotivated. Thus, it was necessary to offer students additional support.

Pedagogic approaches used in medical education have been changing and a variety of new teaching strategies are used in many curricula to promote active learning (3-5). Many schools have reduced the number of lectures in favor of a problem-based learning approach (3,4). However, in our school with more than 1500 students enrolled in the first year, the implementation of a problem-based learning approach was considered to be far too costly. As an alternative instructional strategy, team-based learning (TBL) has been used. It allows a single instructor to manage multiple small groups simultaneously in one classroom and has the potential to promote small group, interactive learning without requiring large numbers of faculty facilitators (5-7). The primary purpose of TBL is to maintain a high level of content learning, enhance application learning both at a quantitative and qualitative level, and support the development of interpersonal and team skills of the students (7).

We have successfully implemented TBL activities in an intensive course format in the first year of the medical curriculum in Vienna with a very large number of students (8). The aim of the study was to examine the impact of this instructional strategy on the learning attitudes of the students and the influence on the performance in the summative and integrative exam at the end of the first year.

METHODS

Activities

The presented data are from the academic year 2004/05 and courses held in subsequent years yielded similar results.

TBL was first offered to all first year students in the first semester, block 3 – From Molecule to Cell, as a single, non-obligatory 2-hour exercise to illustrate the value and dynamics of a learning team. In the second semester, it was offered as an optional, intensive course covering the material of block 4 – Functional Systems and Biological Regulation. Eight parallel courses, each with six intensive 2-hour sessions over a three-day period, were held two weeks before the final summative integrative exam at the end of the first year.

TBL activities were performed as described by Michaelsen (7). Sessions were held in amphitheater-type lecture halls with groups of 40 to 60 students divided into teams of 5 to 7 members. To prevent students from organizing themselves into preexisting subgroups, instructors formed the teams randomly; in block 3 by assigning the seat to arriving students and in block 4 by managing the course entirely via the internet (9). Students signed up for the courses electronically and were randomly assigned to a team. The teams were given a permanent space in the lecture hall one week before the start of the course.

Each instructional unit began with a readiness assurance test with 8 multiple-choice questions, which each student had to answer on their own. The same format ("single best answer") and time allotment used on the final examination was employed. Answer sheets were provided for this exercise, as well as for the team questions. Though these sheets were collected after each unit, the performance on the test had no influence on the grade students received for the course; at this point we chose not to follow the method of Michaelsen (7), since it was more in keeping with our educational climate.

The readiness assurance test was followed by a team discussion on each question, which resulted in a decision on the best answer. Teams signaled their answer by showing an appropriate alphabetic character to the auditorium. In a discussion between teams, moderated by the instructor, every answer possibility was examined and explanations as to why the right answer was right and the wrong answers wrong had to be given by the team and accepted by the auditorium. The instructor provided immediate feedback when the discussion and decision process was over, usually within five minutes. A key feature of the process was the final oral summing up of the instructor, typically limited to a brief, focused review of only the most challenging aspects of the material that needed additional clarification. In most sessions, two additional, more difficult questions emphasizing core concepts and principles in application-focused assignments had to be answered by the teams.

The multiple-choice questions focused on the learning objectives of the block, but were not identical to the questions on the final summative integrative exam. To elicit members' interest and commitment, application-type questions that require higher-level thinking were preferred over recognition-type questions. The TBL course itself had no exam-based grade. Students received credit if they attended at least 5 of the 6 TBL sessions and, as judged by the instructor, contributed satisfactory to all activities. The authors of this paper, who acted as TBL instructors, were trained at a workshop conducted by C.L. Seidel and V.F. Schneider from Baylor College of Medicine, Houston, Texas, USA at the 7th Graz Conference, Graz, Austria 2003.

Participants

All students participating in TBL activities were self-selected. In the academic year 2004/05, a total of 410 (26%) of 1560 students entering the first semester of the first year participated in the introductory TBL activities in block 3. In the second semester, 588 out of the remaining 1417 registered for the TBL intensive review courses in block 4. Eventually, 386 students participated in the 8 parallel courses offered. Although not thoroughly evaluated, oral feedback from the students indicated that at least some of them were already introduced to TBL in block 3. While 72% of the students in the intensive courses ranged in age from 17 to 20 years, 23% were aged 21 to 25 and 5% were older; 55% of the participants were female.

Evaluations and analysis

Brief evaluations of the first TBL activities in the single-unit approach of block 3 were collected from the standard end-of-block electronic evaluations. The TBL intensive courses in block 4 were evaluated in more detail. Students completed a 12-item program-evaluation questionnaire at the end of the course. They rated the statements on a six-point Likert scale ranging from 1 – strongly disagree to 6 – strongly agree. In addition, two open-ended questions on positive and negative aspects of their experiences with TBL were included. The program-evaluation questionnaire was constructed by the authors. The questions relied largely on students' feedback on the TBL single-unit approach in block 3. The following variables were collected: demographic data (age, sex); group learning experience (1 item); knowledge acquisition (3 items); motivational dimensions (3 items); instructor performance (1 item); organization (1 item); students' recommendations (2 items), and overall rating (1 item). To obtain a higher response rate, data were collected anonymously. Answers to open-ended questions were qualitatively analyzed by the authors. Subjects emerged from open coding and frequency counts. Two authors (HW, HP) reviewed the answers independently and shared their results to verify conclusions and form consensus on issues of disagreement, while one author (RM) performed a final review of the feedback.

Readiness assurance tests were scored with each correctly answered question being awarded one point. Scores from the year's final summative integrative exam were used as an outcome measure. Statistical significance of differences was determined using the Mann-Whitney ***U***-test and two-tailed ***t*** test. The level of significance was set at $P < 0.05$. Analysis was carried out using the SPSS, version 14 for Windows (SPSS Inc., Chicago, IL, USA).

RESULTS

Electronic evaluation of block 3 indicated that many students were dissatisfied with the single-unit approach of TBL. Overall, only 25% of the 221 responding students felt that TBL activities should be more integrated into the curriculum, 48% were neutral, and 27% did not like the idea. The most frequently mentioned negative aspects were: "It is incompatible with my learning style" and "It is not effective and takes away valuable learning time."

In contrast, the results of student evaluations of TBL in the intensive course format were highly positive (Table 1). The response rate to the program-evaluation questionnaire was 68% (n = 262). A total of 386 students participated in TBL activities and 220 (57%) completed the intensive courses.

TABLE 1. Medical students' questionnaire responses to team-based learning (TBL) intensive courses (1 – strongly disagree, 6 – strongly agree)

		Percentage responses (n = 262)			Mean score ± standard deviation			
					total sample	women	men	
	Questionnaire item	1-2	3-4	5-6	(n = 262)	(n = 152)	(n = 110)	*P**
1	TBL helps to assess present knowledge	–	12	88	5.3 ± 0.7	5.3 ± 0.7	5.2 ± 0.7	0.298
2	TBL helps to get me to a higher level of knowledge	2	28	70	4.9 ± 0.9	4.9 ± 0.9	4.8 ± 0.9	0.250
3	TBL reduces the amount of time needed for self-study	32	44	24	3.3 ± 1.4	3.3 ± 1.5	3.4 ± 1.4	0.567
4	TBL challenged me to give my best	5	30	65	4.8 ± 1.1	4.8 ± 1.1	4.7 ± 1.0	0.377
5	TBL had a positive impact on my learning attitudes	6	38	56	4.5 ± 1.2	4.5 ± 1.2	4.4 ± 1.1	0.242
6	TBL is an effective, motivating learning strategy	2	24	74	5.0 ± 0.9	5.0 ± 0.9	4.9 ± 1.0	0.530
7	The instructor highly facilitated the learning process	3	15	82	5.3 ± 1.0	5.3 ± 0.9	5.3 ± 1.0	$P \geq 0.950$
8	The TBL course is well organized	2	12	86	5.3 ± 0.9	5.3 ± 0.9	5.3 ± 0.8	0.720
9	I will recommend TBL to other students	1	9	90	5.4 ± 0.9	5.5 ± 0.7	5.3 ± 1.0	0.221
10	TBL should be offered more frequently in the curriculum	–	8	92	5.5 ± 0.7	5.6 ± 0.7	5.4 ± 0.8	0.101
11	Overall, I am very satisfied with this TBL approach	–	9	91	5.5 ± 0.7	5.6 ± 0.7	5.3 ± 0.8	0.005
12	I frequently study with colleagues	56	34	10	2.6 ± 1.4	2.5 ± 1.3	2.7 ± 1.5	0.567

**U* test for differences between female and male students.

Three items describe the students' view of TBL in regard to knowledge acquisition. The item with the greatest mean score was "TBL helps to assess present knowledge," followed by "TBL helps to get me to a higher level of knowledge." Both scores indicate that most students felt they could benefit from this new learning strategy in mastering the content of the block. The statement which received the lowest mean score was "TBL reduces the amount of time needed for self-study." Although scores were broadly scattered within this item, the overall rather neutral assessment indicates that students felt that TBL had no significant influence on the time required for self-study.

Items describing motivational dimensions indicate that students felt highly motivated and engaged with TBL activities. The item with the greatest mean score was "TBL is an effective, motivating learning strategy," closely followed by "TBL challenged me to give my best" and "TBL had a positive impact on my learning attitudes."

High score on the item "The TBL course is well organized" indicated that signing up and pre-course management of the TBL intensive courses were managed successfully via the internet. Generally, students thought TBL activities would be helpful for other students as well, which is demonstrated by high scores on the statements "I will recommend TBL to other students" and "TBL should be offered more frequently in the curriculum." According to a highly scored concluding statement, "Overall, I am very satisfied with this TBL approach," students obviously appreciated TBL in the intensive course format.

TABLE 2. Summary of readiness assurance tests in team-based learning (TBL) intensive courses: analysis of 21 teams*

	Mean score ± standard deviation	
Performance	total points†	percentage of maximum
Individual performance:‡		
lowest	24 ± 6	49 ± 12
average	32 ± 3	66 ± 6
highest	39 ± 4	81 ± 8
Team performance	44 ± 1	91 ± 3§

*Tests were scored with each correctly answered question being awarded one point.
†Cumulative scores from 6 tests; maximum 48 points (100%).
‡Lowest – score of the weakest team members; average – score of all team members; highest – score of the best team members.
§Team scores are 10% higher than the highest individual scores (*t* test; $P < 0.001$).

In the open-ended questions, the most frequently cited positive aspects of students' experience with TBL were the immediate feedback and input by the instructor, promoting a deeper understanding of course content and the open atmosphere for problem-based discussions. Indeed, 82% of the students strongly agreed with the evaluation item: "The instructor highly facilitated the learning process" (Item 7, Table 1). However, a few students were dissatisfied

with the pacing of teamwork, complaining of it being too slow.

Interestingly, there was a sex-specific difference in the evaluation profile. Female students tended to rate the most items somewhat higher than male students (Table 1). The item "Overall, I am very satisfied with this TBL approach" received a significantly ($P=0.004$; *U*-test) higher mean score from female than from male students. Female students also rated other general statements higher, but not significantly. The item used as an indicator of students' individual group learning experience was "I frequently study with colleagues" (Item 12, Table 1). Only 10% of students agreed entirely with this statement, 34% indicated that they sometimes learned together with colleagues and, surprisingly high 56% answered definitely not. There was no sex-specific difference on this answer.

The analysis of readiness assurance tests (Table 2) indicated that mean team scores were 25% above the average individual scores. In fact, teams outperformed their own best member by an average of 10%, suggesting effective team interaction. Actually, in two courses the lowest team score was higher than the best individual score in the entire course. On individual tests, students scored on average 66% of the maximum, indicating that test questions were difficult enough to stimulate discussions. Indeed, students' feedback (n = 262) showed that 90% felt that the level of task difficulty was appropriate, 9% felt tasks were too difficult, and 1% felt that they were too simple.

In some cases, dropout of students reduced the size of teams from 7 to 2 members. In readiness assurance tests at the team level (n = 207), undersized teams scored lower than regular-size teams of 5 to 7 members. Compared with a mean score ±SD of 91 ± 9% of regular-size teams (n = 83), teams with only 2 members scored significantly lower (84 ± 12%; n = 27; $P=0.025$; *t* test). Although undersized teams are clearly unfavorable for many reasons, we avoided any rearranging of students to regular-size teams during the course to prevent interference with team development in complete teams. In fact, it was a key learning goal of the courses that students learn the difference between a newly formed group and a well-developed effectively-functioning team.

Finally, the association of TBL activities with the performance of students in the final summative and integrative exam at the end of first year was assessed (Table 3). In the academic year 2004/05, 1354 students took the final exam consisting of 230 multiple choice questions distributed in 6 blocks corresponding to the 6 teaching blocks of first year. The passing score was 60% of the maximum score of 230 points; each exam block had to be passed in order to pass the exam. Students who completed the TBL intensive courses of block 4 (n = 220; 55% female) had a 25.3% higher score on the corresponding exam block; they also had higher scores (mean 16.5%) in all other blocks. In fact, 31.1% of TBL participants passed the final exam, whereas the percentage of all students who passed the exam was considerably lower (17.2%).

Table 4. Sex differences in test performance of team-based learning (TBL) students; analysis of mean scores (points) in multiple choice tests

Multiple choice test	Mean score ± standard deviation		*P**
	women	men	
Individual readiness assurance test†	5.0 ± 1.8 (n = 531)	5.25 ± 1.7 (n = 366)	0.038
Final exam‡	133 ± 30 (n = 109)	147 ± 32 (n = 91)	0.002

**t* test for differences of means.
†Maximum score per test 8 points.
‡Maximum total score 230 points.

TABLE 3. Impact of team-based learning (TBL) intensive courses on the score of students on the final exam

	Scores (±standard deviation)* of students who		
	did not participate in TBL intensive courses	participated in TBL intensive courses†	Percentage of higher score of TBL vs non-TBL students
Exam:			
exam block 4	22 ± 9	28 ± 9	25.3
other exam blocks	94 ± 29	109 ± 26	16.5
total	116 ± 37	137 ± 34	18.3
Fraction of students who passed exam (%)	17.2	31.1	

*1354 students took the final exam. The maximum score for block 4 was 50 points (passing score 30 points); the maximum total score was 230 points.
†Students who completed the TBL intensive courses (n = 220; 55% female).

There were sex-specific differences in the students' test performance (Table 4). In the readiness assurance tests of TBL, female students scored somewhat lower than male students. Although small, the difference was significant ($P=0.038$; *t* test). On the final exam, female students who completed the TBL intensive courses also scored significantly lower than their male peers ($P=0.002$; *t* test).

DISCUSSION

The results of our study showed that TBL in an intensive course format was an effective and efficient strategy to promote active learning in the first year of medical curriculum with more than 1500 students. However, the students' satisfaction with the initial exposure to TBL in an introductory single-unit approach during the first semester was mostly low, although an earlier pilot indicated that students, though sometimes ambivalent, were basically interested in this new strategy (10). TBL is fundamentally different from traditional educational approaches and seems to be so much at odds with the mainstream educational practice, which may be why many students initially felt very uncomfortable with this approach. A major complaint of students was that guided learning in teams is incompatible with their own learning style. Indeed, it has been shown recently that many students at the Medical University of Vienna, even the more successful ones, basically prefer autonomy to guidance in education (8,11). A second worrisome outcome of this single instructional unit was that students were rather skeptical about the efficiency of TBL in terms of knowledge acquisition.

Our main objective of the single-group exercise was to lay the groundwork for learning in teams in general, to explain freshmen the rationale for this approach to learning, and to demonstrate how TBL courses will be conducted. The initial students' skepticism about the efficiency of TBL may at least partly be attributed to the normal inefficiencies of newly formed groups. Probably the most important lesson we learned, however, was that many students are largely unskilled in team work and thus are difficult to convince that TBL will have a positive impact on their learning. In subsequent years, we performed TBL without the single-unit exposure and conducted the intensive course with similar success. In fact, the percentage of students participating in the TBL intensive courses of block 4 continuously increased from 27% in 2004/05 to 39% in 2007/08.

One important aspect of preparing medical students for future work in teams involves building their confidence that group discussions are an effective way to accomplish intellectual work. Although even a single well-designed group assignment can produce some positive outcomes, it is only when students work together over time that they become cohesive enough to evolve into effective learning teams and can fully assess and benefit from the resources of all members of the group (12). Consequently, we provided TBL in an intensive course format with six 2-hour sessions over a 3-day period as an elective review course 2 weeks before the final exam, covering the material of a critical teaching block. Indeed, it was this demanding setting that turned students' initial skepticism and opposition into enthusiasm. Students quickly developed the attitudes and skills they need to effectively work with, and learn from, their peers as indicated in the readiness assurance tests. Average team scores were more than 25% above mean individual scores and even more than 10% higher than their own highest-scoring member. It is well known that truly effective learning teams typically will outperform their own best member (13). Considering mean team scores of over 90% of the maximum, it appears that students were indeed motivated to prepare for, and participate fully in, the team assignments. Because the teams did such good work, the question arises if students were not challenged enough. However, team discussions were dynamic and most students' responses indicated that the level of task difficulty was appropriate and that TBL in the intensive course format challenged them to give their best. Unfortunately, irregular presence and dropout of team members sometimes resulted in undersized teams, which tended to score lower than the regular-size teams of 5-7 members. While unintended, these data confirm the conclusion that the minimum size for an effective group performing significant intellectual work with complex tasks is 5 members (14).

The TBL intensive courses were provided to students as an elective course covering the material of a critical block of the curriculum. Students' responses indicate that this strategy had a positive impact on motivation and knowledge acquisition and provided also a deeper understanding of the course content. Indeed, students who completed the courses got a considerably higher score in the corresponding exam block on the final exam. The score was also higher in all other blocks. In fact, roughly one third of these students passed the final exam, whereas the percentage of the total student population who passed it was considerably lower. Thus, an important limitation of the study is that any apparent advantage of students who were exposed to the given TBL setting can be partially explained by se-

lection difference. Students participating in TBL were not randomized but self-selected and the higher score may simply indicate that the students who select TBL are generally better students. This aspect of self-selection has been shown recently also with students who selected a problem-based learning approach (15).

Our study indicated that female and male students responded differently to both educational format and knowledge tests. With TBL in the intensive course format, satisfaction was significantly higher for female students though it was also high for their male peers. Apparently, this educational format was even more adapted to the needs of female learners. On the other hand, in the readiness assurance tests men outscored women by 0.25 points (out of 8) and also the average scores for TBL students in the final exam showed women were 14 points (out of 230) below their male peers. The reason of sex-related test bias remains unclear and this study was not designed to address this complex question. However, it has been shown in medical students that sex influences the learning process by means of the different interactions men and women have with the learning environment (16).

Several important pedagogical aspects were identified. A central tenet of TBL as an instructional strategy in higher education curricula holds that students should learn more about the benefits of team work (7). Indeed, the value of people who know how to work effectively in teams on intellectual tasks is increasingly recognized. On the other hand, an evaluation of the individual group learning experience of the students in our courses revealed that more than half of them were traditionally used to learn alone and hence had never discovered the value of high-performance learning teams.

We showed that many benefits of TBL could be obtained by providing it as an elective in an intensive course format for medical students in the first year of the curriculum. Educationally most important, it appears that TBL was effective in engaging members who would benefit from group work but, lacking the opportunity, would rather work alone. TBL should not only improve the students' ability to master the content material but has the potential to promote the development of interpersonal and team skills. TBL students in the intensive courses rated the benefit of their education much higher than students in the single-unit procedure. Providing TBL as an elective fosters a positive selection of the best students of the year making them even more successful on the final exam. The TBL students not only have closer interactions with faculty and other students, but they may develop more versatile learning strategies as they progress through the curriculum.

References

1 Merl PA, Csanyi GS, Petta P, Lischka M, Marz R. The process of defining a profile of student competencies at the University of Vienna Medical School. Med Educ. 2000;34:216-21. Medline:10733711 doi:10.1046/j.1365-2923.2000.00509.x

2 Medical University of Vienna. Education [in German]. Degree Programme Human Medicine. Available from: http://www.meduniwien.ac.at/index.php?id=5&language=1. Accessed: March 25, 2008.

3 Colliver JA. Effectiveness of problem-based learning curricula: research and theory. Acad Med. 2000;75:259-66. Medline:10724315 doi:10.1097/00001888-200003000-00017

4 Norman G. Editorial – beyond PBL. Adv Health Sci Educ Theory Pract. 2004;9:257-60. Medline:15583481 doi:10.1007/s10459-004-5539-8

5 Searle NS, Haidet P, Kelly PA, Schneider VF, Seidel CL, Richards BF. Team learning in medical education: initial experiences at ten institutions. Acad Med. 2003;78(10 Suppl):S55-8. Medline:14557096 doi:10.1097/00001888-200310001-00018

6 Thompson BM, Schneider VF, Haidet P, Levine RE, McMahon KK, Perkowski LC, et al. Team-based learning at ten medical schools: two years later. Med Educ. 2007;41:250-7. Medline:17316209 doi:10.1111/j.1365-2929.2006.02684.x

7 Fink LD. Beyond small groups: harnessing the extraordinary power of learning teams. In: Michaelsen LK, Baumann Knight A, Fink LD, editors. Team-based learning: a transformative use of small groups. Westport (CT): Praeger; 2002; p. 3-25.

8 Frischenschlager O, Haidinger G, Mitterauer L. Factors associated with academic success at Vienna Medical School: prospective survey. Croat Med J. 2005;46:58-65. Medline:15726677

9 Plass H, März R, Wiener H. Team Learning – online organisation. GMS Zeitschrift für Medizinische Ausbildung. 2007;24:DOC94. Available from: http://www.egms.de/pdf/journals/zma/2007-24/zma000388.pdf. Accessed: January 13, 2009.

10 Plass H, Wiener H, Kremser K, Marz R. Team learning as a novel component of the new Vienna medical curriculum. Zeitschrift für Hochschuldidaktik. 2004;5:31. Available from: http://www.zfhe.at/uploads/media/ZFHD_01_04_Fulton_AbstractsGraz2004.pdf. Accessed: January 13, 2009.

11 Frischenschlager O, Kremser K, Marz R. Evaluation of the short remedial course "SOL" for beginning medical students in Vienna – which subgroups benefit most [in German]. Zeitschrift für Hochschuldidaktik. 2004;1:3-13.

12 Watson WE, Michaelsen LK, Sharp W. Member competence, group interaction and group decision-making: A longitudinal study. J Appl Psychol. 1991;76:803-9. doi:10.1037/0021-9010.76.6.803

13 Michaelsen LK, Watson WE, Black RH. A realistic test of individual versus group consensus decision making. J Appl Psychol. 1989;74:834-9. doi:10.1037/0021-9010.74.5.834

14 Birmingham C, McCord M. Group. Process research: implications for using learning groups. In: Michaelsen LK, Baumann Knight A,

Fink LD, editors. Team-based learning: a transformative use of small groups. Westport (CT): Praeger; 2002; p. 77-97.

15 Cariaga-Lo LD, Richards BF, Hollingsworth MA, Camp DL. Non-cognitive characteristics of medical students: entry to problem-based and lecture-based curricula. Med Educ. 1996;30:179-86. Medline:8949551

16 de Saintonge DM, Dunn DM. Gender and achievement in clinical medical students: a path analysis. Med Educ. 2001;35:1024-33. Medline:11703638 doi:10.1046/j.1365-2923.2001.01043.x