



Using team-based learning to prepare medical students for future problem-based learning

Nahed Abdelkhalek, Amal Hussein, Trevor Gibbs & Hossam Hamdy

To cite this article: Nahed Abdelkhalek, Amal Hussein, Trevor Gibbs & Hossam Hamdy (2010) Using team-based learning to prepare medical students for future problem-based learning, *Medical Teacher*, 32:2, 123-129, DOI: [10.3109/01421590903548539](https://doi.org/10.3109/01421590903548539)

To link to this article: <http://dx.doi.org/10.3109/01421590903548539>



Published online: 17 Feb 2010.



Submit your article to this journal [↗](#)



Article views: 571



View related articles [↗](#)



Citing articles: 10 View citing articles [↗](#)

Using team-based learning to prepare medical students for future problem-based learning

NAHED ABDELKHALEK¹, AMAL HUSSEIN¹, TREVOR GIBBS² & HOSSAM HAMDY¹

¹University of Sharjah, UAE, ²Chinese University of Hong Kong, PR China

Abstract

Background: The original concept of problem-based learning (PBL) was built upon an acceptance that its participants would be of a more mature age, and with personal and potential qualities that would equip them for problem solving as part of their learning process. However, despite global acceptance for the use of PBL in medical and health sciences education, and knowledge of the diverse background of students about to embark upon PBL, structured programs preparing medical students for such an educational activity are not common.

Aim: The primary aim of this study is to describe the experience in adopting and adapting an educational approach analogous to PBL, team-based learning (TBL), in preparing medical students to later study in a PBL environment and secondarily, to measure the students' reaction to this experience.

Methods: At the University of Sharjah, 363 students were enrolled over four semesters in the 'Introduction to Medical Sciences Education (IMSE)' course. They were divided into groups of 25–27 students per class, where their learning was facilitated through a TBL approach. The course was evaluated both quantitatively and qualitatively and appropriate statistical analysis was applied to their responses.

Results: Out of 363 students, 304 (84%) responded to a 28-item closed-ended questionnaire. Their mean scores and consensus measurements indicated a high degree of students' satisfaction. Eighty-two students (65%) responded to the open-ended questions providing 139 comments. Content analysis of the responses supported the quantitative results.

Conclusion: This study demonstrated a high degree of students' satisfaction from the course in acquiring skills preparing them for future PBL. Although this represents an evaluation of the TBL effects upon the early exposures to PBL, TBL was considered to be a feasible, efficient and cost-effective educational approach in preparing the students for their new educational experience.

Introduction

Over the past two decades, major changes have occurred in health professions education at the undergraduate and post-graduate levels. The main features of these educational changes include strategies grounded in adult learning theories (Knowles 1990), social theories of learning (Bandera 1986; Burns 1995) and experiential learning (Kolb 1984). They support the views that adults learn best by actively engaging with each other and processing new knowledge in the context of such engagement. Many of these key educational principles supported the introduction and spread of problem-based learning (PBL; Barrows & Tamblyn 1980) in health professions education. The characteristic small group tutorial of PBL offers a learning environment which encourages students to collaborate with each other in order to achieve individual and group learning objectives. This environment supports self-directed learning, personal development, tolerance and respect to the views of others (Hamdy 2008). These social skills should help students interact with other students from diverse backgrounds, cultural, social and educational, within the close settings of small groups. This not only increases their knowledge but also develops them personally for their future role as a health care team member (Albanese & Mitchell 1993;

Practice points

- Students joining an integrated PBL medical curriculum need to be prepared for their future learning.
- PBL is resource intensive for faculty and these resource implications may cause resistance to any intended introductory courses.
- TBL is a feasible and effective educational approach in preparing large numbers of students for learning in a PBL environment. Its implementation could be adapted to fit the course objectives, content and context.
- TBL is a cost-effective and less resource demanding approach that appears to develop students' understanding of PBL.
- TBL could be combined with PBL as a strategy to support guided discovery learning.

Vernon & Blake 1993). Although early work by Colliver (2000) cast doubt on the effectiveness of PBL to improve knowledge and clinical performance, the relatively recent systematic review by Koh et al. (2008) now supports a view that suggests PBL has beneficial effects upon the students' competencies in the social and cognitive domains.

Correspondence: Nahed Abdelkhalik, Department of Family Medicine, Community and Behavioral Sciences, College of Medicine, University of Sharjah, PO Box 27272, Sharjah, UAE. Tel: 971 6 5057116; fax: 971–6 5585879. email: nkhalik@sharjah.ac.ae

The early introduction of PBL in McMaster University was on a group of graduate entry students who had been previously selected for their maturity, personal qualities and potential in problem solving (Ferrier 1990); a logical approach to a mature approach towards adult learning. Graduate entry programs are not a common practice throughout the rest of the world, and are not always a feature of many schools that adopt a PBL approach to learning, suggesting that medical students may not be 'fit' to engage upon a PBL curriculum at the start of their studies.

It is logically assumed that the introduction of PBL into any educational program requires preparation and adjustment on the part of students, faculty and institution, especially when those students tend to originate directly from a didactic secondary education. Students new to PBL take time to adapt to this new approach of learning; this pedagogy differs from their past educational experiences, which are commonly discipline based and teacher centred.

PBL is known to be resource intensive (Maudsley 2007); hence many institutions have difficulty in applying such resource intensive educational approaches. They require an increased number of trained faculty, major curriculum reform, and continuous institutional and leadership support.

An educational approach analogous, but with distinct differences to PBL is team-based learning (TBL). It is described and used successfully in business education (Michaelsen et al. 1997) and more recently in medical education (Michaelsen et al. 2002; Haidet et al. 2002; Searle et al. 2003). It resembles PBL by providing small group learning experience but with more tutor guidance and is more unidirectional in its expected student outcomes.

It differs from PBL, since TBL allows a single faculty to interact with several small groups of students in the same classroom or lecture hall, and can avoid or alleviate the faculty resource problem previously described (Maudsley et al. 2007). TBL has been shown to promote active learning and nurture the development of high levels of group cohesiveness (Searle et al. 2003) without requiring large numbers of facilitators, as needed and seen in PBL (Dunaway 2005; Thompson et al. 2007).

In the United Arab Emirates (UAE), the University of Sharjah Medical and Dental Colleges have adopted, since their inception in 2004, PBL as their main educational strategy; based upon positive perceptions from the rest of the educational world that PBL addressed many of the principles of adult education lacking in medical education.

Students join the University directly after high school, with admission being based mainly on their school academic achievements and proficiency in English, which is the language of instruction. They embark upon a 6-year program consisting of a foundation year followed by 5 years of medical or dental studies.

The main aim of the foundation year is to reinforce their knowledge in subjects such as biology, chemistry, physics, information technology, English and humanities. Students are from mixed nationalities and although the majority are from the United Emirates and Arab countries, they have different cultural backgrounds and come out of different educational systems.

Within this foundation year and in order to prepare the students for their future studies in a PBL environment, an introductory course in medical sciences education (IMSE) has been developed and implemented.

The major challenge encountered was how best to teach this course in the foundation year, which is heavily subject based, teacher centred and with limited human resources, many of whom are inexperienced in teaching and medical education. A TBL approach to learning was considered as one way of overcoming the resource issues and using at the same time a learner-centred approach to inform the students about future exposure to PBL.

The aim of this study is to describe the experience in using TBL to facilitate the skills required for PBL, and report students' reaction to the course and its methodology.

Methods

Three-hundred and sixty-three medical and dental students were enrolled in the IMSE course over four consecutive semesters (spring 2006–2007, fall 2007–2008, spring 2007–2008, and fall 2008–2009). Students were divided into classes of around 25 students per class, and then each student was placed into a team, of about eight or nine students, in which they remained throughout the semester. The course was taught by one faculty (N.A) who was experienced in community medicine, medical education and PBL.

Course objectives were explicit and clustered around three integrated themes:

- 'Life long learning skills and PBL',
- 'Personal development',
- 'Knowledge related to Health and Wellness'.

The course was implemented over three phases detailed in the following sections.

Phase one: 'Preparatory phase'

Four mini workshops (2 h each) were conducted over a period of 4 weeks. It introduced students to adult learning principles, small group and PBL, concept mapping, reflective and constructive feed back, self and peer evaluation and information search, assimilation and presentation. This gave the students a background understanding of why the school had adopted a PBL approach to learning.

Phase two: 'Application of TBL and PBL'

This phase extended over 6 weeks. All students were introduced to three health related problems: (a) the newborn, antenatal and postnatal care, (b) obesity in adulthood, and (c) care of the elderly (Figure 1). Each problem was studied over two sessions (2 weeks); one session per week for 2 h. Session one included in-class and out-of-class activities.

In the class, each team read the problem and discussed possible explanations of the different cues and identified team-learning issues. In each team, the tutorial session was lead by one student 'peer tutor' (Maudsley et al. 2007). The 'peer tutor' was responsible for facilitation of 'intra-group

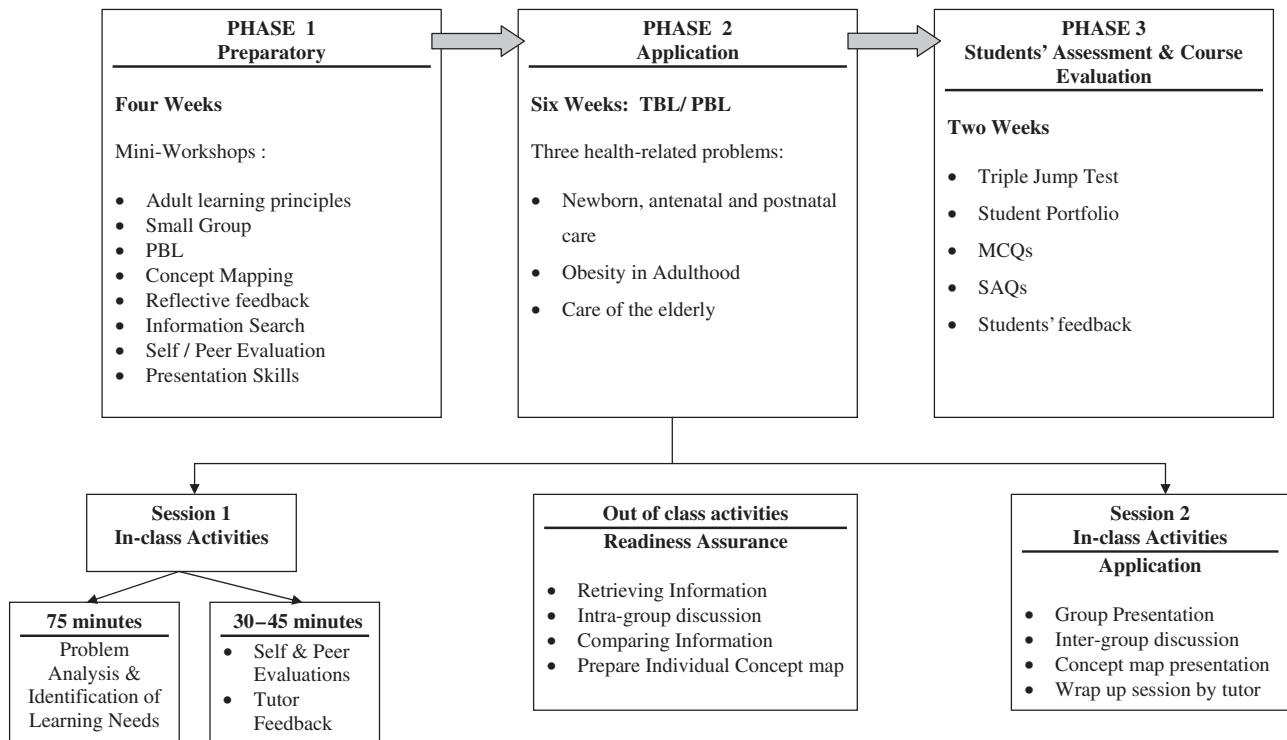


Figure 1. Introduction to medical sciences education course outline.

discussion' asking questions, ensuring group progress, time management and encouraging all team members to participate in the discussion.

Problem analysis and identification of learning needs took on average about 75 min. During this period, the faculty tutor/instructor observed group dynamics and checked their progress.

In the remaining time of the session '30 to 45 min', the team evaluated the session, provided self, peer and tutor evaluation.

During the out-of-class, individual and team activities (the 'readiness assurance process' phase; Figure 1), members of each team were responsible individually and collectively (from eight to nine students) to prepare for session two by retrieving and assimilating information relevant to the team's identified learning needs 'objectives', and prepared individually a concept map.

The team met at least once in between the two sessions to review their progress, compare and exchange information and review answers to the raised questions. The team reviewed the individually prepared concept maps and selected the best map which visually linked issues and concepts related to the problem.

In session two ('Application Activity'), presentations were given by representatives from each team. The presenters responded to questions and comments by students from other groups, and were thought to fulfil 'teach and learn' and 'inter-group discussion' activities.

This activity was followed by a wrap-up presentation by the faculty who is now functioning as a subject matter expert, highlighting the main concepts of the problem and responding to students' questions. At the end of the second session, the

instructor/tutor gave feedback to the class on their performance and received students' feedback in relation to the problem, faculty and class performance.

Phase three: 'Student's assessment and course evaluation'

It was important to design an assessment system matching the course objectives. The assessment blueprint was developed in order to match assessment instruments with the course outcome. Different formative and summative assessments were used; triple jump tests and individual student portfolio were used to assess their problem-solving skills and critical thinking. A final written examination, which included multiple choice questions (MCQs) and short answer questions (SAQs), assessed their knowledge related to health and wellness.

Program evaluation and students' perception of the course was obtained through a structured questionnaire which included 28 items measuring individual students' perception of the course learning process (TBL/PBL) and learning skills (12 items), knowledge contents (2), personal development (3), educational environment (3), student assessment (1) and evaluating the faculty (7) (Table 1).

Students' responses were quantitatively measured in relation to statements on the questionnaire using a five-point Likert scale (strongly agree '5' to strongly disagree '1'). Students were asked to indicate the extent to which they agreed with the statements. Mean scores and strength of consensus measure (sCns) were used. This measure allows the description of a groups' shared agreement on a particular item and the hierarchical comparison among the different items of a

Table 1. Strength of consensus measure (sCns) of students' perceptions of introduction to medical sciences education course and TBL ($n = 304$).

Description	Strongly agree		Agree		Uncertain		Disagree		Strongly disagree		Mean (SD)	sCns (%)
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%		
Learning process and skills												
'TBL' increased the extent of my usual classroom involvement	139	45.7	138	45.4	18	5.9	7	2.3	2	0.7	4.3 (0.759)	87
'TBL' enhanced the educational value of my usual classroom involvement	108	35.5	168	55.3	23	7.6	5	1.6	0	0	4.2 (0.663)	85
Small group participation improved my understanding of the educational material that was presented	123	40.5	123	40.5	42	13.8	16	5.2	0	0	4.2 (0.855)	83
Small group learning motivated my preparation prior to attending class 'session two'	111	36.5	134	44.2	50	16.4	8	2.6	1	0.3	4.1 (0.807)	83
'TBL' was worth the time that could have been otherwise available to the traditional lecture	99	32.7	103	34	64	21.1	26	8.6	11	3.6	3.8 (1.146)	75
Participation in the group presentation extended my basic knowledge of the topic	166	54.6	111	36.5	25	8.3	1	0.3	1	0.3	4.4 (0.730)	89
Participation in the group presentation at the end of the second session was a valuable learning experience	140	46.1	125	41.1	32	10.5	6	2	1	0.3	4.3 (0.771)	86
The course helped me in analyzing simulated health problems and identifying learning issues	154	50.6	117	38.5	25	8.3	8	2.6	0	0	4.4 (0.766)	87
The course helped me in searching the literature and identifying relevant learning resources	112	36.8	141	46.4	47	15.5	3	1	1	0.3	4.2 (0.748)	84
The course helped me in developing a 'concept map'	143	47.2	127	41.9	24	8	8	2.6	1	0.3	4.3 (0.771)	87
The course helped me in developing and improving my presentation skills	148	48.6	125	41.1	24	8	6	2	1	0.3	4.4 (0.757)	87
The course helped me in developing educational portfolios	135	44.4	128	42.1	26	8.6	9	2.9	6	2	4.2 (0.879)	84
The course prepared me well for my next phase of medical study	115	37.8	128	42.1	44	14.5	12	4	5	1.6	4.1 (0.911)	82
Course content 'knowledge'												
Understand what is PBL and its value	142	46.7	131	43	26	8.6	2	0.7	3	1	4.3 (0.758)	87
Understand what is health, its scope, dimensions and variables	102	33.5	151	49.7	41	13.5	10	3.3	0	0	4.1 (0.768)	83
Personal development												
Recognize my strengths and weaknesses 'self evaluation'	108	35.5	134	44.2	46	15.1	15	4.9	1	0.3	4.1 (0.859)	82
Accept and give constructive feedback 'peer evaluation'	97	32	146	48	43	14.1	17	5.6	1	0.3	4.1 (0.857)	81
Educational environment												
The class room was comfortable and well maintained	176	57.9	94	30.9	25	8.3	5	1.6	4	1.3	4.4 (0.847)	88
Group arrangements suitable to the tasks	121	39.8	121	39.8	46	15.2	10	3.2	6	2	4.1 (0.923)	82
Audio-visual supportive to educational process	133	43.8	132	43.4	30	9.8	6	2	3	1	4.3 (0.799)	85
Assessment												
Assessment appropriate to the objectives	107	35.2	145	47.7	38	12.5	6	2	8	2.6	4.1 (0.890)	82
Instructor												
Facilitates student learning	163	53.6	114	37.6	22	7.2	4	1.3	1	0.3	4.4 (0.749)	89

(continued)

Table 1. Continued.

Description	Strongly agree		Agree		Uncertain		Disagree		Strongly disagree		Mean (SD)	sCns (%)
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%		
Encourages and stimulate students to be active	191	62.8	89	29.3	20	6.7	2	0.6	2	0.6	4.5 (0.781)	91
Supports self-directed learning	167	54.9	106	34.9	25	8.3	5	1.6	1	0.3	4.4 (0.774)	88
Competent in her area of expertise	141	46.4	116	38.2	40	13.1	6	2	1	0.3	4.3 (0.796)	86
Manages the sessions appropriately	180	59.2	105	34.6	17	5.6	2	0.6	0	0	4.5 (0.712)	91
Approachable and keen about the students	173	57.3	92	30.5	27	8.9	8	2.6	2	0.6	4.4 (0.837)	88
Gives frequent feedback	192	64	74	24.7	26	8.7	8	2.6	0	0	4.5 (0.816)	90

questionnaire (Tastle et al. 2005). It describes the dispersion of the Likert scale answers around a focal point, i.e. 'strongly agree' category and is reported as a percentage (Tastle and Tastle 2005).

The reliability and validity of the 28-item questionnaire were statistically evaluated. Cronbach alpha coefficient was used to measure the internal consistency of the questionnaire. Exploratory factor analysis using principle components method was performed to test its construct validity. The correlation matrix was analyzed using the orthogonal rotation method (varimax) with the minimum eigenvalue for rotated factors being one. The statistical software used for quantitative data analysis was SPSS 15.0.

A qualitative component was added to the questionnaire by asking students to respond to three open-ended questions on 'what they liked most about the course', 'suggestions for future improvements' and any other comments. Content analysis of students' responses on the qualitative component of the questionnaire was performed using frequency of the emerging themes. In relation to each theme, examples of quotations from students' responses without editing were presented.

The questionnaire was pilot-tested on 10 students in the medical program to ensure face and content validity.

Results

Out of 363 students, 304 (84%) responded to the questionnaire on closed-ended questions. Cronbach alpha coefficient was 0.898 for all questionnaire items and ranged from 0.892 to 0.900 for each item, suggesting a high degree of internal consistency.

The mean scores of the 28 items ranged between 4.5 highest (sCns = 91%) and 3.8 lowest (sCns = 75%) indicating a high degree of students' satisfaction on all the items.

The average mean scores on the 13 items evaluating TBL/PBL process and related learning skills were 4.2. For the other items on the questionnaire, the average mean scores were:

- (1) two items of the course knowledge (4.2),
- (2) two items on personal development (4.1),
- (3) three items on the educational environment (4.3) and
- (4) one item on student assessment (4.1).

The average mean scores on evaluating the course instructor seven items was (4.4). Table 1 summarize the results of the responses to the closed-ended questions.

Employing a 0.40 item-to-factor loading criterion, factor analysis resulted in a total of six factors accounting to 60% of the overall variance: learning process (16%), instructor (15%), assessment (11%), course content (7%), knowledge management skills (6%), and educational environment (5%).

About 82 students (65%) responded to the open-ended questions. They provided 139 responses on 'what the students liked most about the course', out of which eight themes emerged from the content analysis. On suggestions for improvement, they provided 42 comments which were clustered under four emerging themes. The statements in *italic* are some of the students' comments without editing (Table 2).

Discussion

This study introduces several aspects related to improvement in educational approaches as applied to health professions education. The IMSE course in a premedical foundation year is an important attempt to prepare the students to their future learning in an integrated PBL curriculum. Most medical schools who have adopted PBL usually prepare the students to the new learning process through short orientation programs or workshops. The effectiveness of these programs is unknown. It is expected that students joining PBL health professions education programs should benefit from a course like the one described, aiming to improve their learning skills and introduce them to alternative strategies fostering active learning.

The implication of TBL and PBL approaches to teaching is based on the assumption that students construct knowledge for themselves, with TBL being much more directional and supported by the tutor. This should not be confused with a pure discovery learning (Bruner 1961) in which students are free to work in a learning environment with little or no guidance. Several researches in educational psychology on problem solving and its implication to PBL found that guided discovery is generally more effective than pure discovery in promoting learning and transfer to new problems (Mayer 2004).

The IMSE course combined several educational approaches. PBL as an instructional method that emphasizes

Table 2. Content analysis of students' responses to open-ended questions.

	<i>n</i>	%
'WHAT I LIKED MOST'		
Small group learning: <i>TBL is a great learning experience, motivating, enjoyable, different from the traditional lectures</i>	46	33
Problem based learning: <i>Learning from problems using TBL is relevant to my future medical education and practice</i>	24	18
Personal development: <i>Self and peer evaluation helped me to understand my strengths and weaknesses. Improved my social communication and leadership skills</i>	25	18
Learning skills: <i>Concept maps, discussions and elaboration, encouraged understanding not memorization</i>	9	6
Presentation skills: <i>I am more confident about my presentation skills</i>	12	9
Instructor: <i>Effective, caring, motive students, understand students' needs</i>	12	9
Learning environment: <i>Classroom and seating arrangements suitable for TBL</i>	6	4
Student assessment: <i>The new type of assessment like the Triple Jump exercise and portfolio</i>	5	3
Total	139	100
'SUGGESTIONS FOR IMPROVEMENT'		
Small group learning: <i>Needs to clarify more the assignments, give more examples particularly portfolios</i>	12	29
Student assessment: <i>No need for final traditional examination MCQ. It inhibits learning particularly in this course more weight to process</i>	6	14
<i>Give more quizzes before final examination and examples of final examination</i>	5	12
Instructor: <i>Teacher should give more individual feedback</i>	3	7
Problem-based learning: <i>Give more problems 'scenarios' and more time for discussion</i>	9	22
<i>Change the group composition to give more chances to students to interact</i>	6	14
<i>Use TBL in other courses in the foundation year</i>	1	2
Total	42	100

learner centred small group learning. TBL which resembles in some structural aspects PBL, designed to foster the effectiveness of small group working independently but in a relatively large class with high learner faculty ratio (up to 200:1) without losing the advantages of facilitator led, small group learning (Kelly et al. 2005; Haidet 2006). The rationale of the TBL/PBL as described in this study is supported by the guided discovery methods in which the teacher provides systematic guidance without inhibiting the learners from being behaviorally active. TBL as applied in this course maintained the three fundamental principles of TBL (Michaelsen et al. 1997). First, all teams worked on the same task ensuring that all students have the same frame of reference. Second, all teams reported their work and newly gathered information at the same time. We did not use as commonly described multiple-choice questions (Haidet et al. 2002; Michaelsen et al. 2002; Thompson et al. 2007), but we relied more on students' presentations and concept maps. The third principle of TBL is that the team tasks should be complex and realistically simulate real-life health problems. The problems discussed in the course were multi-faceted and stimulated the students to identify their learning needs and search for information and answers.

Due to the nature of the course, the three phases of a TBL time line were modified; however, their functions maintained. 'The advance preparation phase' prepared students through the four workshops to small group learning, PBL, presentation skills and concept mapping. 'The readiness assurance phase' was implemented as the first session of a typical PBL session where the problem was analyzed and discussed ending with students' identification of learning needs and followed by individual and group searches for information and preparation of presentations for session two. 'The application activity' included the usual inter and intra team discussions, teacher presentation of summary and wrap up. Peer tutoring as implemented in this course introduced the students to an important skill which is useful in PBL (Maudsley et al. 2007).

TBL as implemented in this study, demonstrated that it is possible to apply TBL and PBL principles with large group of students. Typically PBL group have a maximum of 10–12 students. In this study, we have successfully implemented TBL/PBL while having 25 students per class, with one instructor while maintaining small group learning educational advantages.

Over years, there has been a debate about how Likert scale responses should be analyzed and presented (Carifio & Perla 2008). Although Likert scales are ordinal in character, several studies have considered them as producing interval data and thus accepted the use of parametric tests specifically weighted means, and standard deviations in summarizing the ratings generated by the Likert scale (Pell 2005; Carifio & Perla 2008). On the other hand, other studies have considered this type of analysis unacceptable and acknowledged the use of nonparametric tests in analyzing Likert scales (Carifio & Perla 2008). In this study, students' evaluation of the course, whether reported in weighted means or percentage of consensus around the strongly agree Likert scale, demonstrated a high degree of satisfaction.

The combination of quantitative and qualitative approaches in program evaluation increased the confidence in the results. The questionnaire used was found to be a reliable and valid tool. The six factors identified by the factor analysis explained a good percentage (60%) of the variance. In addition, the composition of the factors was quite similar to the distribution of the questionnaire items under the defined sections. Qualitative analysis of students' responses to open-ended questions supported the quantitative data and added valuable information to be used in program improvement. The main strengths of the course, as perceived by the students, were pertaining to considering TBL as an enjoyable learning experience, improving students' learning and presentation skills, and effectiveness of the course instructor. Students' suggestions for course improvement included exposure to

more health-related problems. However, in an introductory course with limited time frame (16 weeks), it was more than enough to discuss three problems, as students will be exposed to a lot of problems in the coming years of their medical education. The pass rate in the IMSE course was above 90%. The feedback from faculty in the medical college, who acted as tutors in the PBL program, was positive, indicating their satisfaction with the abilities of the students to apply skills needed in a PBL program.

Conclusion

This study indicated that using TBL in preparing students for their PBL integrated medical curriculum is a successful experience as perceived by the students. The introduction of TBL at the University of Sharjah opened the door for adopting the same approach in other courses in the foundation year taught in a traditional teacher centred approach. Students are now asking for a change and some faculty are encouraged to adopt it. Students who have successfully completed the foundation year and moved to the first year in the college of medicine were able to start PBL tutorials immediately from week one. Currently, we are investigating its implication in other courses as well as its impact on students' performance in the first and subsequent years of the medical program. One of the main advantages of TBL is that it is cost-effective and less resource demanding.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

Notes on contributors

NAHED ABDEL-KHALEK initiated the research idea and was solely responsible for the implementation of the TBL, actively participated in writing of the manuscript.

AMAL HUSSEIN conducted the quantitative data analysis and contributed in the results interpretation and writing of the manuscript.

TREVOR GIBBS contributed in the editing and writing of the final submitted version of the manuscript.

HOSSAM HAMDY developed research concepts and ideas, analysis of the results and writing of the manuscript.

References

Albanese MA, Mitchell S. 1993. Problem-based learning: A review of literature on its outcomes and implementation issues. *Acad Med* 68:52–81.

- Bandera A. 1986. Social foundation of thought and action. A social cognitive theory. Englewood Cliffs, NJ: Prentice Hall.
- Barrows HS, Tamblyn TM. 1980. Problem-based learning. New York: Springer Publishing.
- Bruner JS. 1961. The act of discovery. *Harv Educ Rev* 31:21–32.
- Burns S. 1995. Rapid changes require enhancement of adult learning. *HR Monthly* June:16–17.
- Carifio J, Perla R. 2008. Resolving the 50-year debate around using and misusing Likert scales. *Med Educ* 42:1150–1152.
- Colliver JA. 2000. The effectiveness of problem-based learning curricula: Research and theory. *Acad Med* 75:259–266.
- Dunaway GA. 2005. Adaption of team learning to an introductory graduate pharmacology course. *Teach Learn Med* 17(1):56–62.
- Ferrier BM. 1990. Problem-based learning: Does it make a difference? *J Dent Educ* 54(9):550–551.
- Haidet P, O'Malley KJ, Richards BF. 2002. An initial experience with team learning in medical education. *Acad Med* 77:40.
- Haidet P. 2006. Team-based learning: A promising strategy to foster active. *J Cancer Educ* 21(3):125–128.
- Kelly PA, Haidet P, Schneider V, Searle NS, Seidel C, Richards BF. 2005. A comparison of in-class learner engagement across lecture, problem-based learning and team learning using the STROBE classroom observation tool. *Teach Learn Med* 17:112–118.
- Koh GC, Koo HE, Wong ML, Koh D. 2008. The effects of problem based learning during medical school on physician competency: A systematic review. *CMAJ* 178(1):34–41.
- Knowles MS. 1990. The adult learning; a neglected species. 4th ed. Houston: Gulf Publishing Company.
- Kolb D. 1984. Experiential learning. Englewood Cliffs, New Jersey: Prentice Hall.
- Maudsley G, Williams E, Taylor D. 2007. Junior medical students' notions of a 'good doctor' and related expectations: A mixed methods study. *Med Educ* 41:476–486.
- Mayer RE. 2004. Should there be a three-strikes rule against pure discovery learning? *Am Psychol* 59(1):14–19.
- Michaelsen LK, Foml D, Knight A. 1997. Designing effective group activities: Lessons for classroom teaching and faculty development. In: DeZure D, editor. Editor To improve the academic resources for faculty, instructional and organizational development. Stillwater, OK: New Forums Press. pp 373–379.
- Michaelsen LK, Knight AB, Fink LD. 2002. Team based learning: A transformative use of small groups in college teaching. Sterling, VA: Stylus Publishing.
- Pell G. 2005. Use and misuse of Likert scales. *Med Educ* 39:970.
- Searle NS, Haidet P, Kelly PA, Schneider VF, Seidel CL, Richards BF. 2003. TBL in medical education: Initial experiences at ten institutions. *Acad Med* 78(10Suppl.):S55–S58.
- Tastle W, Russell J, Wierman M. A new measure to analyze student performance using the Likert scale. Proceedings of the 22nd annual conference on Information Systems Education (ISECON), 2005. Columbus, OH: EDSIG. p 2142.
- Tastle J, Tastle W. Extending the consensus measure: analyzing ordinal data with respect to extrema. Proceedings of the 22nd annual conference on Information Systems Education (ISECON), 2005. Columbus, OH: EDSIG. p 2322.
- Thompson BM, Shreider VF, Haidet P. 2007. Team-based learning at ten medical schools: Two years later. *Med Educ* 41(3):250–257.
- Vernon DTA, Blake RL. 1993. Does problem-based learning work? A meta-analysis of evaluative research. *Acad Med* 68:550–563.