The Effect of Using Team Learning in an Evidence-Based Medicine Course for Medical Students

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Background: *We implemented team learning, an instructional method that fosters small-group learning, in an evidence-based medicine (EBM) course. Our goal was to align instructional methods with EBM practices.*
Description: *Team learning provides an alternative to lectures in large-group settings. It involves out-of-class preparation followed by in-class readiness assurance tests and group application activities. We used the method to teach a 7-week course in EBM for 2nd-year students. We evaluated the course using student performance, external observation, and student focus groups.*
Evaluation: *Students performed well on all written assignments, indicating attainment of learning objectives. Observation data revealed a high level of student engagement in the classroom. Focus group data indicated that desired learning behaviors tended to occur but that many students devalued the method.*
Conclusion: *Team learning served as a useful framework, enabling a large enrollment course to have small-group experiences without large numbers of faculty. The method fostered individual accountability and promoted teamwork—behaviors consistent with effective EBM practice. Students' lack of enthusiasm for the method may stem from their comfort with didactic lectures.*

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Courses in evidence-based medicine (EBM) are being introduced into medical school curricula as recognition of the value of EBM in clinical practice continues to increase. EBM refers to the regular use of the best available evidence to inform management decisions in the care of patients. The literature suggests that courses in EBM may, and often do, increase students' knowledge and use of EBM principles and concepts.[1–3] Consequently, in 1997, faculty implemented an EBM course at our institution for 2nd-year medical students not unlike EBM courses at other institutions. Nevertheless, soon after implementation, faculty and administration recognized an inconsistency between the learning strategies commonly promoted in these EBM courses and the underlying problem-solving strategies inherently espoused by EBM practices.

Most instruction directed to large groups of learners, including instruction in many EBM courses, tends to place heavy emphasis on the transmission of facts. Consequently, instruction tends to relegate learners to a passive role in the learning process. Grading schemata, which often emphasize individual accountability over learning in community, tend to rely on multiple-choice examinations that reinforce students' tendency to focus their learning on "acquiring the facts needed for the test" rather than on real-life application of medical knowledge. Unlike these teaching and evaluation settings, EBM is often practiced in team settings where individuals share in problem solving and contribute to group success, in which problems are not well defined and decision makers have imperfect knowledge and in which no single best answer is readily available.[4]

Over time our EBM course was redesigned with an overarching goal to "practice what was preached" by using instructional strategies shown in the literature to foster student learning behaviors closely related to the types of behaviors expected of effective practitioners of EBM.[2,4] This redesigned course specifically sought to promote individual responsibility and accountability for independent, out-of-class learning of core concepts and to promote group responsibility for collaborative, in-class learning through solving of real-world problems.

Recent trends in medical education suggest that this goal for an EBM course is philosophically sound but pragmatically difficult.[5] During the past 15 to 20 years, significant changes have been made at most medical schools to introduce teaching methods that foster active learning (e.g., problem-based learning).[5,6] Such teaching methods often incorporate small-group learning processes that rely on faculty facilitators and require high faculty-to-student ratios (e.g., 1:6). Although theoretical and empirical evidence suggests that such learning experiences can foster the communication, teamwork, and problem-solving skills that are valuable to reinforce,[7–11]the use of active learning strategies is threatened by a lack of faculty with the time available to assist in implementing those strategies.[5] The major reason is that faculty time for teaching is being eroded by pressures to increase involvement in patient care and research.[12] For our institution, creating many faculty-facilitated small groups has become increasingly impractical.

Fortunately, faculty at our institution were recently introduced to team learning as an alternative to didactic lectures in large group settings.[13,14] Publications describing the use of team learning in large-enrollment undergraduate courses (e.g., business) suggest that the method can enable students to master desired content while promoting team communication, content application, and individual and group accountability for learning.[14]

In this article, using the outline for reporting results of curriculum development proposed by Reznich and Anderson,[15] we describe the application of team learning principles in the design and execution of the EBM course in 2001. After describing details of course development and implementation, we present evidence regarding the degree to which goals were achieved of fostering student learning behaviors consistent with behaviors expected of effective practitioners of EBM. Specifically, these learning behaviors include individual responsibility and accountability for independent, out-of-class learning and group responsibility for collaborative, in-class learning through application of content in the context of real-world problems. The evidence we present was derived from student focus groups, student performance outcomes, and external observations of engagement. We emphasize focus group data because they provide a window to the perspectives and perceptions of students. The other data sources are used to reinforce our findings.

Methods

Development Process

Background and Context. Baylor College of Medicine has an 18-month preclinical curriculum so that students (n = 168 per class) begin their clinical rotations in January of their 2nd year. Starting in 1997, students have been required to return to main campus one afternoon a week during the last 6 months of the 2nd-year to participate in a sequence of classroom-based courses entitled "Clinical Applications of Biomedical Science (CABS)." A course in EBM has been a part of this sequence. Because of the timing of CABS, there is a strong emphasis on making course content relevant to students' patient-care experiences during their clinical rotations. Over the years, a number of different strategies were used to ensure clinical relevancy of the material and to align instructional methods

with EBM practices. For example, in 1999, students were organized into groups by their current clinical rotation and faculty from those rotations were asked to facilitate group discussions of relevant topics. Because of difficulties obtaining faculty volunteers for these groups, this method was discontinued in 2000 when elements of team learning were first employed. Initially, course directors using team learning divided the class into four rooms, assigned one to two faculty to each room, and divided students in each room into six learning teams. As described later, use of team learning further evolved in 2001 with the students divided into 22 learning teams and remained in the lecture hall for team intragroup and intergroup discussions. Course instructors took turns managing the team learning process from the front of the lecture hall.

From the outset of the course, class sessions have occurred on Thursday afternoons between 1:30 p.m. and 4:30 p.m. In 2001 we were allocated a total of 15 hr of class time during 7 consecutive weeks in late April through early June. Because class sessions take students away from their clinical duties, attending class is often a low priority for students. Historically, attendance ranges from 50% to 60%. Furthermore, the demands of the clinical rotations limit the amount of time students can spend preparing and studying. Students' fatigue from stressful clinical rotations also limits their enthusiasm for acquiring new information and concepts during Thursday afternoon sessions.

Course Design. On assuming leadership of the EBM course in 2001, we organized ourselves into a project team consisting of five members, three clinicians (two internists, D.H. and P.H., and one psychiatrist, J.C.), a medical educator (B.R.), and an administrative assistant from the school's Office of Curriculum. The three clinicians also served as course instructors. Collectively, we possessed a strong background in the subject matter and extensive experience teaching medical students in both the preclinical and clinical curricula. Seven months before implementation, we initiated weekly 1- to 2-hr meetings to share ideas about needs, goals, objectives, strategies, and course content and to plan for implementation.

We decided early in the planning process to use team learning as the primary instructional method for the course because previous course directors had employed important elements of the method in 2000 and because it appeared from their experience and from the literature to promote active student learning.[14] Furthermore, we collectively had positive experience with the method in other contexts groups.[16,17]

Course content focused on critical appraisal of the medical literature because of the topic's relative importance in EBM, the expectations of the school's curriculum leaders that we cover this topic, and the time constraints that prevented inclusion of other material.

Curriculum

Team Learning Defined. Team learning is a well-defined instructional strategy developed over 20 years by Dr. Larry Michaelsen, Professor of Management at the University of Oklahoma and a 1999 Carnegie Foundation Pew Scholar, and is used in college business and science courses.[13,14,18] Team learning brings together theoretically based and empirically grounded strategies[13] for ensuring the effectiveness of small groups working independently in classes with high student-to-faculty ratios (e.g., up to 200:1) without losing the benefits of faculty-led, small groups with lower ratios (e.g., 7:1).[9] As an instructional method, team learning consists of repeating sequences of three phases (see Table 1). In Phase 1, learners study independently outside of class to master identified objectives. In Phase 2, individual learners complete a multiple-choice examination (a Readiness Assurance Test, or RAT) to test their readiness to apply Phase 1 knowledge. After individual learners have submitted their answers to a RAT, teams of six to seven learners then retake the same RAT and turn in their consensus answers. In Phase 3 the same teams complete identical in-class assignments in parallel; these assignments are designed to promote collaboration among students within a team, require use of Phase 1 and 2 knowledge, and identify learning deficiencies. At designated times, all learning teams simultaneously share their answers with the entire class for easy comparison and immediate feedback. This stimulates an energetic, total-class discussion with teams defending their answers and the instructor helping to consolidate and focus learning.

Course Goals and Objectives. The course had three objectives: (a) to promote the use of EBM in the students' current clinical work on rotations, (b) to set a pattern of lifelong learning through students' use of principles of EBM, and (c) to help students become familiar with the medical literature and its application to patient care. Table 2 presents the course sequence of topics and learning objectives for each session in 2001.

Table 1. *Session Organization for Team Learning*

Phase	Activity
1	Independent study to master identified objectives
2	Completion of individual Readiness Assessment Test
	Completion of team Readiness Assessment Test
3	Teams complete in-class assignments in parallel
	Teams share answers with the entire class, under supervision of instructor

Table 2. *Session Topics and Objectives*

Session Topic	Objectives for Session
1. Deciding that evidence is needed: Asking focused clinical questions	1. Formulate a logical, useful, and searchable clinical question based on a patient scenario 2. List the major components of a clinical question which would be useful to patient care
2. Finding evidence: Searching the medical literature	1. Devise a search strategy for obtaining evidence pertinent to a well-defined clinical question 2. Use PubMed in searching for evidence 3. Identify the utility of the MeSH browser in building search strategies 4. Employ limiting terms in search strategies
3. Evaluating the evidence: The power of randomization	Understand the following: 1. The process of randomization in a clinical trial 2. The importance of "Table 1" in determining the adequacy of randomization 3. The definition of RRR (relative risk reduction), ARR (absolute risk reduction), and NNT (number needed to treat) 4. The rudiments of p values and confidence intervals 5. The rationale and weaknesses of subgroup analyses
4. Evaluating the evidence: Basics of study design	1. Define commonly used terminology regarding clinical trials, including RRR, ARR, NNT, 95% CI (95% confidence interval), p-value, OR (odds ratio), RR (relative risk), NNH (number needed to harm) 2. Determine the type of study being reported in a paper 3. Discuss the strengths and weaknesses of the following study types: randomized controlled trial (RCT), cohort study, case control study 4. Apply the results of studies to a clinical question
5. Evaluating the evidence: systematic reviews	1. Assess the validity of a systematic review 2. Discuss the importance of a systematic review to individual patient management 3. Explain the utility and limitations of a guideline in the care of a particular patient problem 4. Access appropriate resources, including the Cochrane Library and Web sites dedicated to practice guidelines
6. Effective use of diagnostic tests	1. Understand the conceptual definitions of sensitivity and specificity and relate these to their mathematical definitions 2. Understand the conceptual definition of predictive value and relate this to the mathematical definitions of positive and negative predictive value 3. Understand the concept of prevalence and how or whether it affects the previous concepts 4. Use the concepts of sensitivity, specificity, and prevalence to effectively construct diagnostic testing strategies and interpret their results
7. Final examination	A practical examination covering the skills learned in the first six sessions

We followed a progression of topics typical for a critical appraisal course, requiring students to learn how to formulate clinical questions, to conduct relevant literature searches, and then to critically appraise the results of those searches.

Instructional Methods and Materials. Based on the team learning framework, we distributed, via e-mail in advance of the first day of class, a course description and asked students to familiarize themselves with it. On the 1st day of class, we distributed a syllabus reiterating the course format and topic sequence. This syllabus also contained assigned readings, which represented the "factual" content of the course and constituted the Phase 1 activities in the team learning framework. On the 1st day of class, we assigned students to learning teams and assigned teams to specific areas of the lecture hall. These areas represented each team's physical space during the remainder of the course's in-class activities. On weeks, 2, 4, 5, and 6, we prepared and administered open-book RATs. As described previously, students took the RATs first individually, then again as a team. We based the content of our RATs on the reading material assigned in the syllabus for a given session. RAT questions were generally based on clinical scenarios, as illustrated by a typical question in Figure 1. Our intent was to use an OMR scanner with print capability to score and return individual and group RATs during the session to provide immediate feedback (i.e., scores and identification of missed questions) to individuals and groups.

After completion of the individual and group RATs, the remainder of our sessions consisted of activities designed to promote application and practice of desired knowledge and skills. All activities were based on common clinical situations to increase the relevancy to student clinical activities, as illustrated by a typical activity in Figure 2. For these activities, we gave all teams a set of colored cards labeled A through E. After an appropriate amount of time, the instructor asked all teams to simultaneously reveal their chosen answer using the appropriate card. This led to an intergroup discussion comparing and contrasting group responses. While facilitating this discussion, the instructor was able to clarify misconceptions, misunderstandings, or both. These application-based activities were not graded.

Learner Evaluation and Grading. In addition to the individual and group RATs, course grades were based on two homework assignments, a final examination, and a peer assessment of individuals' "helping behaviors:"

- The homework assignments required students to perform and report on various critical appraisal exercises related to their current activities on clinical rotations. An example of one of the homework assignments appears in Figure 3. Course directors divided up and graded homework assignments using a criterion-based scoring rubric. Students received both individual and group grades. The group grade was based on the average homework score for individuals in the group and was intended to foster out-of-class collaboration within the group.
- The final assessment of student performance was an open-book examination on the last day of class. The examination tested the practical skills taught in the course and consisted of a series of patient problems. It focused on students' ability to critically analyze articles in a limited period of time. Answers were short answer or essay. Course directors again divided up and graded examination answers using criterion-based scoring rubrics. Students only received individual grades on the examination.
- The peer assessment of team helping behavior involved having students evaluate, on the last day of class, each of their team members based on the degree to which each team member was helpful to the evaluating student in terms of learning and understanding the content of the course. Each student was given a total number of points based on the number of students in their group (10 points per student). For example, in a group of six students, each student would use a total of 50 points, which would then be distributed to the other team members. Students were instructed to give each

"A 66 year old man comes to your office at the insistence of his wife. Over the past week he has noticed chest discomfort when he takes his 10 month old Labrador retriever for a walk. He says, "It's really not that bad, Doc, I don't have any pain, just a little tightness when Rover makes me step fast at the beginning of the walk. It goes away a minute or two after one stop." The patient smokes two packets of cigarettes daily. His body mass index is 18kg/m2. On examination, his blood pressure is 156/98 mm Hg. Given this clinical data you estimate that there is a 90% possibility that he has coronary artery disease. You order a Bruce exercise stress test (sensitivity = 85%, specificity = 80%). Although the patient achieves his expected heart rate, the test is interpreted as negative. Given the negative result, the probability that the patient has coronary artery disease is

a) 90% b) 63% c) 37% d) 22% e) 13%

Figure 1. *Example of readiness assessment question.*

Each group was given a set of three published studies of estrogen use in patients at risk for cardiovascular disease. The groups were given a limited amount of time to read the papers and then were asked to address the following patient scenario:

53 y.o. woman civil attorney presents to the office for a routine physical examination. Her menstrual periods ended six months ago and since that time, she has had occasional hot flashes and night sweats. She has no other symptoms at this time. Specifically, she has no chest pain or shortness of breath. PMH is remarkable only for a C-section with the birth of her second child 17 years ago, appendectomy in her early 20's. She takes occasional aspirin, daily Tums for calcium, and a multivitamin. Family history includes heart disease (Father had a myocardial infarction at age 55, brother a CABG at age 57, mother reportedly has angina at age 76), but no cancer, no history of deep venous thrombosis, no history of hip fractures or osteoporosis.

Physical exam is remarkable for a BP of 148/86, but is otherwise entirely normal.

Laboratory data is remarkable for the following: Fasting glucose 118 Cholesterol 224, LDL 141. EKG is normal. Chemistries, CBC, U/A are normal. Mammograms are class 1. (normal) PAP smear is normal.

She seeks your advice regarding hormone replacement therapy, particularly in light of her strong family history of coronary artery disease. Which of the following would you advise?

1. Conjugated equine estrogen (Premarin) 0.625 mg q day.
2. Conjugated equine estrogen (Premarin) 0.3 mg q day.
3. Conjugated equine estrogen (Premarin) 0.625 mg q day along with medroxyprogesterone 2.5 mg q day.
4. Conjugated equine estrogen (Premarin) 0.3 mg q day along with medroxyprogesterone 2.5 mg q day.
5. No hormone replacement therapy.

Figure 2. *Example of group application activity.*

Instructions:

1. Write a brief summary of a patient history from among the patients you are following this month. This should be no more than two paragraphs in length.
2. Write the clinical question you would like to answer for this patient, using the standard format discussed during week 1 of class.
3. Search the question.
4. Choose the study from your search which you feel will best address the question.
5. Analyze the validity of the study.
6. Appraise the importance of the findings with respect to your patient.

Brief summary of patient problem:

Clinical Question (four parts, to include patient description, intervention, comparison and outcome):

Study which you feel is appropriate to the question:

Validity of the study:

Importance of the study to your patient:

Attach a copy of the study or (at minimum) of the abstract of the study.

Figure 3. *Example of homework assignment.*

peer a grade between 5 and 15 and to differentiate among peers.

Overall grades for the course were based on students' individual performance (as determined by individual grades for RATs, the final examination, and the homework), team performance (as determined by team grades on the RATs and homework), and helping behavior. To foster student buy-in for the grading scheme, we asked teams during session one to negotiate, within prescribed boundaries, the amount of weight to give each of these areas in the calculation of final course grades. After discussion, a single weighting scheme was established. In addition to student buy-in, the purpose of this exercise was to build team cohesion from the outset and to give teams the chance to decide how committed to group performance they collectively wanted to be.

Course Evaluation Methods

We used multiple methods to evaluate the course, both in terms of process and outcome. Given the focus of this article, we present the results of three methods: (a) student performance on the homework assignments and final examination (as described previously), (b) external observations, and (c) focus groups. We describe data collection methods for the observations and focus groups.

Student Performance. We computed mean scores and standard deviations on homework assignments and the final examination. Because these scores were criterion-based, scores higher than 80 were considered to indicate content mastery.

External Observations. Two trained observers, using an observation instrument specifically designed for measuring student engagement in health sciences classrooms, recorded in-class interactions during a single, representative, class session (i.e., day 4). Use of the observation instrument consisted of 5-min observational cycles repeated continuously throughout the learning session. At the beginning of each cycle, the observers checked off from a list of possibilities the behavior of four randomly selected students. Student behaviors on the instrument included talking, listening, reading, organizing, writing, or other. Observers also recorded whether these behaviors are directed at (or in response to) the instructor, a group of students, one other student, or themselves (e.g., writing or reading). Because of the availability of other datasets using the observation instrument,[19] we are able to compare the pattern of interactions recorded during the EBM course to the pattern of interactions recorded during sessions of six other team learning-based courses and eight didactic lecture-based courses taught at Baylor.

Focus Groups. To better understand the experience of the students in our course, we randomly selected students that participated in at least 60% of class sessions and invited them to participate in a focus group discussion. We conducted three such focus groups with six to nine students in each group. The groups were moderated by a qualitative methods consultant from an outside institution who was not associated with the team learning method. We developed an interview guide to address two overarching questions: (a) "What effect did the team learning method have on individual responsibility and accountability for out-of-class learning?" and (b) "What effect did team learning have on group responsibility for collaborative in-class learning?" Our interview guide was organized to probe three broad areas of student experience in the course related to the overarching questions: (a) students' experiences and attitudes regarding learning in teams versus learning as individuals, (b) students' perceptions of the grading scheme and its effects on their learning behaviors, and (c) students' perceptions of learning teams in our course compared to their other types of small group learning (problem-based learning, learning as part of ward teams on clinical rotations). An independent secretary not associated with the course audiotaped and transcribed the focus group sessions removing all student names to ensure anonymity. We analyzed the focus group transcripts through three iterations of independent reading, annotation, and discussion among all of the authors.

Results

Course Implementation and Logistics

For many of our students, team learning represented a novel approach to learning in the classroom. Consequently, we found that the focus of the first session (i.e., clarification of the team learning framework, RAT process, and expectations of group collaboration) was essential. Although we provided advance instructions about the course through e-mail, there still seemed to be some confusion during the first session. After our practice RAT on day one, we concluded that it was too confusing for students and too difficult for instructors to collect, score, and return over 180 individual and group RAT answer sheets during the session. We opted, instead, to score the quizzes out-of-class and return them the following week rather than use the OMR scanner as planned.

Attendance throughout the course remained high (approximately 82% to 95%). During individual RATs, students worked quietly to record their answers. During team RATS and intrateam discussions of application exercises, the lecture hall became a buzz of noise and activity. It appeared to us that most students were on task and participating in team discussions. Intergroup discussions—when groups shared, compared, and defended their answers—were energetic, sometimes controversial, and always on task.

Student Performance Outcomes

The two homework assignments provided a major gauge of student progress in the course. The average grades on the two homework assignments were 88.2% (*SD* = 7.16) and 92.6% (*SD* = 6.36), respectively. Each of the instructors commented that there were many very impressive homework submissions.

The class average grade on the final examination was 86.0 (*SD* = 7.38). The vast majority of students demonstrated mastery of all objectives of the course as assessed by this examination.

External Observation

The two observers recorded a total of 175 observations during the observed EBM session. These data reveal a relatively high level of engagement using the team learning format compared with lectures from several different traditional lecture-based courses in the medical school. Of the recorded observations in the EBM course, 46% involved student-to-student interaction (i.e., students talking or listening to other students) and 27% involved student-to-instructor interaction (i.e., student listening to instructors). This compares with an average of 51% and 22%, respectively, for other team learning-based course sessions and 8% and 62%, respectively, for lecture-based sessions, all taught at Baylor with similar populations of learners.

Student Focus Groups

Three themes emerged from student focus group data related to the questions of interest. After summarizing each theme, we present illustrative quotes substantiating the theme.

The students in our focus groups actively took responsibility for out-of-class learning. Although we had speculated that students would prepare for class sessions to perform well on individual RATs, this was not mentioned as an incentive for preparation in any of the focus groups. Rather, students identified the desire to help and participate in the group learning process as a powerful incentive to prepare for class. In addition, in cases in which students did not prepare, the group process was identified as a stimulus to review session content:

- Student, focus group #1:

> I just felt like you wanted to be a team player, so you wanted to be there to help your team out when they were answering the questions and give your input. And you wanted to try to read the night before to help your team.

- Student, focus group #3:

> …a part of it is that you have already sat there and thought about it and you either come to a conclusion that you were right or wrong or whatever but you've gone through a certain part of the thought process already and then the group usually builds on whatever you have come to, but if you hadn't done anything at all, [your benefit would not be as great].

- Student, focus group #2:

> We don't wanna try to make each other look bad or anything like that… [it would] make us feel guilty for doing this if our grade is going to affect somebody else's grade. That incentive made me do a little better.

- Student, focus group #3:

> I didn't read it before, even though we had RATs and stuff like that. But when we were working on the quiz actually, somebody taught it to me and it wasn't enough to just have them teach it to me and then I understood it afterwards; I had to go back and look at it myself… [it] allowed me to, you know, really understand it by the time I was done.

Because the team learning method provides a number of incentives to learn in small groups, we were interested in students' learning experiences in the setting of their learning teams. In our focus groups, students readily identified the teams as a major component of their learning process in the course, and they identified a number of advantages to learning in groups. In some cases, these experiences were seen to parallel and reinforce the concept of learning in teams in other medical settings:

- Student, focus group #1:

> A lot of times students were kind of learning the stuff, you know, from scratch and because of their levels of understanding are able to explain it to other students in a way that students can understand because they are kind of at the same level… there is always kind of this good interaction from students because we can com-

municate with each other pretty well in a small group. We know each other.

- Student, focus group #3:

In the standard classroom format, if you don't study or you fall asleep in class, you don't learn anything; whereas in this one, because you go over it in a group, you are kind of forced to talk it over and learn something.

- Student, focus group #3:

If there is something you didn't know, someone else could teach you or…[if] you didn't know already and you thought about it and couldn't get it, then they would show you. That's kind of what happens on the wards where if you don't know, your resident will show you.

Despite being able to identify the incentives for learning and experiential learning experiences such as those illustrated previously, students in our focus groups also devalued the team learning method and perceived it to be inefficient compared to didactic lectures in which instructors present course content:

- Student, focus group #1:

…on the one hand, it was good because it forced you to learn a skill that we have to use now for the rest of our lives and it becomes invaluable when you are trying to look up information on a patient. But as far as *the course instructors teaching us how to do it,* I think they failed at that point. (Emphasis added by authors).

- Student, focus group #3:

I like learning didactically. I want someone to stand up in front of me and teach me what I need to know and I'll take my notes and I'll go and learn it on my own.

Discussion

Courses in EBM for 2nd-year medical students, including the course at Baylor, face significant challenges imposed by an erosion in faculty time for teaching and the goal of matching instructional methods with EBM practices. Baylor's response to these challenges has progressed over the years, to our use of team learning principles and practices in 2001. The results we have presented from the 2001 course demonstrate that most students achieved the learning objectives, despite the fact that we minimized in-class lecturing and shifted the burden of content-learning to students through out-of-class individualized preparation and in-class group problem solving. In general, team learning served as a useful framework, enabling the course with 168 students to move away from didactic instruction to small-group experiences without increasing faculty involvement. Use of the team learning method ensured individual accountability and promoted team work (including students helping and teaching each other). Key aspects of the method were the readiness assurance process and the format of group application activities.

In 2000, the course directors first divided students into four different classrooms before dividing them into learning teams because of concern of conducting intragroup discussions in the lecture hall setting. Although the physical arrangement may have been more comfortable with this configuration, it required more faculty and left students wondering if they were getting an equal experience as students in other classrooms. We perceived that intragroup and intergroup discussions to be as effective in the lecture hall setting with all students present as when divided into four different classrooms.

We were generally disappointed when students appeared to devalue team learning, although we were not surprised by this finding. We believe at least four different factors may have contributed to students' limited enthusiasm with the method: (a) students, comfortable with lecture after years of experience, may not have been adequately prepared for the responsibility we gave them to prepare before class; (b) students, with traditional clerkship responsibilities, had to squeeze their out-of-class preparation into already busy schedules; (c) many students who had developed habits of skipping earlier courses may have objected to attending to participate in their learning teams; (d) course directors may not have sufficiently "pulled things together" at the end of class discussions, leaving students to feel more uncertain about their learning than need be.

In response to results regarding student responsibility for out-of-class learning and group responsibility for collaborative, in-class learning, we plan to make several revisions. Some of these revisions deal with subtle changes in logistics, such as using closed-book RATs (to emphasize the need for out of class preparation and to increase discussion and minimize "looking up the answer") and to try again to collect, score, and return RAT answer sheets in class (to emphasize individual accountability and highlight the tendency for groups to outperform their best individual member). We also plan on finding or creating more focused reading materials and creating several videolectures accessible via the Internet for students to use as alternative sources of information if the prereading and in-class discussions are insufficient (particularly in the area of statistics). We also hope to adjust the course schedule, such as alternative weeks with one of the other courses, so that students will have more time between EBM sessions to complete out-of-class studying. In response to

students' lack of enthusiasm for the method because of a desire for more direct teaching, we plan to consolidate learning after in-class group application activities with concise reviews of take home points.

In sum, we remain committed to the ideal of teaching EBM with instructional methods consistent with the types of behaviors expected of effective EBM practitioners. It appears to us that team learning can be an effective overarching framework to make this happen and recommend that directors of EBM courses designed for large classes of midlevel medical students consider the potential merits of team learning in such settings.

References

1. Wadland W, Barry H, Farquhar L, Holzman C, White A. Training medical students in evidence-based medicine: A community campus approach. *Family Medicine* 1999;31:703–8.
2. Ghali W, Saitz R, Eskew A, Gupta M, Quan H, Hershman WY. Successful teaching in evidence-based medicine. *Medical Education* 2000;34:18–22.
3. Norman GR, Shannon S. *The effectiveness of instruction in evidence-based medicine: A critical appraisal.* Hamilton, Canada: McMaster University, 1998.
4. Mallinger M. Improving the quality of working life in the classroom: QWL as self-managed learning. *Organizational Behavior Teaching Review* 1986;11:43–56.
5. Whitcomb M, Anderson B. Transformation of medical students' education: Work in progress and continuing challenges. *Academic Medicine* 1999;74:1076–9.
6. Albanese MA, Mitchell S. Problem-based learning: A review of literature on its outcomes and implementation issues. *Academic Medicine* 1993;68:52–81.
7. Millis BJ, Cottell PG. *Cooperative learning for higher education faculty.* Phoenix, AZ: Oryx, 1998.
8. Michaelsen LK, Fink LD, Knight A. Designing effective group activities: Lessons for classroom teaching and faculty development. In D DeZure (Ed.), *To improve the academy: Resources for faculty, instructional, and organizational development.* Stillwater, OK: New Forums, 1999.
9. Michaelsen LK. Myths and methods in successful small group work. *National Teaching and Learning Forum* 1999;8:1–4.
10. Johnson DW, Johnson RT, Smith KA. Constructive controversy: The educative power of intellectual conflict. *Change* 2000;January/February:29–37.
11. Westburg J, Jason H. *Fostering learning in small groups.* New York: Springer, 1996.
12. Ludmerer KM. *Time to heal: American medical education from the turn of the century to the era of managed care.* New York: Oxford University Press, 1999.
13. Michaelsen LK. Three keys to using learning groups effectively. *Teaching Excellence: Toward the Best in the Academy* 1998;9:9.
14. Michaelsen LK. Getting started with team learning. In LK Michaelsen, AB Knight, LD Fink (Eds.), *Team learning: A transformative use of small groups.* Westport, CT: Greenwood, 2002.
15. Reznich C, Anderson WA. A suggested outline for writing curriculum development journal articles: The IDCRD format. *Teaching and Learning in Medicine* 2001;13:4–8.
16. Haidet P, O'Malley KJ, Richards B. An initial experience with "team learning" in medical education. *Academic Medicine* 2002;77:40–4.
17. Seidel C, Richards B. Application of team learning in a medical physiology course. *Academic Medicine* 2001;76:127.
18. Michaelsen LK, Fink LD, Knight A. *Learning teams: A transformative use of small groups.* Westport, CT: Greenwood, 2001.
19. O'Malley KJ, Moran BJ, Haidet P, et al. Validation of an observation instrument for measuring student engagement in health professions settings. *Evaluation and The Health Professions* 2003 (in press).

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