

INSTRUCTIONAL DESIGN AND ASSESSMENT

Using Team-based Learning in an Endocrine Module Taught Across Two Campuses

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Objectives. To implement a team-based learning (TBL) format in an endocrine module to promote students' active learning in a course delivered to 2 campuses.

Methods. Course lectures were transformed into 13 TBL sessions consisting of content pre-assignments (self-directed learning), in-class readiness assurance tests (accountability), and team problem solving of patient cases and faculty-led class discussion (knowledge application). Student performance was evaluated through multiple assessments during the TBL sessions and on unit examinations. Students evaluated each individual TBL session and the course as a whole.

Results. Course grades were higher using the TBL method compared to the traditional lecture-based method that was used previously. Individual readiness assurance tests and team contribution scores significantly predicted overall course grades ($p < 0.001$). Students accepted the change in course format as indicated by course evaluation results.

Conclusions. TBL is an effective active-learning, instructional strategy for courses with large student-to-faculty ratios and distance education environments.

Keywords: team-based learning (TBL), distance education, active learning, self-directed learning, endocrine module

INTRODUCTION

Tell me and I'll forget; show me and I may remember; involve me and I'll understand.

Chinese Proverb¹

The lecture continues to be the one of most common methods of delivering information in university courses. It is an efficient teaching strategy that delivers an up-to-date summary of material adapted to a particular student group regardless of size.² Yet, despite the amount of focused, pertinent material given to the students, retention of material is poor and it is a less than desirable vehicle for developing problem-solving or lifelong learning skills. The development of critical thinking is inversely proportional to the amount of time students spend listening.³ Pharmacy faculty members commonly practice collecting, evaluating, synthesizing, and then distilling the bottom line information into a neatly packaged handout that students then listen to during a lecture. Faculty members are knowledge dispensers who emphasize passive learn-

ing, listening, memorizing, and repeating back.² Memorization of facts does not ensure understanding concepts of care that they will need in practice.

One study of engineering students' problem-solving skills found that they had poor insight into the abstract concepts behind the formulas they memorized to solve problems. This failure was attributed to the limited number of real world problems requiring analysis and synthesis used to challenge the students' thinking and application of the concept.^{4,5} Therefore, faculty members need to teach students to learn actively and think critically, which appears to be the process that the educators go through to develop lecture handouts. Teaching to promote active learning and critical thinking requires time and a reorientation of our educational process.

As practitioners and faculty members responsible for teaching an endocrine course to third-year pharmacy students using a lecture-based approach, we became dissatisfied with the students' ability to think critically and apply information to patient cases during class and to live patient interactions during their advanced pharmacy practice experiences. We were concerned that we were developing passive learners dependent on faculty members to evaluate, synthesize, organize, package, and deliver information

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for them. How was this approach going to develop the “lifelong learners” required in the ACPE Accreditation Standards?⁶ Other significant motivators were the following student attitudes and behaviors: varying degrees of preparation and participation in class discussions and activities; inconsistent opportunities for application of material; varying strategies, expectations, and outcomes for problem-solving; inadequate peer teaching and learning; difficulty in keeping students engaged in the material during lectures; and lack of student responsibility for their own learning. These shortcomings are problems faced by many colleges.⁷ We perceived them to be magnified by our expanded class size and distance education classroom. With this expansion, faculty members were challenged with how to best conduct active learning in the classroom with a significantly larger number of students while simultaneously broadcasting to a distance education site with a limited number of faculty members to facilitate the activities.

In response to these changes and challenges, the faculty members in the endocrine module sought to transition this course from a heavy lecture emphasis (with only 20% of time devoted to active learning, primarily through case discussions) to an active-learning emphasis. After considering several teaching strategies, faculty members selected a team-based learning (TBL) approach. TBL advocates self-directed learning of course content and student application of this new knowledge within small collaborative teams and full classroom discussions; thus, promoting both low and high-level learning.⁸ TBL requires constant student preparation, attendance, and participation and gives students the opportunity to learn from their peers as well as how to work and negotiate within a team using features such as self- and peer evaluation.⁷ In our experience, utilization of the TBL strategy can reduce content delivery time by 40% and increase time spent in application activities without a detrimental effect on the acquisition of knowledge. Although TBL has been used in medical as well as business education,^{9,10} there has been limited documentation of its use in a pharmacy curriculum or in the multi-campus, synchronous distance education setting. This paper describes our implementation of a TBL format for an endocrine module delivered across distance in a class with a high student-to-faculty ratio.

DESIGN

The endocrinology module is the fifth in a series of 10 pharmaceutical care modules that integrate basic sciences with applied therapeutics. This module is a 3 credit-hour course at the beginning of the fall semester of the third professional year (2 years preprofessional + 4 years professional program). In 2004, the course was transformed

from a primarily lecture-based format to a TBL format. Although the module required students to meet daily for 6 weeks, using the TBL method, the class met only 17 days (1 orientation day, 13 TBL sessions, and 3 examinations) out of a potential 29 days, thereby decreasing in-class time by 40%. Each session was 3 hours in length. The course topics are described in Table 1. Students were randomly assigned by the course coordinators to 1 of 20 teams with 6 to 7 students per team. The Oklahoma City campus had 12 teams and 1 course coordinator, and the Tulsa campus has 8 teams and 1 course coordinator. The students remained on the same campus and with the same team throughout the course. While 7 faculty members taught within the course, there was a minimum requirement of 2 faculty members (one on each campus) to conduct each TBL session. One faculty member served as the leader/facilitator on his/her campus (faculty:student ratio of 1:80) and 1 faculty member from the opposite campus served as a facilitator for his/her campus (faculty:student ratio of 1:60). Of note, the leader of an individual TBL session could originate from either site depending on the primary faculty facilitator for a given topic. Each TBL session consisted of 4 phases: pre-class preparation, readiness assurance testing, application of concepts to patient cases, and post-class reflection. The first phase occurred prior to the TBL session and was completed by each student individually. The second and third phases occurred during the class session and involved the individual, the teams, and the entire class. The fourth phase occurred following

Table 1. Team-based Learning Session Topics for Endocrine Module

Unit 1
1. Growth hormone abnormalities
2. Thyroid disorders
3. Erectile dysfunction and benign prostatic hypertrophy
Unit 2
4. Pathophysiology of diabetes mellitus
5. Pharmacology and treatment of Type II diabetes and prediabetes
6. Pharmacology and treatment of Type 1 diabetes
7. Chronic diabetic complications
8. Acute hyperglycemic complications
Unit 3
9. Contraception
10. Pregnancy, lactation, and teratogenesis
11. Infertility and polycystic ovary syndrome
12. Dysmenorrhea, premenstrual syndrome, and menopause
13. Osteoporosis

the TBL session and was completed by the individual students. The 4 phases were repeated for each TBL session.

Prior to each TBL session, students were assigned material to study independently to master predefined objectives. Faculty members provided well-developed objectives and assignments to facilitate individual learning. The assigned study materials included 1 or more of the following: detailed handouts, textbook chapters, journal articles, videotaped vignettes, slide presentations, and Internet web sites. The materials covered pathophysiology, pharmacology, medicinal chemistry, and pharmacotherapeutics of course topics. For each TBL session, assigned reading materials were limited to 30 pages based on prior TBL experience of faculty members in the University of Oklahoma medical school. Our collective experience was that this was a reasonable amount of material for students to learn within 2 to 3 days of preparation time. At orientation and throughout the course, students were encouraged to devote the same amount of study time that they would give for review of material before or after attending a lecture. The incentive for students to complete the pre-class assignments was to perform well on the individual and team readiness assessment tests, to contribute to the team's discussion of patient cases, and to achieve a high score on unit examinations.

In the second phase of TBL, the first 30 to 50 minutes of each 3-hour session were devoted to assessing students' preparation. First, students took an individual readiness assurance test (IRAT) of 10- to 15-multiple-choice questions over the content in the pre-class assignments. Next, students retook the same test within their teams, allowing for peer teaching and assuring everyone was prepared to move to the application phase (phase 3). This process was called the team readiness assurance test (TRAT). After the IRAT and TRAT were completed, the faculty leader reviewed the answers with the whole class and clarified any concepts that students did not understand relating to the test and the pre-assignments. IRAT/TRAT questions primarily tested the understanding of basic concepts and knowledge from the pre-class assignments and included a couple of higher-level questions to differentiate the higher-performing students.

In the third phase, application was the focus for the remainder (second and third hour) of the 3-hour TBL session. Patient cases with 6 to 8 corresponding questions were used to practice application of the TBL session topic. Case questions posed therapeutic dilemmas or problems that were commonly encountered in pharmacy practice. Each question was written in multiple-choice format with 4 plausible options to provoke discussion and debate among the teams. Case questions were written to represent the ambiguity of practice and to facilitate

students' clinical reasoning skills, argument construction, evidence generation, and conclusion articulation. The faculty leader began by reviewing 1 case and its related question with the whole class. Then, each team considered the 4 options and the available evidence, selected the best answer, documented with evidence why they considered it was the best answer, as well as why they did not select the other available options. All the teams worked on the same question during the 5 to 7 minutes allotted for team discussion. The team discussion provided opportunities for peer teaching and collaborative problem-solving. Teams used the pre-class study materials and any other references they chose to bring to class to assist them in the selection and defense of their response. Teams were required to select a scribe (rotates among team members throughout the module) for each session to record their answer and the justification for their selection and rejection of other choices. The teams also selected a spokesperson for each case (rotation among all team members required) to explain their reasoning for answer selection during the class discussion. During the team discussions, the faculty facilitator(s) circulated the classrooms to observe team discussions, clarified misconceptions, answered questions, promoted engagement in the discussion, and provided feedback to help students in their approach to the case. At the end of the team discussion, each team scribe completed the team's written explanations/justifications, drew a line and provided a signature to signal the end of their answer. The faculty leader then asked the teams to simultaneously post their answer card (for responses A, B, C, or D) and verbally report the number of teams selecting each option on their campus, and the faculty facilitator at the distant campus reported team responses for their site. The faculty leader then facilitated discussion among the whole class by calling on teams who volunteered to share their evidence for selecting or rejecting the various options. Through this process, faculty members used the IRAT/TRAT discussion, observation of team discussion of the case, student questions, and the class discussion of each case to assess general understanding of the material. Students received feedback from their peers and faculty members about their understanding of the material at 5 points throughout the session: (1) during team discussion of TRAT, (2) through faculty-led class discussion of TRAT, (3) during team discussion of each case, (4) through faculty-led class discussion of the cases, and (5) finally, at the conclusion of the case discussion when the faculty member summarized what he/she considered the best answer and justification for this selection while reviewing and validating team comments made during the class discussion. Within this process, the faculty member provided immediate

feedback to the students on the best answer while at the same time modeling his or her problem-solving approach and ability to use evidence-based medicine to defend their choices. The faculty members devoted 5 to 10 minutes for the class discussion of each question. The entire process was repeated throughout the class period until all case questions were completed.

Beginning with the fourth phase, following each TBL, all students were required to complete a minute evaluation of the session. Minute evaluations were brief online evaluations conducted within 48 hours of class dismissal that were designed to be completed in approximately 1 minute. The purpose of the minute evaluations was to encourage student self-reflection and to allow faculty to quickly identify potential problems related to pre-class assignments, team dynamics, student-faculty relations, and overall learning. Although the need for intervention has not yet occurred, this evaluation offers students an additional and timely mechanism to alert faculty members to problems that could detract from the learning process.

The method for determining the course grade is summarized in Table 2. The weight of the course grade was based on individual assessments: 3 unit examinations and 13 IRATs accounted for 78% of the final grade. Team assessments (22% of final grade) were based on 13 TRATs, 13 team discussion answers, team participation points earned during the TBL sessions, and team contribution assessment. During the individual team discussion, teams recorded their case responses and submitted these at the end of the session for grading. During the TBL case discussions, participation points were awarded to teams as they volunteered responses that meaningfully contributed to the facilitator-led class discussion. Additionally, each individual student earned a team contribution score for his/her teamwork throughout the course. The team contribution grade was determined by peer, team, and faculty evaluations. Throughout the course, the faculty facilitators observed teams and perform random assessments of students' contributions within their teams (average of 3 or more evaluations). Faculty members evaluated students on their active participation in the

team discussions, contribution to the team answers, leadership in serving as a team spokesperson and secretary, and adherence to classroom standards of behavior and professionalism. At the end of the course, students were required to complete a peer assessment of each team member's contribution, as well as an overall assessment of the team's effectiveness. Peers rated each other on preparation, participation, leadership, attitude, confidence, and professionalism during the TBL sessions. Students evaluated their team as a whole on leadership, participation, decision-making, collaboration, communication, support, trust, productivity, and accountability.

An important refinement to the course grading structure was to require students to achieve a passing IRAT score in order to earn the full credit of team points. The IRAT performance was an important indicator of the students' preparedness for TBL sessions and thus their ability to contribute to the team. Therefore, the IRAT score had to be 70% or higher in order to receive the full credit of team scores (TRAT, written team case responses, and team contribution score) for the TBL session. This modification increased individual student accountability because it prevented students from inadequately preparing for the TBL sessions while receiving a satisfactory overall score for the session because the team score boosted their grade. Statistical analysis of student performance was conducted using multivariate linear regression on scores from the individual graded components to determine their impact on the final grade.

ASSESSMENT

Evidence of student learning was demonstrated by individual student performance on unit examinations and within the course. The average scores (81% versus 86%) on the 3 unit examinations were similar in 2003 (last year lecture-based) to the results in 2006 (third year of TBL). The same examination format had been used throughout the existence of the endocrine module, making the comparison of the scores from these 2 years more reliable. Overall, students performed similarly or better on unit examinations and achieved higher grades in the course as a whole when it has been delivered in the TBL format. Notably, there were higher percentages (23% in 2006 compared to 9.5% for 2003) of students earning a letter grade of A and no students with failing grades (D or F) in the course after transitioning to the TBL format. IRAT and team contribution score significantly predicted overall course grades ($p < 0.001$). Whereas, the TRAT, written team cases responses, and unit examinations did not.

Student minute evaluations were completed following each of the 13 TBL sessions. Overall these evaluations demonstrated that the majority of students learned from

Table 2. Course Grade Distribution

Component	Total Points	Weight, %
Three unit examinations	630	63
IRAT/TRAT ^a	230	23
Written team case responses	60	6
Team contribution score	50	5
Team voluntary participation	30	3

Abbreviations: IRAT = individual readiness assurance test;

TRAT = team readiness assurance test

^aweight distribution is 70% for the IRAT and 30% for the TRAT

the individual TBL sessions and that their teams and faculty members facilitated this learning. While course evaluations remained positive, there was a higher average overall course rating for the prior lecture-based format in 2003 (4.6 ± 0.55 on a 5-point scale, with 5 being the highest) than for the newer TBL format in 2006 (3.5 ± 0.89).

DISCUSSION

The TBL strategy we have presented is innovative in that it is within a pharmaceutical care module and has been utilized in a distance learning arena with 2 separate campuses. TBL implementation in the endocrine module met the multiple goals and needs of our evolving course including: self-directed learning, active learning, knowledge application, student accountability, class size expansion, distant campuses, and limited faculty numbers. Student-centered and self-directed learning occurred as students planned when they would learn material, monitored their own learning progress, and evaluated their success in achieving the learning objectives. In addition, students received faculty and peer feedback and evaluation about the quality and level of their learning during the TBL sessions. Since students studied course content prior to the TBL, the class sessions were used exclusively for assessment and application of knowledge through case-based discussions. This emphasized problem-solving and allowed for discussing course content in the context of real-life patient scenarios in the ambulatory care, acute care, and community settings. The case format has also increased the ability to integrate endocrine pharmacotherapy with other curriculum topics such as ethics, professionalism, scope of practice, and pharmacotherapy knowledge from prior modules. Maximum student accountability, participation, and engagement were encouraged through course credit being given for IRATs, TRATs, written case responses, voluntary participation in class discussion, and team contribution. Anecdotally, the level of student engagement increased, with the most substantial improvements made in engaging students on the distant campus. For the past 3 years, the course has been successfully delivered to large class sizes of nearly 140 students on 2 campuses, with live videoconferencing and a minimum of 2 faculty members present per class session. As evidenced by the grades over several course cycles, the repetitious nature of the TBL process appears to provide the most benefit to academically weak students due to the increased structure and accountability for learning.^{7,9}

It is important to note that the course content has not changed throughout the offering of this module. However, student accountability did significantly increase with implementation of the TBL design. As a result, stu-

dents were required to work independently and at a more rigorous pace during the course because they were held accountable for learning and applying course content throughout the 13 TBL sessions versus only at a few designated examinations where students are more prone to superficial learning as a result of cramming. We feel that the increased course rigor and accountability took students out of their comfort zone and adversely affected overall course ratings. Additionally, we believe that these results are not atypical for courses that transition to active learning, instructional strategies that require adoption by the entire class versus course designs where students could elect to remain in a traditional lecture control group. The majority of students appreciated and embraced the student-centered learning opportunities, while some were challenged by the increased accountability and workload. Overall, the results of these narrative comments in addition to the quantitative evaluations support that students accepted the TBL instructional strategy.

Upon reflection, there were many factors aiding in the successful transition to a TBL instructional strategy in the endocrine module. The buy-in and adoption of the TBL format by course faculty members has been present since the very early stages of the transition. This has been critical as course faculty members were required to significantly revise materials to articulate measurable learning objectives and develop rich self-directed study materials, as well as perfecting their facilitation of discussion skills and suppressing their typical in-class lecturing approach. In addition, college administration and faculty colleagues have supported the TBL format within this and other pharmaceutical care modules. The fact that 100% of students earned passing grades in the course and none required remediation is evidence of student learning in the course and acceptance of this new instructional strategy. Additionally, course evaluations demonstrated that students accepted the transition. The most encouraging anecdotal evidence was that when students entered new courses following this module, they were frustrated by the lack of self-directed and active learning and requested that the course adopt TBL methods.

The transferability of this teaching strategy seems to have potential throughout many courses in the pharmacy curriculum including biostatistics, pharmacy administration, pharmacotherapy, and experiential education. In addition, the TBL method would be practical for other colleges of pharmacy with either single or live multisite campuses. Since distance learning is being implemented at several colleges of pharmacy settings around the country, the ability to engage students in active learning makes this instructional strategy particularly advantageous in this setting.

CONCLUSION

The TBL format has been successfully implemented and sustained within an endocrine module with the key goals of promoting self-directed learning, student accountability, and knowledge application. Additional benefits are fostering teamwork, increasing faculty-student interactions, improving faculty member feedback on content and the problem-solving process, increasing opportunities to practice higher-level thinking, engaging students at both live and distant campuses, and developing skills for students to become lifelong learners. In conclusion, TBL is a viable active-learning instructional strategy for large student-faculty ratios and distance education environments that could be easily adapted for other courses and curriculums.

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