

INSTRUCTIONAL DESIGN AND ASSESSMENT

Integration of Team-Based Learning Strategies Into a Cardiovascular Module

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Objectives. To integrate components of team-based learning (TBL) into a cardiovascular module to increase students' responsibility for their own learning and actively engage students across 2 campuses in patient cases.

Design. An existing cardiovascular course module was modified by replacing 8 hours of lectures with self-directed learning (SDL) assignments and transforming case discussion sessions using TBL methodologies. Case discussions were delivered using TBL methods to increase engagement of all students across both campuses while maintaining a low faculty-to-student ratio in the classrooms. Readiness assurance quizzes were performed with each SDL assignment and TBL case session.

Assessment. Student and faculty satisfaction improved with the addition of SDL assignments and TBL cases without adverse effects on grades in the wake of the 14% decrease in lecture time. Total faculty time required increased primarily in the first year because of development of course materials.

Conclusion. A modified TBL format was successfully integrated into a lecture-based cardiovascular module, resulting in improved student and faculty satisfaction with the course and no adverse effect on student performance.

Keywords: cardiovascular, distance education, self-directed learning, team-based learning, active learning

INTRODUCTION

Integrated course modules are often used in pharmacy curriculum to teach pathophysiology, pharmacology, medicinal chemistry, and therapeutics for each organ system.¹ These content-rich courses often use active-learning strategies, such as cases, to facilitate content integration and teach problem-solving skills.

In 1998, the University of Oklahoma College of Pharmacy implemented a series of 10 pharmaceutical care modules to integrate the teaching of pathophysiology, pharmacology, medicinal chemistry, and therapeutics according to organ systems or major topic areas. In 2002, the program expanded from a single campus in Oklahoma City with 80 students to include a second campus in Tulsa, with an additional 60 students. This presented the challenge of learning to teach the course using distance, synchronous-learning technology as well as the challenge of teaching to a larger class.

Module coordinators and faculty members were allowed the flexibility to choose the teaching method they

preferred. However, the variations in teaching methods often made it difficult for students to understand the expectations of the various faculty members teaching the modules. The cardiovascular module, second in the series, had expanded over the years to include the many new therapies and increased knowledge in the field. The addition of a distant campus presented new challenges such as how to optimally employ active-learning strategies simultaneously to a larger number of students. The faculty members also needed a solution for how to devote adequate time to both content and application and do so within the course time allotted, while engaging students on both campuses in active learning. In response to these challenges, the faculty members integrated components of team-based learning (TBL) strategies within the lecture-based cardiovascular module.

Team-based learning consists of 3 repeating phases: preparation, application, and assessment. In the preparation phase, students are required to complete an out-of-class reading and then are tested at the beginning of the next class to assure they adequately reviewed the reading. In the application phase, teams of students practice real-world problems within small groups followed by discussion within the class, with feedback on team responses provided by faculty members. The final phase is assessment of student learning.

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Several elements of TBL instructions are supported by the 2007 standards set forth by the Accreditation Council for Pharmacy Education (ACPE). Requiring students to complete out-of-class readings in the preparation phase of TBL addresses the standard for encouraging students to transition from dependent to active, self-directed, lifelong learners and assume responsibility for their own learning. The application phase of TBL meets ACPE standards for teaching students to integrate and apply learning while developing and modeling critical thinking and professional judgment skills. Additionally, TBL addresses the ACPE standard for programs using synchronous, distance learning to employ techniques to keep learners actively participating with the content, instructor, and their fellow students at the other campuses.³

TBL was originally developed in business schools.² This instructional strategy also has been used in medical education as well as in other health sciences, with positive learning outcomes.⁴⁻⁸ Specifically, TBL provides the most benefit to low-performing students probably because it requires continual study of the course material to pass readiness assurance quizzes and participate effectively in small-group assignments.^{6,7} At the University of Oklahoma, traditional lectures were eliminated from the endocrine module and it was successfully transformed to exclusively TBL instruction.⁶ As a result, faculty members of the cardiovascular module realized that student engagement at 2 campuses could be better achieved using TBL strategies. Given that the cardiovascular module is taught second in the course series, a modified TBL approach was implemented, incorporating the key components of TBL while retaining significant lecture hours to optimize student learning. The objectives for revising this module were to increase students' responsibility for their own learning and actively engage all students simultaneously at both campuses in patient cases. To our knowledge, this is the first published report of integrating TBL strategies within a lecture-based course in a pharmacy curriculum.

DESIGN

Course Background

The cardiovascular module was offered to second-year pharmacy students during the spring semester. The course was team-taught by 4 basic science faculty members and 4 pharmacy practice faculty members and focused on commonly encountered cardiovascular disorders. It followed the first pharmaceutical care module, which was a health module that focused on general health and wellness topics such as immunizations and nutrition. The other courses preceding the cardiovascular module covered the basic sciences and an introduction to pharmacy

practice, providing a foundational knowledge base. The cardiovascular module was the first course to fully integrate basic and applied clinical sciences for an organ system. As such, this introduced the students to a higher level of thinking and problem solving and began the transition to thinking and functioning as health care professionals. Since it was a transitional course in the curriculum, the module faculty attempted to provide a smooth transition while developing students' time management, self-learning, and critical-thinking skills that required integration of concepts.

The cardiovascular module was a 4-credit hour course taught over 7 weeks primarily using traditional didactic lectures followed by non-graded case studies for each major topic. No routine delivery method was used for these active-learning case exercises, resulting in students completing the cases either individually or within groups and answering the cases either prior to or while in class. During case discussions, faculty generally solicited responses from students individually, resulting in 1 student answering a question while the remaining 139 students listened passively. These inconsistent methods led to concerns about student preparation and engagement in the intended active-learning process. In addition, student evaluations expressed concerns about the lack of a routine case delivery and suggestion that a more consistent approach might improve performance and understanding. During each case discussion, a second faculty member was assigned as an observer to assure appropriate student conduct and participation on the distant campus. Throughout the course, students were assessed with multiple unannounced quizzes. The module had run under this initial structure for delivery and assessment for 6 years (2000-2005) with overall good student performance and satisfaction.

Revised Course Module Format

In 2006, a decision was made to begin adding modified components of TBL targeted at encouraging student self-learning and improving active-learning strategies. Self-directed learning (SDL) assignments and assessments were added with the expected outcome that students would become responsible for their own learning by transitioning from passively listening during lectures to actively studying material independently, thereby promoting skills for lifelong learning. This also allowed for a reduction in classroom hours by 14% for content that could be mastered by students' self-study of materials and returned the number of classroom hours to the appropriate number for the credit hours earned for the course. Using TBL methodologies, case studies were standardized to improve the engagement and participation of all students

within their small teams and through faculty-led class discussions.

Content

Self-directed learning (SDL) assignments. In 2006, SDL assignments were added to the cardiovascular module. The total lecture hours were reduced from 58 to 50 to give students time out of class to complete their SDL readings. The faculty members identified topics that were either considered to be of low-complexity (used early in the course) or high-complexity (taught later in the course) for SDL assignments. Low-complexity SDL assignments consisted of self-study handouts on hypertension pathophysiology, cardiovascular tests, and thromboembolic prevention with surgery and heart valve replacements. High-complexity SDL assignments required students to review handouts in advance of therapeutics lectures for ischemic heart disease, heart failure, and dysrhythmias. This allowed students to pre-study the material ahead of the complex lecture so that more discussion and understanding could take place. To guide the students' self-study, all SDL assignments included learning objectives using lower-level Bloom's Taxonomy to be assessed on the SDL quiz and higher-level Bloom's Taxonomy to be mastered by the examination following the lectures and case discussion on the topic.⁹ Generally, each week the students were assigned an SDL reading to review outside of class that was followed by an SDL assessment in class.

Team-based learning (TBL) cases. In 2007, the cardiovascular module transformed the case discussion sessions utilizing the principles of TBL. Each TBL session was allotted a 3-hour timeframe and was conducted at the conclusion of the lectures and SDL assignment for each major course topic. There were 6 TBL sessions covering hypertension, dyslipidemia, thromboembolic disorders, ischemic heart disease, heart failure, and dysrhythmias. Each TBL session began with a quiz to assure students were ready to participate in the day's activities, and the remaining time was devoted to TBL patient cases.

At the beginning of the TBL patient cases, students picked up their team folder labeled with the team number containing answer cards (A-D) and the patient cases. Students worked in teams of 5 to 6 individuals with 14 teams at the Oklahoma City campus and 9 teams at the Tulsa campus. Two faculty members were required to conduct each TBL session: 1 to serve as the content leader and 1 to facilitate on the alternate campus. The faculty leader shared the case keys with the faculty facilitator prior to each session. The faculty leader would begin the session by reviewing a case with the class and posing a question with 4 possible answers. Many times, more than one concept was assessed in a question to allow the faculty

member to cover multiple key points. A sample case question is provided in Table 1. The teams were given 5 to 7 minutes to discuss and record their answers, with justification provided for each option explaining why it was correct or incorrect. Students were encouraged to use their class notes, textbooks, and Internet resources to aid in answering the cases. During these team discussions, the faculty member on each campus circulated among the teams to answer questions and observe participation. At the conclusion of this time, the faculty leader instructed the teams to post their answer cards, provided a summary of team responses, and led a class-wide discussion for the case question. The faculty leader called on volunteers to explain why their team had or had not chosen certain options. In a controlled manner, the teams debated and defended their answers. Team participation was graded to incentivize students to volunteer to answer questions. When the 5-10 minute discussion was complete, the faculty leader summarized the final answer to the question and corrected any misunderstandings, then directed the teams to move on to the next question. A maximum of 3 questions per hour was usually optimal, so each TBL case session typically had 8 to 9 questions.

EVALUATION AND ASSESSMENT

Assessment Methods

Students were assessed by various methods, with each comprising a percentage of their final grade, including SDL quizzes, 8%; TBL quizzes, 16%; TBL participation and cases, 3%; and examination scores, 73%. Students were given quizzes following each SDL assignment and at the beginning of each TBL session to ensure students were prepared to complete the application exercises and be a contributing member of their teams. The SDL quiz consisted of 5 multiple-choice questions on the given SDL assignment, and the TBL quiz consisted of 5 to 6 short-answer questions testing lecture and SDL materials related to the topic. In addition, students were assessed for participation within the team and class-wide discussions and for responses given on the written cases collected at the end of the TBL session. To keep faculty workload manageable, course coordinators randomly selected 3 to 4 teams to be graded in each session. Throughout the 7-week module of 6 TBL sessions, each group was graded 1 unannounced time. Student participation was graded by direct faculty observation (full participation points were awarded if the student was contributing to teamwork by serving as the scribe, looking up information, or providing verbal input to the team or class discussion, and no points if the student was not participating). Additionally, all team members received a grade on their team's written case responses based on a scoring rubric. The teams never

Table 1. Sample Team-based Learning Case Question on Thromboembolic Disorders Presented to Pharmacy Students Completing a Cardiovascular Module

RS is a 27 year old female who is currently a college student. She has no significant medical history. Medications include oral contraceptives. She is 5'7" and 60 kg. She began noticing progressive left leg swelling and discomfort over the past week. She presents to the ER on Saturday concerned that her symptoms are not improving. A Doppler ultrasound reveals a thrombosis within the popliteal vein of the left lower extremity. The ER physician prescribes fondaparinux 7.5 mg SC daily and warfarin 5 mg daily. She gets one dose of each in the ER and is given prescriptions to initiate outpatient DVT management. The ER physician stresses the importance of medication adherence to her upon ER discharge and instructs her to return to the ER if any problems arise. She presents to your pharmacy later that day with the 2 new prescriptions. You begin to process the prescriptions and note that you do not have fondaparinux in stock and that it is not on RS's formulary (requiring her to pay full retail price of \$750). What is the best action to take at this time?

- a. Tell RS that you are unable to fill the fondaparinux prescription because it is out of stock and refer her to another pharmacy.
- b. Call ER physician and suggest changing to her plan's formulary agent, enoxaparin, which you have in stock.
- c. Order fondaparinux and fill warfarin today. Instruct patient to return on Monday to pick up fondaparinux prescription.
- d. Instruct patient to go back to ER for hospital admission for treatment of DVT since you do not have fondaparinux and she would likely not be able to afford it.

Circle your answer and explain the reasoning behind your answer.

knew which week they would be graded, ensuring continued effort and participation. At the end of the course, students were notified of their participation and case scores.

In 2007, a multiple-choice format was adopted for all unit examinations to keep faculty workload manageable and provide consistency between the TBL case exercises and the course examinations. Examinations continued to include sections on pharmaceutical calculations, product knowledge, and comprehensive information in addition to core content. Questions were written at differing complexities throughout the examination to include basic, moderate, and high-level thinking. Many of the higher-level questions were complex cases similar to those practiced during the TBL case exercises.

Student Performance

Upon implementation of SDL assignments and TBL cases, student performance on class assessments was maintained with no statistical differences shown in comparison to the pre-implementation year of 2005 (Figure 1). In addition, average course grades and grade distribution were similar from 2005 through 2008; however, there were some trends that did not reach significance. After the incorporation of TBL cases in 2007 and 2008, there were no students with nonpassing grades (D's or F's) as compared to 2005 (2.7% D's and no F's) and 2006 (1.7% D's and no F's). In addition, the number of students earning A's decreased and those receiving B's increased in 2007 and 2008 compared to 2005 and 2006 (Figure 2). Specifically, the percent of students earning A's in the years 2005 through 2008 were 19.6, 22.5, 16.4, and 17.8, while the percent getting B's in 2005 through 2008 were 58.9, 56.7, 67.2, and 63, respectively. The influence of quizzes

changed from 2005 to 2008 after incorporation of the SDL assignments and TBL cases. The standard deviation of the unannounced quizzes in 2005 and the SDL quizzes in 2006 was wider than the SDL and TBL quizzes in 2007 or 2008, while the standard deviation of examination scores was similar throughout 2005 to 2008.

Course Evaluation

These course modifications were assessed to determine whether they met the desired outcomes for their implementation. Average quiz scores were 85.3, 87.6, and 86.3, in 2006, 2007, and 2008 respectively. Additionally, student performance on examinations further supported that students were able to learn this material by self-learning. During both 2007 and 2008, all students earned the full credit of 5 points on the individual participation score. Teams scored an average of 4.5 and 4.6 (out of 5 possible points) on written case responses in 2007 and 2008, respectively.

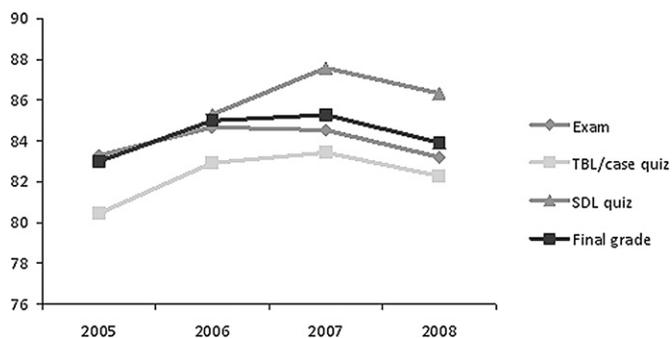


Figure 1. Averages on self-directed learning (SDL) quizzes, team-based learning (TBL) case quizzes, examinations, and final grades for 2005 through 2008

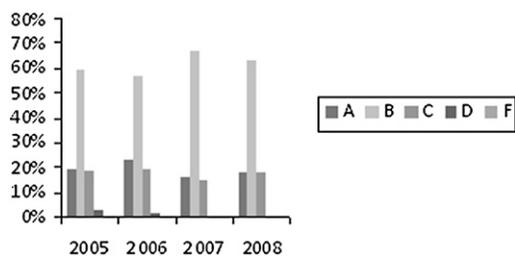


Figure 2. Distribution of final course grades, 2005 - 2008

Student evaluations were collected every year at the end of the module. Student grades were released after 70% of the class completed evaluations to assure an appropriate cross-section of student opinions were collected. In the first year, the class voiced resistance to SDLs mainly due to concerns regarding the relative weight of SDL quizzes towards the final grade. However, by the end of the module, students' comments were generally positive regarding the SDL assignments and quizzes as well as the TBL case discussions. The students' ratings of the course were higher in 2007 and 2008 (4.3 and 4.4, respectively, on a 5-point scale) after the addition of TBL cases compared to ratings in 2005 and 2006 (4.2 on a 5 point scale for both years). Summative evaluation comments reinforced that students were meeting the objectives and goals the faculty members set out to achieve by modifying the course.

Resource Utilization

Implementation of a modified TBL approach resulted in minor expenses and increases in faculty workload primarily during the first year of development. The only direct cost was for folders and laminated response cards for the TBL cases. Teaching materials were adapted from existing handouts, cases, and quizzes rather than creation of new materials. For the SDL assignments, previous lecture handouts were modified into detailed self-study documents, but assigning textbook reading was also an option. Teaching time was not increased as 2 faculty members already were assigned for each case session (1 per campus) and the class time for SDL quizzes and TBL patient case sessions was exchanged for the unannounced quizzes and unstructured case discussions, respectively. In fact, 8 hours of lectures were eliminated in exchange for SDL assignments, which reduced the teaching time. There was a small increase in faculty time spent on grading, but this was kept at a minimum by using Scantrons for quizzes and randomly sampling teams for participation and case grading.

DISCUSSION

Teaching the revised cardiovascular module using TBL instruction increased student's responsibility for

their own learning and improved engagement of students within patient case discussions across 2 distant campuses. TBL involves 3 steps of preparation (through preclass readings), application (through practicing problems within teams and then within the whole class), and assessment²; however, we elected not to fully transform the course using only TBL and instead took a modified approach, selecting those elements of TBL that would most benefit our students without placing a substantial burden on our faculty members. Given the early sequencing and complexity of the cardiovascular module, the faculty did not feel that students would best learn all the course content through independent reading. Therefore, this step was modified to require the students to complete SDL readings for 14% of the course content and maintained lectures for teaching 86% of the course content. TBL patient cases were modified only in the sense of how students were assessed. We elected not to require students' to complete peer evaluations on their team members and did not grade every team at every session for participation and written case responses. Faculty members observed students maintaining good participation within their teams and through class-wide discussion despite these activities only contributing to 3% of the total grade. Though effort was required, especially in the first year of development, course coordinators and faculty members as a whole did not feel like the course modifications resulted in a significant increase in faculty time. This was accomplished by modifying existing course elements and selecting specific components of TBL delivery to focus on course challenges while minimizing graded elements.

Course faculty members met in the semester preceding the module and agreed upon which elements to incorporate into the course to help ensure buy-in of participating faculty members. The module had experienced coordinators and faculty members that allowed for a more stable environment in which to make changes. Initially, there was 1 faculty member who was skeptical of the new delivery methods, citing concerns that they were not well proven as to the difference that they made in students learning. The faculty collectively agreed to try a modified TBL format in an attempt to address some of the class challenges with overextended lecture hours and inconsistent structure and poor engagement of the full class during case discussions. Course grades and student satisfaction were monitored closely to assess the impact on student learning. The most significant student barrier was the classes' initial resistance to the self-directed learning assignments. This is likely because they were being moved from passively sitting through lectures to being responsible and accountable for their own learning. The students eventually adapted to the course structure

and accepted the SDL assignments. Another obstacle noted was in the TBL case sessions. Faculty realized during the first couple of TBL sessions that more time had to be devoted to helping students understand the process and their expectations. Therefore, the first 2 TBL sessions had only 6 or 7 case questions instead of the usual 8 or 9 case questions.

Achievement of student learning was demonstrated through the maintenance of course grades similar to the year preceding the course change. After implementing both SDL assignments and TBL cases, all students earned passing grades suggesting a potential benefit for low-performing students, which is consistent with evidence showing a benefit to using TBL structures for academically vulnerable students.^{6,7} In addition, fewer students earned A's and more students earned B's, suggesting grades were not falsely inflated by the addition of TBL quizzes, participation, and case scores. Students' ability to learn the material through self-study was evidenced by SDL quiz grades and overall course grades. The quizzes having a narrower grade distribution in 2007 and 2008 likely can be attributed to fewer students performing in the very high and very low ranges in the years after incorporation of TBL strategies. The SDL and TBL quizzes could have both influenced the academically vulnerable and discriminated better among the academically gifted (ie, distinguished between A and B students). Learning from the use of TBL cases was primarily assessed through faculty observations of team discussions of cases and student answers provided in the class discussion. Faculty were most impressed by seeing students engage with the content with their small groups and then being able to see the students' thought processes through reviewing all the teams answers and hearing input on selection of the answers from many of the teams. The benefit seen with student participation in the TBL cases was likely at least partially impacted by these assignments being graded even though they were low stakes. Students were also likely more confident in sharing answers since they had previously discussed the answers with their team of classmates.

Student evaluation ratings and faculty comments were both favorable for the integration of TBL strategies within the module. Students were especially positive about the standardized process and expectations for case discussions. The faculty most commonly cited improved participation and engagement from the latter methods of very few (and often the same) students volunteering to the new TBL methods that resulted in the majority of the teams raising their hands to be called on to contribute to the discussion. The TBL case format allowed faculty to immediately see the answer of each team representing the

full classes' thinking and afforded the opportunity to call on teams with alternate answers to understand their thinking and selection and clarify any misunderstandings or misinterpretations on the spot. The faculty facilitator at the distant campus also noted a positive and more fulfilling change having moved from an observer role to a more active role of facilitation. Overall, the course faculty members were supportive of these changes and felt that they were aligned with the ACPE standards to enable students to be active, self-directed learners, to develop and model critical thinking, and to keep learners on distant campuses actively participating with the content, faculty members, and fellow students.

Future research is needed to provide further evidence of the value of TBL as a teaching methodology. Additional outcomes that should be assessed include the retention and transfer of knowledge gained from the SDL assignments by assessments later in the course and curriculum, as well as students' argument construction to show critical thinking and communication skills gained from TBL cases.

SUMMARY

At the University of Oklahoma College of Pharmacy, a cardiovascular module that integrated TBL strategies to require students on 2 synchronous distant campuses to assume responsibility for their own learning and engage them in active learning was successfully implemented. This was accomplished by adding 6 SDL assignments in place of 8 hours of lecture and modifying case studies to be structured using TBL principles. All classroom activities were supported by 1 faculty member per campus, thus maintaining low faculty-to-student ratios. Compared to pre-TBL implementation, student performance was maintained and student satisfaction with the module increased. Faculty members also were satisfied with the course modifications as evidenced by the continued inclusion of the SDL assignments since 2006 and TBL cases since 2007. Our experience shows that a TBL strategy can be modified and implemented to enrich a course, while retaining some lecture content. This innovative TBL approach could be applied to other courses and at other pharmacy schools.

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