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Assessing the Impact of Team-Based Learning

Joan Nicoll-Senft
Central Connecticut State University

The author details the implementation of team-based learning (TBL) in a graduate-level special education class. TBL use has grown in popularity in colleges of business and in the sciences; however, few applications of TBL in other areas of higher education are documented in the literature. A traditional lecture format was replaced by individual and team quizzes, application exercises, and individual and team assignments. Results from the analysis of data show that students performed significantly higher on the TBL team quizzes than they did prior to the application of TBL or during the TBL individual quizzes. The benefits and challenges of TBL are also discussed.

Introduction

Educational research has shown that college students tend to comprehend and retain complex concepts much longer when they become actively involved in the learning process (Chickering & Gamson, 1987; Johnson, Johnson, & Smith, 1991; Light, 1990). As a result, there has been a growing trend to incorporate instructional strategies that facilitate active student learning in higher education (Grasha, 2002), foremost among them being small-group instruction (Cheng & Warren, 2000; King & Behnke, 2005). There are three general approaches to the use of small groups that have been well defined in the literature on college teaching: cooperative learning, problem-based learning, and team-based learning (McInerney & Fink, 2003).

Cooperative Learning

Cooperative learning is defined as the instructional use of small

groups so that students work together to maximize their own and each other's learning. The essential components of cooperative learning are positive interdependence, face-to-face interactions, individual and group accountability, interpersonal and small-group skills, and group processing (Johnson, Johnson, & Holubec, 1993). One example of a cooperative learning technique is the jigsaw activity (Aronson, Blaney, Stephin, Sikes, & Snapp, 1978). Students are divided into small groups, and each student is assigned a specific task. After each student has completed his or her task, they meet with students from other groups responsible for the same task. After meeting, each student reports back to his or her original group. To ensure group accountability, this activity typically is followed by some form of assessment. Cooperative learning also typically involves providing students with clearly defined roles and responsibilities and with structured opportunities to reflect on and process their experiences in order to improve individual and group participation and performance. Training in small-group social skills is also frequently associated with cooperative learning.

Cooperative learning has become increasingly popular in higher education classrooms. Johnson, Johnson, & Smith (1998) reviewed over 160 studies comparing cooperative learning to traditional learning of students age 18 and older. Overall, these studies indicated that cooperative learning promotes significantly higher individual achievement than competitive or individualistic approaches.

Problem-Based Learning

Problem-based learning (PBL) is another popular approach to small-group learning. It involves the development of authentic and complex learning tasks as a format for students to work together, share their expertise, and learn from each other (Savery & Duffy, 1995; Scheiman, Whittaker, & Dell, 1989). The core characteristics of PBL were originally developed at the McMaster Medical School (Neufeld & Barrows, 1974). Barrows (1996) defines these characteristics as follows: (a) learning is student-centered, (b) learning occurs in small groups, (c) tutors serve as facilitators or guides, (d) authentic problems are presented prior to preparation or study, (e) problem-solving skills are engaged, and (f) new information is acquired through self-directed learning.

Problem-based learning originated in the training of medical doctors in an effort to develop self-directed learning and improve problem-solving skills (Barrows, 1983). Since its introduction in medical schools, PBL has been applied to several disciplines in higher education (Bridges, 1992; Camp, 1996).

Team-Based Learning

Team-based learning (TBL) is a relatively new form of small-group instruction that has grown in its application in college teaching over the past four years (Michaelson & Boyd, 2005). It is a highly structured teaching strategy that relies extensively on small-group learning. Fink (2004) defines TBL as an instructional strategy that is designed to support the development of high-performance learning teams and provide opportunities for these teams to engage in significant learning tasks.

Team-based learning differs from cooperative learning in that it does not necessitate the assignment of specific roles within a group. Proponents of TBL assert that as groups learn how to function effectively as teams, they naturally and automatically begin to manage their team's functioning themselves (Fink, 2004). Compared to PBL, TBL is more structured and encompasses strategies—specifically, individual and team quizzes—to hold students accountable for assigned outside readings. In contrast to the use of open-ended problems that form the foundation of PBL, TBL requires the instructor to develop in-class application exercises with very specific answers that are simultaneously reported by teams.

Central to the implementation of TBL is the design and implementation of procedures that transform small groups into teams. Michaelson (1983) has identified four principles of TBL. First, groups must be carefully formed by the instructor in order to maximize team performance and student learning. Second, students must be responsible for their individual and group work. It is imperative that students be individually accountable and not simply rely on their team members to learn the material. Equally important is that students be accountable not simply for their individual contribution to the group, but for all of the learning that occurs within their team. Third, in TBL, group assignments must promote both academic learning *and* team development. Structured opportunities are provided for students individually and collectively to reflect on and improve their team's performance. Finally, as in any optimal learning environment, students require frequent and timely feedback pertaining to their learning. In TBL, formal feedback from the instructor occurs via tests and graded assignments, and informal feedback from peers occurs via team quizzes and in-class activities.

Although large-scale research on the impact of TBL on student learning is limited, several successful applications of the strategy in undergraduate and graduate-level courses have been published. For example, McInerney and Fink (2003) implemented TBL in a senior-level undergraduate microbial physiology course. Passive lectures, which resulted in an emphasis on

memorization with little relevance to future applications, were replaced with weekly individual and team quizzes and team projects. Students' performance on a cumulative final examination improved significantly. Student evaluations also indicated that a greater number of students learned more with the implementation of TBL and that their independent critical thinking also improved.

Weeks (2003) applied TBL principles to a graduate-level course on electrical and computer engineering. In previous semesters students were presented with rigorous mathematical definitions, theorems, and proof sequences via lectures. In redesigning the course, Weeks implemented individual and team quizzes, student reflections, learning portfolios, and student presentations. Additional changes to the course included allowing students to resubmit homework to improve their score and an "intra-class design challenge," in which student teams competed to design and test the best computer code. Outcomes that Weeks reported as a result of these changes included increased student-to-student interactions and increased overall student participation. Student evaluations also showed an overall increase in instructor ratings across all variables measured.

White (1998) describes the application of TBL in a graduate-level accounting course. Students were assigned to heterogeneous groups and were responsible for downloading reading and discussion questions. Students read these materials outside of class and came to class ready to engage in small-group discussions about the assignment questions, which often dealt with controversial issues. The group discussions took the place of lectures. Students were responsible for keeping a binder that included copies of all of their group work, detailed records of each meeting, an attendance list, and a summary sheet. Grading was carefully planned to include attendance and class participation. In addition to quizzes, students were also graded on group presentations and written assignments. Students enrolled in course sections using TBL outperformed the students in sections using more traditional methods of instruction taught by the same instructor.

Team-based learning appears to be an appropriate methodology for teaching many college courses that cover a wide range of factual knowledge combined with a focus on applying this knowledge to real-life situations. Thus, it would seem TBL would have applications across multiple disciplines at both the undergraduate and graduate level.

The use of TBL appears to be expanding in colleges of business and in the sciences. Few applications of TBL in other areas of higher education have been documented in the literature, however. This may be due to the amount of preparation time required to redesign a course using TBL.

The purpose of this study was to assess the impact of TBL on a 3-credit graduate-level class in special education. Because assessment in special education is grounded in collaboration and teams, my interest in using TBL for this particular course was inspired by the method's emphasis on these techniques. The class met once a week for 2 hours and 40 minutes. Of the 14 students (12 females and 2 males), the majority were certified general education teachers pursuing a masters degree in special education.

Method

I used Fink's approach to course design (2003) to plan initial course goals, subsequent course topics, and learning activities. The foundation of Fink's approach is the development of goals based on a taxonomy that goes well beyond rote knowledge toward the development of reflective students responsible for their own learning. Course goals were developed to address each of Fink's six dimensions of learning in higher education: "Foundational Knowledge," "Application," "Integration," "Human Dimension," "Caring," and "Learning How to Learn" (see Table 1 for a list of course goals and how they were assessed).

After determining course goals, I made significant changes to the instructional design of the course. These changes included the assignment of students to heterogeneous teams, the development of individual and team quizzes based on readings to be taken prior to class instruction, the development of related in-class application exercises, and the creation of individual and team assignments.

Team Assignments

During the first class meeting students were assigned to four permanent heterogeneous teams (two teams with four members and two teams with three members) based on each student's prior experience in teaching and assessment. One of the first responsibilities of each team was to select a representative to assist in the determination of overall course grade weights (Michaelsen, 1983). Together, team representatives negotiated what percentage of their grade would be determined by individual assignments, team assignments, and team maintenance (peer feedback on each student's contribution to their team). Through this process the class agreed on the following grade weights: 35% for individual assignments, 35% for team assignments, and 30% for team maintenance. Each of the four teams received a color-coded canvas container to organize their team's

Table 1 Course Goals Using Fink's Taxonomy		
<i>Taxa</i>	<i>Course Objective</i>	<i>Assessment</i>
Foundational Knowledge	Demonstrate the appropriate application and interpretation of scores, including raw scores, standard scores, and percentile ranks.	Individual and team quizzes; written report
	Explain procedures for screening, pre-referral, referral, and classification of students with disabilities.	Individual and team quizzes
	Report assessment results to individuals with disabilities, their parents, administrators, and other professionals.	Presentation of final report
Application	Demonstrate the ability to select appropriate criterion and norm-referenced assessments.	Assessment plan
	Demonstrate the ability to accurately and efficiently administer standardized assessment.	Performance-based assessment (in-class administration of assessment)

Integration	Demonstrate the ability to interpret data from formal and informal assessment instruments that result in the development of comprehensive and effective educational recommendations.	Final report
Human Dimension	Demonstrate the ability to collaborate with others in the selection, administration, and interpretation of assessments.	Team maintenance (peer feedback on contributions to team)
Caring	Demonstrate an overall understanding and appreciation of the assessment process and its role in the development of appropriate educational programs for students with disabilities.	Reflection paper
Learning How to Learn	Demonstrate an understanding of how to “keep current” pertaining to issues related to the assessment of students with disabilities.	Reflection paper

course materials throughout the semester. Each team was also provided with a color-coded folder to record individual and team quiz scores, a color-coded marker and a small dry erase board for in-class application exercises, and a handheld computer for administration of team quizzes.

Individual and Team Quizzes

Students took quizzes individually and as a team. Each quiz consisted of 20 multiple-choice questions. When students completed their quiz individually, they turned in their answer sheet and joined their teammates to take the same quiz as a team using a handheld computer. Students received separate grades based on their individual and team performance on each quiz. In total, students participated in three individual and team quizzes throughout the semester.

Quizzler©, a software program from Pocket Mobility (www.quizzler-pro.com) that enables teachers to create quizzes for downloading onto handheld computers, served for administering the team-based quizzes. This software program gave students immediate feedback on their answers in a video game-like format and kept track of each team's correct and incorrect responses. While students worked on their team quizzes, I graded their individual quizzes. When teams completed their team-based quiz, they were able to transfer their scores to me using the infrared capabilities of their handheld computers.

Teams were responsible for recording their individual and team quiz scores in their team's file folder. I then posted each team's score on the board. If teams felt that any questions they missed on the team quiz were due to the quality of the question or inadequacies in their pre-class readings, they were able to negotiate for restored credit and an improved score using a formal written appeals process as described by Michaelsen (2004). Appeals were granted based on the strength of the team's written appeal. Additional points were granted only to teams that received approval through this process.

In-Class Application Exercises

Because students learned basic course content through the individual and team quizzes, the majority of class time was devoted to in-class application exercises. The purpose of the in-class application exercises was to provide the teams with opportunities to apply their learning from the pre-class readings. To facilitate simultaneous group reporting, Michaelsen (2004) recommends that in-class application exercises be designed so that

teams can respond to case studies or similar assignments using a simplified format, such as multiple choice.

The in-class application exercises I designed included applying statistical formulas to student assessment data, reading brief scenarios pertaining to assessment in special education and determining whether administration procedures were implemented appropriately, reading brief case studies and prioritizing action steps, and editing poorly written educational reports. In most instances, teams used their dry erase boards simultaneously to record and report their responses. This team response format enabled students to receive immediate feedback from both their peers and me.

Individual and Team Assignments

In addition to designing in-class application exercises I also developed a combination of individual and team-based assignments to facilitate each team's growth and development. Specifically, I wanted to avoid assignments that allowed for uneven student participation or that could be divided easily among team members for completion. Michaelsen and Knight (2004) have identified four key variables that determine whether or not a particular assignment will build group cohesiveness effectively: (a) a high level of individual accountability for team members, (b) the degree to which the assignments bring members into close physical proximity, (c) the potential to promote discussion among team members, and (d) the provision of timely feedback to team members.

Taking into account these variables, I created two team assignments: an assessment plan, due by mid-semester, and a final report outline due at the end of the semester. The assessment plan required each team to identify a student with a disability from the school in which members currently teach or a school affiliated with the university. Next, each team identified a battery of special education tests based on their identified student's academic strengths and needs. Each assessment plan included academic areas to be assessed, a list of selected assessment instruments, and a rationale for each identified instrument. Each team member was then responsible for administering one of the assessments identified in his or her team's assessment plan and submitting an individually graded written report.

After each student received feedback on his or her individual report, teams were required to develop a final report outline integrating all of their assessment data. One of the requirements for this assignment was that test data be reported by academic area, not by the test that was ad-

ministered. This required students to work together continually to make sense out of their assessment data. Second, students were required to compare each other's findings and provide hypotheses in an attempt to explain any discrepancies found in their assessment results. Finally, the team's recommendations needed to take into account all of their team's findings. I chose an outline format over a written report format for the final report to discourage the division of labor between students.

Students were allotted class time to collaborate on individual and team assignments. Outlines, rubrics, and exemplary samples of previous student assessment reports were also provided to students.¹

Results

Twelve students (86%) achieved higher scores on their team quizzes than on their individual quizzes. Two of the students (14%) achieved the same scores on their individual and team quizzes. The overall mean score for individual quizzes was 90.95%, while the mean score for team quizzes was 98.21%. On average, students scored 7.26 points higher on their team TBL quizzes than on their individual TBL quizzes. Differences between students' individual and team quiz scores ranged from 0-20 points, with a mean difference of 7.30%.

In order to assess the impact of TBL on student achievement, I compared these students' individual and team quiz scores to students' quiz scores from the fall 2004 semester, prior to the redesign of the course. The content of the quizzes was the same across both semesters. It is important to note, for comparison purposes, students in the 2004 course were allowed to use their notes and course text during quizzes, but those in the TBL course were not. This might lead one to assume that student scores from the previous semester would be higher than those from the redesigned TBL semester. This was not the case, however.

I compared students' mean quiz scores prior to and after course redesign as well as mean quiz scores from individual and team TBL quizzes using a one-way analysis of variance (ANOVA) at $\alpha = 0.05$.

Data analysis confirmed that the application of TBL had a significant effect on students' quiz scores, $F(2,34) = 11.65$; $p < .001$. Post hoc Turkey-HSD tests showed that students performed significantly higher during the TBL team quizzes ($M = 98.21\%$) than did those students prior to the application of TBL ($M = 90.56\%$) or than they did during the individual TBL quizzes ($M = 90.95\%$). No other differences were statistically significant.

A final point concerning the team quiz scores is that they represent only a fraction of each student's final grade for the course. As previously

described, each student received a separate grade for both individual and team quiz scores. In addition to their quiz scores, students received grades for their individual and team-based assignments. Finally, formal feedback from peers pertaining to each individual's group performance throughout the semester (team maintenance) also contributed to each student's final grade.

Students also were required to write a reflection paper addressing their strengths, weaknesses, and future goals pertaining to the course. I used Emergent Category Designation (Lincoln & Guba, 1985) to identify common themes pertaining to TBL in the students' papers. Six themes emerged as a result of this process: (a) the relationship between TBL and special education; (b) the overall structure of the course; (c) self-reflective comments pertaining to a student's perceived strengths and weaknesses; (d) outcomes of the course; (e) future goals; and (f) learning how to learn. Table 2 presents a list of sample student comments representative of these themes.

Discussion

Redesigning a college course using TBL involves changes to the entire course, including the development of classroom activities, student assignments and student grading. Since most of the factual knowledge is learned independently via outside readings and quizzes (individual and team), in-class application activities need to be developed to replace the traditional lecture format which is typical of many college courses. Keeping with the TBL model, these in-class activities also need to be designed to allow simultaneous team reporting. Because of the extent of redesign needed, the amount of preparation time to teach a course using TBL is significant.

Student personality clashes/disagreements can present yet another challenge in a TBL course. Instructors must be prepared to deal with potential group conflicts. Guidelines for how to address student conflicts must be carefully worded and shared with students in order to prevent such situations from occurring. It is also important to design individual and team assignments that ensure both individual and team accountability. I also found it extremely helpful to incorporate a peer feedback mechanism (team maintenance), which constituted one third of each student's overall grade for the course.

In my experience, however, the drawbacks of using TBL were outweighed overwhelmingly by its benefits, which included increased student learning, enhanced student-to-student discourse, and an overall improvement in students' self-directed learning. Students came

Table 2
**Categories Identified in Student Papers
 Via Emergent Category Designation**

<i>Category</i>	<i>Sample Student Comments</i>
The relationship between TBL and special education	Cooperative teamwork is a key component of special education.
The overall structure of the course	Through the team project I learned how important it is to collaborate and agree on further assessments, and then on further recommendations.
Self-reflective comments pertaining to a student's perceived strengths and weaknesses	This experience also helped me to realize my strength in working with a team. I was reluctant to allow my grade to be impacted by our team's performance, but I quickly learned that each team member's knowledge and input was valuable in making appropriate decisions.
Outcomes of the course	I am proud of the progress I have made in terms of becoming a competent special education assessment administrator and a contributing member of an assessment team.
Future goals	I would like to become more proficient at choosing appropriate tests and to continue to develop my analytical and report writing skills associated with different tests.
Learning How to Learn	I will continue to borrow tests from the special education library to practice testing adults and children. I will also seek out colleges that offer training/workshops in testing to further my experiences/knowledge.

prepared for class, eager to ask critical questions pertaining to their pre-class readings before each quiz. During team quizzes I observed students passionately defending and critiquing each other's answers. The in-class

application exercises provided individuals and teams with ongoing opportunities to apply their newly acquired knowledge. As a result of the individual and team quizzes, students were well prepared to engage in discussions and activities pertaining to the readings. Using simultaneous reporting via the dry erase boards enhanced the overall collaborative nature of these activities. Finally, the team assignments promoted a more sophisticated level of dialogue between team members because they needed to share detailed information with each other pertaining to their individual assignments in order to complete their team assignments successfully. On more than a few occasions these discussions and deliberations continued well past the class's official end time.

Due to the overall design of the course, students learned ways to work as a team to solve problems and overcome obstacles. In her final reflection paper one student wrote,

One of my weaknesses is my deep accent. I have difficulties making others understand me. I try to overcome this weakness by talking slowly but that is not always helpful. My group members have been patient with my accent and now manage to understand everything I say. The high peer interaction exercised in this course helped me with my communication skills.

In addition to negotiating problems, students achieved higher scores on their quizzes than did students in previous semesters despite the fact that they were not allowed access to their notes and text as in previous semesters. Another student wrote,

The individual and team quizzes forced me to memorize and familiarize myself with terms I normally would never have grasped over several years. At the time not all of what I studied stuck with me, but I remembered enough to build on. I not only know the basics now, but I have enough core understandings and resources to fill in the holes.

In her final reflection paper one student wrote, "This course was one of the best learning experiences I have ever had."

In terms of overall course management tasks, such as record keeping and grading, teaching a course using TBL actually was easier and less time consuming. Students were responsible for taking attendance and recording their individual and team quiz scores in their respective team folders. Team-based assignments also reduced the total number of papers I needed to grade throughout the semester. Finally, providing handheld computers for teams, as opposed to individual students, made the integration of state-of-the-art technology in the course manageable.

I plan to continue refining the use of TBL in this course. Preparation time will be reduced significantly when I teach the course in future semesters because much of the course preparation has already been completed. In conclusion, the amount of time to redesign this course was well worth the effort given the gains in student achievement and engagement.

Footnote

¹Two excellent resources for those interested in using TBL are Michaelson, Knight, and Fink's book, *Team-Based Learning: A Transformative Use of Small Groups in College Teaching* (2004), and the University of Oklahoma's Team-Based Learning homepage (<http://atlas.services.ou.edu/idp/teamlearning/index.htm>). The book provides detailed theoretical information about TBL as well as practical examples of TBL. The website contains classroom management tools to download for use in TBL classrooms, video demonstrations of TBL, links to other TBL websites, and an e-discussion group on TBL.

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Joan Nicoll-Senft received her Ph.D. in special education from Temple University and is currently an associate professor of special education at Central Connecticut State University, where she was recently a finalist for the university's Excellence in Teaching Award. A previous special education teacher, administrator and independent educational consultant, her current research interests include inclusive education, differentiated curriculum, and the scholarship of teaching and learning.