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In this chapter, we examine the relationship between the best practices of evidence-based teaching and the principles that constitute team-based learning.

Team-Based Learning

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In *Evidence Based Teaching* (2006), Petty built on a great deal of educational research (for example, Bransford, Brown, and Cocking, 2000; Marzano, 1998; see also Hattie, 2009) to conclude that the six best practices in evidence-based teaching (EBT) are:

1. Cooperative learning
2. Feedback or "assessment for learning"
3. Reciprocal teaching
4. Whole-class interactive teaching
5. Requiring concept-driven decisions
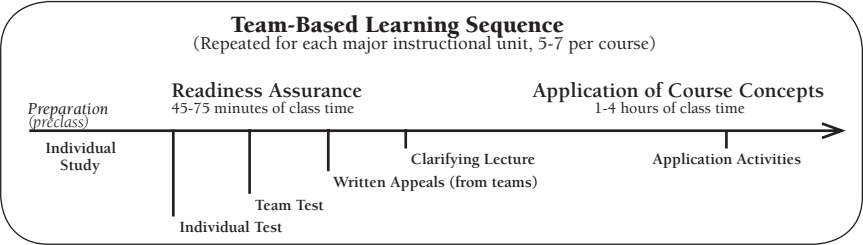6. Visual presentations and graphic organizers

Team-based learning (TBL), when properly implemented, includes many, if not all, of the common elements of these evidence-based best practices. To explain how, a brief overview of TBL is in order.

The four practical elements of TBL are:

1. Strategically formed, permanent teams
2. Readiness assurance
3. Application activities that promote both critical thinking and team development
4. Peer evaluation

(See Michaelsen, Knight, and Fink, 2004; Michaelsen, Parmelee, McMahon, and Levine, 2008.)

Table 1. Typical TBL Unit

Team-Based Learning Sequence
(Repeated for each major instructional unit, 5-7 per course)

Preparation (preclass)

Readiness Assurance
45-75 minutes of class time

Application of Course Concepts
1-4 hours of class time

Individual Study

Clarifying Lecture

Application Activities

Written Appeals (from teams)

Team Test

Individual Test

In brief, the rhythm of a TBL course works in this way: Students begin each unit of the course taking a short test over their understanding of the assigned prereadings. They then take that exact same test again as a team, getting immediate feedback on their team answers through the use of an Immediate Feedback Assessment (IF-AT) answer sheet. This immediate feedback reveals how well they thought and talked about the material and who among them may have the best grasp of it in the moment. Once the team test is completed, they can then write "appeals" to reclaim credit for incorrect answers when they feel they can cite evidence from the reading to make a case for their answer. After this readiness-testing experience, the teacher reviews the team scores to see which material is still unclear to the class and lectures briefly on that material. Students then complete one or more higher-level application exercises in which they apply what they learned during the readiness tests to complex problems or case studies. This process repeats for each unit of the course, with students filling out peer evaluations for members of their team a few times over the course of the term. A typical TBL unit is illustrated in Table 1.

By design, this sequence of activities shifts the focus of class time away from nearly 100 percent content "delivery" to students actively helping each other learn how to apply the content. Experience has shown that by increasing preclass teaching and peer instruction, TBL enables instructors to achieve equal or better content coverage and still use 70 to 80 percent of class time with students engaged in activities that deepen understanding of how course content applies to real-life situations and problems. In addition, TBL uses peer assessment and feedback both to increase team members' accountability to one another and to develop students' team problem-solving and decision-making abilities.

Four Essential Elements of TBL

Each of the four practical pillars of TBL can be implemented to make use of the best practices of evidence-based teaching.

Strategically Formed, Permanent Teams. Although the first essential element of TBL is strategically formed, permanent teams, TBL

practitioners tend to be wary of being grouped with those who practice "cooperative learning." This wariness stems from the fact that, although both TBL and cooperative learning use small groups, there can be more differences than similarities in the way groups and group activities are managed. For example, cooperative learning techniques such as the jigsaw or constructive controversy are activities that can be dropped into an otherwise traditional, lecture-based course. TBL, however, is a comprehensive instructional system that, when implemented correctly, achieves an increasingly interlocking synergy and amplifies students' social and intellectual capacities over time.

However, using Petty's (2006) definitions, TBL very clearly qualifies as an example of cooperative learning. Specifically, Petty (p. 150) described the characteristics of cooperative learning as students sinking or swimming together, students working interactively, students having a goal to learn and a goal to help other students in their group, students learning how to cooperate effectively, and the teacher holding students accountable.

In TBL, the instructor organizes permanent teams of five to seven students in the first week or two of the term. Many of the differences between cooperative learning and TBL stem from the fact that all of the listed characteristics are much more apparent with strategically formed, permanent teams than with the temporary groups that are used for most applications of cooperative learning.

Readiness Assurance. After students have been organized into teams, each unit of the course begins with a four-step process called the readiness assurance process (RAP).

1. *Prereading by students outside of class.* This includes podcasts and other forms of media.
2. *Individual readiness assurance test (iRAT).* This is a short, basic, multiple-choice test about the preparation materials.
3. *Team readiness assurance test (tRAT).* Once students turn in their individual tests, they then take the exact same test again, and must come to consensus on their team answers. Importantly, teams *must* get immediate feedback on their performance, currently best achieved using scratch-off forms in the immediate feedback assessment technique (IF-AT).
4. *Appeals.* When teams feel they can make a case for their answers marked as incorrect, they can use their course materials to generate written appeals, which must consist of (a) a clear argumentative statement and (b) evidence cited from the preparation materials.

The RAP is followed by a clarifying lecture, in which the teacher targets information that the tRAT scores show students do not yet understand (for example, "All the teams got questions 1 to 5 correct, so that material

can be considered 'covered,' but questions 6 to 10 were hit and miss, so let me explain that material a bit more.")

The RAP makes use of several of EBT best practices, primarily *feedback* (assessment for learning) and the principles that underlie *reciprocal teaching*. The purpose of the RAP is not only to motivate students to come to class prepared but also to give them several experiences of feedback on their grasp of assigned material. The key to RAP's success is providing immediate feedback on the tRAT. Currently, immediate feedback is accomplished most often using cards that students scratch like lotto tickets (IF ATs), with the correct answer identified by a star. IF ATs give teams real-time feedback on every team decision and enable teachers to award partial credit when teams require more than one scratch to discover the correct answer. (See Figure 1.)

The benefit of the IF AT is that it provides many rounds of low-stakes, formative feedback in a very short period of time. What may be not so obvious is the extent to which the tRAT stimulates students to interact in much the same way as they would in a formal reciprocal teaching situation. In their search for correct answers, students invariably alternate in and out of a teacher's role by asking each other the kinds of questions that the teacher normally would ask. For example, on any given question, students might ask each other to make predictions, explain their rationales for those predictions, and clarify their different understandings of the material. This interaction pattern is illustrated by an excerpt from a recorded transcript during a tRAT in an undergraduate educational psychology class (Sweet and Pelton-Sweet, 2009, p. 36).

Student 4: I put A.
Student 6: Well, I'd go with A. I put D but—
Student 1: I put D too, but . . .
Student 2: I put D.
Student 3: I put D, but . . .
Student 4: Well!
[group laughter]

Figure 1. Immediate Feedback Technique (IF-AT) Form

Student 4: Well, then someone argue for D and then someone argue for A, and we'll figure it out.

Student 6: I don't even have a good argument.

Student 1: It just seems more logical to me, that's all. D sort of seems more logical, but . . .

Student 4: Yeah, I just, I remember reading A and not D. That's the only thing why I would not change it.

Student 1: Yeah, if you remember reading it. I would be willing to trust your reading it more than my logic.

Student 6: Yeah, we're just trying to justify it.

In this excerpt, Student 4 was not assigned to play the role of the teacher—TBL pointedly does *not* recommend the assignment of group roles—but she briefly assumed the teacher's role by proposing an inquiry-based task to the group: "Someone argue for D and then someone argue for A, and we'll figure it out." In the next few statements, students evaluated their confidence in the sources of their opinions ("I would be willing to trust your reading it more than my logic") with Student 6 even stating that the purpose of this exercise is that "we're just trying to justify it." Although these particular statements do not fall crisply into the categories of predicting, summarizing, and clarifying as prescribed by the formal regimen of reciprocal teaching, they nonetheless structure the interaction and help students coregulate one another's learning in much the same way by alternating teacher and student roles.

After the RAP, the teacher is prepared to deliver, and students are eager to receive, a highly targeted clarifying lecture. The teacher can look at team scores on the RATs and say, for example, "Every team got questions 1 to 5 correct. That material has been covered." Students either learned it from the readings or taught it to each other. When teams struggle with a particular concept, the instructor is able to engage in "whole class interactive teaching" (Petty, 2006) because, at this point, students have been *primed* by feedback on the RAP to listen actively and zero in on exactly the parts of the content they do not understand. At this point the teacher can do one of two things. The ideal strategy is to conduct a class discussion in which teams that correctly answered challenging questions can explain their answers. The other strategy is that, when students' explanations are inadequate, the teacher can deliver a straight-up corrective and/or explanatory lecture.

4-S Application Activities. Having completed the RAP and received whatever clarifying, whole-class interactive teaching was required, teams then apply the knowledge they have acquired to carefully designed 4-S application activities. These activities work best when they require teams to:

1. Address a **<u>Significant problem</u>** that demonstrates a concept's usefulness.

2. Make a **<u>Specific choice</u>** among clear alternatives (for example, Which of these is the *best* example of X? What is the *most* important piece of evidence in support of Y? With which statement would the author *most* agree?).

3. Work on the **<u>Same problem</u>** as other teams, so each team will care about the conclusions and rationales of the other teams.

4. **<u>Simultaneously report</u>** their decisions, so differences among teams can be explored for the optimal instructional effect. Some of the most common approaches for simultaneous reporting include having students:
   a. Hold up lettered and/or colored cards that correspond to specific choices.
   b. Record a short answer on an index card and display their cards simultaneously on a document camera.
   c. Write their choices on flip-chart paper and simultaneously post them for review and critique by other teams (for example, see the concept map in Figure 2).

Although the details of implementing 4-S application activities are unique based on factors such as subject matter and class size, 4-S's are wholly consistent EBT best practices. For example, because all 4-S activities require teams to make specific decisions, even though not all of them involve a card-sorting game, they can be said to employ a general form of the "Decisions, Decisions" learning structure (Petty, 2006). That said, some 4-S applications do involve sorting cards. For example, King (2010) distributed cards with pictures of an infant in various positions and required

Figure 2. Representative Concept Map Generated by TBL Teams

	All relevant concepts are included and are correct		Most relevant concepts and mechanisms are included and are correct	Few relevant facts or concepts are included or correct
Content				
Points	6	5	4 3	2 1
Logic and understanding	Understanding of facts and concepts is clearly demonstrated by correct links and active verbs		Understanding of facts and concepts is demonstrated but with some incorrect links and/or missing active verbs	Poor understanding of facts and concepts with significant errors in links and active verbs
Points	6	5	4 3	2 1
Presentation	Concept map is neat, clear, legible, has easy-to-follow links, and has no spelling errors		Concept map is neat, legible but with some links difficult to follow and some spelling errors	Concept map is untidy with links difficult to follow and spelling errors
Points	3		2	1

teams to sort them according to various criteria—the most basic being normal or abnormal (for example, when lying on their backs, infants of a certain age should habitually face forward and keep their head centerline to their body; dropping their heads and looking to one side or another is a sign of abnormal development).

Similarly, many teachers use 4-S application activities that require teams to complete graphic organizers or concept maps, thereby implementing the EBT practice of visual presentations or graphic organizers. For example, Restad, Onion, Reynolds, and Sweet (2010) had teams fill out "argument templates" that required them not only to gather evidence from the readings, but also use that evidence to take a stand on a given statement. An example is shown in Table 2.

Table 2. Argument Template Example

The McCarthy Era: What Were the Fears? How Real Were the Fears?

I. WHAT FEARS DO EACH OF THE FOLLOWING PRIMARY SOURCE DOCUMENTS CALL INTO PLAY?

Be as precise as possible in describing each of the fears.

Source	Specific fears
A. "Duck and Cover"	
B. *Communism*	
C. "Hiss and Chambers"	
D. "Is This Tomorrow"	

II. THE BEST EVIDENCE. Rank the "sources" 1 (strongest) – 4 (weakest) in response to each of these statements:
1. The most balanced and reputable information about the early Cold War period
2. The most useful for understanding era

Source	1. most balanced	2. most useful
A		
B		
C		
D		

III. HISTORICISM versus PRESENTISM
Referring to the above documents, the readings, and your knowledge of Cold War events, agree or disagree with the following statement. Write a short (no more than 25 words) justification for your answer that reflects the team's best "history essay" style.
"The hysteria and restriction of civil liberties during the Cold War was justified."

AGREE / DISAGREE

Another popular form of visualizing TBL course content is to ask teams to generate concept maps in response to a given prompt. For example, Thompson, LeClair, Winterson, and Manyan (2010) received the concept map shown in Figure 2 from a team diagramming the primary and secondary biochemical effects in the case of an eighteen-month-old infant with medium-chain acyl-coenzyme A dehydrogenase deficiency. Teams then critiqued one another's concept maps with different colors representing primary and secondary effects. Then teams critiqued each other using the rubric shown to the right.

Application activities can be graded or ungraded and need not have a "correct" answer. Although it may seem difficult to grade a concept visualization, Thompson and others (2010) developed an elegant rubric with which to grade team-generated concept maps.

Once teams produce their decisions—either in simple form by holding up cards indicating A, B, C, D or producing more complex output, such as a graphic organizer or concept map—the teacher again has the opportunity for a rich round of whole-class interactive teaching. The fact that students can see each other's specific choices in relation to the same problem, they are both prepared and motivated to challenge each other's choices and defend their own. As a result, the teacher need only invite the teams to inquire about each other's rationales to begin what will inevitably be a content-rich class discussion that he or she will typically conclude by confirming the points that students have already made and adding his or her own insights and/or providing corrective instruction when it is needed.

Peer Evaluation. Peer evaluation is the fourth and final practical element of TBL, providing students with both formative and summative feedback from their teammates about their contributions to the team and its success. Whereas members of a group feel mostly accountable to an outside authority, team members also feel accountable to each other, and peer evaluation is a mechanism by which the teacher can stimulate that experience in one's students.

As Petty (2006) noted, the format of feedback is important so that it is informative and not judgmental. Therefore, many TBL teachers have students fill out peer evaluation forms that ask them to express things they "appreciate" about their teammates and things they "request" (see Table 3). This language is carefully chosen so as not to stimulate attacks or judgments but instead promote constructive peer feedback. Students submit these forms to the teacher, who then processes the feedback and e-mails it to each student. Because the teacher knows who said what to whom, the feedback tends to be civil and constructive. However, because students do not know the specific source of the comments they receive, team members are more likely to be honest in giving negative feedback when it is called for.

Table 3. Sample TBL Feedback Form

Team Reflection and Feedback   Team#_____   Name_____

To help your team become more effective, give your teammates some <u>anonymous</u> feedback.

Consider such things as:

- *Preparation:*   Were they prepared when they came to class?
- *Contribution:*   Did they contribute to the team discussion and work?
- *Gatekeeping:*   Did they help <u>others</u> contribute?
- *Flexibility:*   Did they listen when disagreements occurred?

You have 25 points to distribute among your teammates. These are anonymous, so be honest. :-)

1. Team Member Name:	Points
Things I appreciate about this team member:	
Things I would like to request of this team member:	
2. Team Member Name:	Points
Things I appreciate about this team member:	
Things I would like to request of this team member:	

. . .

Evidence for the Effectiveness of TBL

One strong, although indirect, set of evidence for the effectiveness of TBL is the extremely close fit between TBL and virtually all of the prescriptions common to the best practice approaches identified by Petty (2006). In fact, in many cases, TBL goes beyond the specific prescriptions in ways that promote consistency *across* the entire set of the best practice approaches. For example, a common practice of "Decisions, Decisions" involves assigning students to specific roles to ensure differences of opinion as they attempt to reach a decision that affects multiple parties. By contrast, TBL creates differences of opinion by using 4-S application assignments that require students to make decisions about what they think is the best answer to a highly complex problem and then have their choices immediately challenged by other teams that have reached a different conclusion.

TBL benefits students in three ways.

1. The positions they are defending are truly authentic.
2. Consistent with all best practice approaches, as long as they do not get

discouraged and give up, students learn more as the questions they face become more difficult.

3. Because TBL explicitly harnesses the power of real teams, teachers are able to provide decision tasks that would be overwhelming for individual students and that are too difficult for most learning groups.

Given the consistency between TBL and EBT best practices, it is not surprising that TBL produces a wide range of positive outcomes. Since initial studies nearly thirty years ago (for example, Wilson, 1982), the volume of literature about TBL's effectiveness has accumulated across a wide variety of disciplines in dozens of countries worldwide and has grown too large to be well summarized here. The best we can do in this limited space is to describe the breadth of the landscape across which TBL has been found to produce positive results. To date, empirical studies of TBL have reported increased test performance (Koles, Stolfi, Borges, Nelson, and Parmelee, 2010), attendance/engagement (Shankar and Roopa, 2009), retention (Wilson, 1982), student attitudes toward group work (Clark, Nguyen, Bray, and Levine, 2008), student satisfaction with their learning experience (Beatty and others, 2009), and coregulated learning (aka team "synergy") (Watson, Michaelsen, and Sharp, 1991). In addition, because of increasing use of TBL and its focus on active student engagement and outcomes achievement, several schools using TBL have been cited as promoting exemplary teaching practice by visiting teams from their respective accreditation agencies (S. Doscher, personal communication, 2010; M. Sinclair, personal communication, 2010). The two best sources for a more complete listing of empirical studies of TBL are the bibliography at the online Team-Based Learning clearinghouse (www.teambasedlearning.org) and Wright State University's database of medical education TBL scholarship (www.med .wright.edu/aa/facdev/tbl/ArticleAppl.htm).

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