6

The purpose of instructional technology is to make things possible that are otherwise not, or to make easier things that otherwise are difficult. This chapter describes a few of the tweaks to team-based learning that the authors have developed using technology.

Technological Alternatives to Paper-Based Components of Team-Based Learning

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We have been using components of team-based learning (TBL) in two undergraduate courses at the University of Texas for several years: an educational psychology survey course—Cognition, Human Learning and Motivation—and Introduction to Statistics. In this chapter, we describe how we used technology in classes of fifty to seventy students to improve the implementation of three key TBL activities: readiness assurance tests, reporting complex team assignments, and providing feedback on peer evaluations.

Readiness Assurance Tests

For a number of years, we used the individual-plus-team-testing sequence for the readiness assurance process (RAP), including the immediate feedback assessment technique (IF-AT) forms, and experienced a number of positive learning and team development outcomes along the lines of those described elsewhere in this volume. However, we also encountered several problems that led us to consider a technology-based alternative to paper tests and IF-ATs.

Problems with Paper Tests and IF-ATs. We encountered problems with paper tests and IF-ATs in four areas: logistics, the potential for cheating, test security, and problems with the forms themselves. Even with team

NEW DIRECTIONS FOR TEACHING AND LEARNING, no. 116, Winter 2008 © Wiley Periodicals, Inc.
Published online in Wiley InterScience (www.interscience.wiley.com) • DOI: 10.1002/tl.335

folders (see Michaelsen, Knight, and Fink, 2004), ensuring that each student receives and returns a copy of the test and answer sheet becomes difficult as class size increases. This task is complicated for instructors who use alternate forms of the test form to discourage cheating. Even if they require students to write their names on the test forms themselves (as well as their answer sheets) and penalize students who fail to turn them in before leaving, students occasionally forget and leave the room without turning them in. This compromises item and test security because—if and when instructors do get the test form back from the student—they have no way of knowing whether the student copied the items for later use by friends. Finally, the IF-AT forms themselves also have disadvantages, including cost (a minimum order is just over a hundred dollars) and susceptibility to cheating (students can see the stars with a high-powered penlight laser). We also had a batch of forms on which the covering had dried out so that students could not scratch it off without scratching off the star as well.

Our Computer-Based Alternative. A few years ago, we began to develop an online team-based testing (TBT) system that would incorporate all of the desirable features of the IF-AT while avoiding some of the pitfalls. (For a lengthier description of our system, see Robinson, Sweet, and Mayrath, 2008.) At the heart of TBL is engaged dialogue, so we wanted students to be able to sit close to each other and see each other's body language and facial expressions—which would be almost impossible in a typical computer lab in which computers are placed side-by-side in rows and columns. Fortunately, at the University of Texas, by using a combination of student- and university-owned laptops, we can provide each student with a computer and space for fifty to seventy students to use them.

On the days we give readiness assurance tests (RATs), we allow students to arrive at class a few minutes early to log in to the system. As with paper-based tests, students who arrive late are still expected to finish within the allotted time. Once students log into the TBT system, they answer multiple-choice questions on their computer. Early on, we presented the questions randomly ordered and one at a time, and with randomly ordered answer alternatives, as a means of discouraging cheating. However, some students were adamantly opposed to the one-question-at-a-time option because they wanted to be able to go back and change their answers if they wished, although there is no evidence that this improves test performance (Bodmann and Robinson, 2005). Thus, on the individual readiness assurance test (iRAT), we still present the questions and answer alternatives in random order to discourage cheating, but we now allow students to scroll to see all the questions. They click to make their selections and then click a submit button when finished.

Once all of the team members have submitted their iRAT, the team readiness assurance test (tRAT) becomes available on the following screen (a password is required), and a designated team member submits answers for the team and relays feedback on their choices. The remaining members

log in to an area where the order of the questions is the same for everyone and they can see their own iRAT answers.

Beyond the security of randomly ordered questions for individual tests and the convenience of uniformly reordered questions for team tests, we soon discovered another advantage of the electronic format. With paper-based testing, when all students had the same form with the same order of multiple-choice options, we had noticed that they could simply refer to the answer options by letter when counting votes to reach consensus on team answers (for example, "I put A," "I put B"). Students typically began by going around the circle reporting the letter of the answer they chose and would move forward based on a majority vote. After watching team interactions that occur with TBT, we are convinced that having the opportunity to decide on a team answer by simply stating the letters related to the answer options sometimes short-circuits the more meaningful consensus-seeking dialogues intended by collaborative learning environments and can result in more incorrect answers. So in TBT, the response options on the iRATs are randomly ordered and there are no response labels such as letters or numbers. This forces students to read the answer alternatives aloud (because they cannot vote simply by referring to the letters that represent the options) and increases the likelihood of thinking more carefully about the course vocabulary and discussing more deeply before rendering their decisions. In fact, we are in the process of analyzing data that reveals decisions take longer with TBT and result in higher tRAT scores (Robinson, 2008).

Similar to the IF-AT forms, teams are required to keep trying until they answer correctly. Each time a team answers incorrectly, 50 percent of the points for that item are removed. Thus, for a five-option question, item points can range from 100 percent to about 6 percent: after the first wrong choice, the most they can get for that item is 50 percent of the point value; after the second wrong choice, the most they can get is 25 percent; and so on. As a result, TBT maintains the immediate feedback and partial credit advantages of the IF-AT.

Once teams submit their final answer, they automatically receive their score for that question. Again similar to the IF-AT, throughout the team testing process, correct answers are revealed and individuals are able to score their own test. If a team wants to appeal a question, they write it out by hand on paper and submit it to the instructor by the end of class. Immediately after class, we take the appeals to the office and rule on them right away. Results of team scores and bonus points are announced by posting on the classroom management system within a few hours of the test. For teams that receive the highest score, each team member receives three bonus points added to the individual test score. Second-place teams receive two points, and third-place teams receive one point. Of course, there are ties so frequently at least half the teams receive bonus points. We also typically award at least one appeal for each test, so teams are encouraged to seriously

consider the accuracy of each item. Our experience with the testing process is that we witness students digging into the material more deeply than any other testing sequence we have seen. We encourage anyone who is interested in using TBT to contact us because the software is open source and free to the public.

Reporting Complex Team Assignments

Perhaps the most challenging component of TBL for us has been developing good team activities. At the same time, this has been the most rewarding component because it forces us to consider ways in which students should be able to enrich their understanding of the course content. For the course we teach on cognition, human learning, and motivation, we decided to focus on the studying and learning strategies that are a major part of the course. We have students do assignments over two chapters at a time, with six assignments for the course. These assignments are designed to capitalize on the TBL principles to enhance learning and performance.

As with any other TBL component, we believe that both individual and team accountability are required to optimize learning. As part of the curriculum, we stress that information found in textbooks can be represented in many ways and that an optimal form of representation is one that allows us to see what we might not have seen otherwise (Tukey, 1977). For example, a row-and-column graphic organizer may reveal comparison relations that are obscured in other displays. Thus, students are aware that outlines and lists are not the only forms of note taking. Preferably, they will create more graphical forms of notes that use space to demonstrate relations and allow visual discoveries. Our goal for these assignments is to have students represent course content in ways that lead to optimal and efficient learning. We accomplish this through an assignment that requires them to consider the features of information that make it difficult for learners to understand and the features of information that enable us to use that information in the future. Thus, in the spirit of TBL, we wanted to allow differences in choices about how to represent the content but also a way to meld individual work into a team product that could be shared with the class as a whole and would stimulate discussion and debate—all within a seventy-five-minute class period.

To save class time, we require students to read two chapters from the textbook and develop an individual PowerPoint file that contains four sets of notes over what section of each chapter contains the content they think is most important (relevant, useful, or something else) and the most difficult to learn. They must also upload their PowerPoint in their team's course management file exchange by midnight before the 11:00 A.M. class.

As the instructors, we create teams and also an entire class team or group in the course management system. Students then go to Communication: Group Pages; they select their team and then File Exchange. This gives

their teammates a chance to look at everyone's work before arriving at class. We use PowerPoint because it has drawing tools that allow students to enhance and enrich their concept notes by creating a wide variety of display typefaces and including pictures that support their conclusions.

We use the first thirty minutes of class for teams to decide whose notes to share with the class and create a team PowerPoint file by copying, pasting, and editing from members' individual work. This activity is fun to observe as students bring considerable energy to the task of discussing the rationales of members' individual decisions. Although there are no absolute right and wrong selections, teams are aware that the entire class will critique their choices, and we consider these critiques in assigning grades. Then, using a computer and projector, we go to the entire class group page and view the teams' assignments by projecting the slide shows on the screen. This is similar to the "gallery walk" some TBL instructors use (see Sweet, Michaelsen, and Wright, 2007).

We score each of the group slide shows for accuracy and originality. Total assignment scores for individuals consist of three parts. First is their individual contribution, which we can access by downloading their PowerPoint file from the course management system. Students receive the most points if they post their file by midnight the night before and if it appears they contributed something that required effort. Second is whether they showed up for class that day. Third, each member receives their team's score on the slide show they created and presented. In addition, students use the information about their teammates' contributions in their later judgments for peer evaluations.

We have found that the teams are very interested in viewing the other teams' work. In addition, we consistently have received positive feedback from the students regarding the assignments; they frequently report that they view the team slides in preparation for the tests, which are generally given the following class period.

Providing Feedback on Peer Evaluations

The third adjustment we have made involving computers is related to the way in which we obtain and share feedback within teams. When we began implementing TBL, we struggled with how to incorporate peer evaluations in our grading system. After trying several ways to do peer evaluations, we settled on having students complete a simple teammate feedback form at least two, and more often three, times during the semester. The form asks them to provide a short answer to the following two questions for each member of their team: "Something I appreciate about this person is . . ." and "Something I would like to request of this person is . . ."

Both we and the students like the outcomes of the feedback process; however, we found ourselves almost buried in paperwork. We would collect fifty to seventy hand-written forms. Then we would have to type

requests and appreciations for each student from their teammates and then print and distribute them as quickly as possible. Even with two of us working to turn the feedback around, it was always more than a week before the students learned what their teammates thought about their contributions to the team.

Technology to the Rescue. Our interim solution to the problem is that we use e-mail to collect the peer input and distribute the results. We simply e-mail the teammate feedback forms and their teammates' names to the students and ask they reply. We copy and paste the responses into a large word processing file for our own records and individual files that we e-mail back to the students, with the identifying information omitted. The electronic copying and pasting and then e-mailing saves valuable time over the paper-based system and allows us to deliver the feedback to the students more quickly.

Our long-term solution that our programmers are finishing is a Web-based system where students can log in and enter the feedback. The program will then sort the feedback and allow students to log in and view the results. This system, when completed, will also be open source and free to the public. It is very easy to use, and we encourage you to contact us if you are interested in using it.

Translating Comments into Grades. One of the unique features of the teammate feedback process is that even though we do not collect any quantitative data, the peer comments can, and in some cases do, raise students' final letter grade. We tell students that for the most part, the comments will not be used or even read by the instructor. However, at the end of the course, a few students fall just short of a grade cutoff and come in to ask us if they can do anything to raise the grade. We tell students that, if they face this situation, then their peers' comments will become the deciding factor. If the comments are mostly positive or if they started a bit rough early in the semester but clearly improved over the course, then we give them the few points. If the comments are negative, that shows us how committed the student was to the course and the answer is no.

Furthermore, as a result of discussions during the preparation of this chapter, we plan to tweak the way we use teammate feedback in a way that we are confident will increase its already positive impact. In future classes, we will give students a short article to read, "Making Feedback Helpful" (Michaelsen and Schulteiss, 1988), and tell them that in borderline cases, "First, we will look at the evaluations you *gave* and if it looks like you were serious about trying to give helpful feedback, then we'll look at the feedback you *received* from your peers and, based on the two, we'll decide about raising your grade." Because students never know whether they will be close to a grade cutoff, the teammate feedback process used in that way will provide a grade-based incentive for learning how to give helpful feedback, using that knowledge to provide feedback to members of their team, and being a responsible team member.

Conclusion

We are fans of TBL and will continue to use many of its features in our courses. We do not believe that technology is the answer to every educational problem. We also realize that often educators rush to implement technology unnecessarily, and it sometimes has negative outcomes. Our goal in using technology has been to avoid negative outcomes and simply improve an already great system—one that after using, we could not go back to our previous instructional methods and still enjoy teaching.

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