

Team Learning: Cooperative Learning in the Science Classroom

by
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The following text was written to accompany the training videotape, "Team Learning: Cooperative Learning in the Science Classroom," produced by the National Center for Case Study Teaching in Science.

Team learning is a special method of cooperative learning devised by Larry Michaelsen at the University of Oklahoma's School of Management. It has been used by a host of different disciplines with great success, but I think it is ideally suited for the sciences. The reason? Science teachers are always harping about the fact that they have to cover so much material that they can't afford to spend time on things like case studies and cooperative learning. Well, team learning is the answer to the coverage problem. (Of course, this still begs the question, "Why do we have to cover so much especially when we know full well that no one will really remember much of it beyond the end of the semester?")

Team learning uses no lectures. Students learn on their own. This is hard for most of them because they really haven't done it before. They always have had teachers lecturing them, just like their parents. Should we be surprised then that they don't remember much or care very much?

Team Learning in a Nut Shell

There are several major elements in team learning. The video shows how these elements come into play in the classroom. Basically, students are given assigned readings. When they come into class, each student takes an individual quiz over the reading. Then they take the same quiz in small groups. They grade their quizzes (both their individual quiz and their group quiz) and have a chance to appeal any question they believe is unfair. Finally, they try to apply the principles of their learning to a real-world problem such as a case study.

That's it.

What most teachers find surprising is that students do actually learn the material this way—from the reading material—without a single lecture. And you can cover the same amount of subject matter as before. But better. And you'll get to know the students. And have fun.

The Steps to the Promised Land

1. Explain the Logic of the Method

When you first meet your students, you have a lot of explaining to do if you are going to use team learning. First, it is a new experience and they will be naturally wary, especially when you tell them there are no lectures. Second, they all have been in classes before where they have been forced to work in groups and for most of them these have not been happy experiences. You must try to reduce their fears if not allay them. Whatever else you say, don't tell them this is an experiment.

Here are some of the points I make on the first day.

- Learning in small groups has been compared to the traditional lecture method in over 1,000 studies and it has been found to be superior every time. In small group learning, students retain the information better, like the subject matter better, become more articulate in expressing their thoughts, and end up appreciating different viewpoints better than with the lecture method. Why do faculty insist on using the lecture method then? Because they don't know about the data and they never have seen anything else used. The lecture method was invented in days when there were no textbooks. We continue today out of habit, inertia, and ignorance. This is not to say that lectures have no place. They do, but in most classroom situations small group work is better. That's why we're going to use it.
- The use of small groups will enhance your ability to work in teams. Most jobs today depend on interpersonal skills. It is important to realize that most people lose their jobs because they can't get along with their associates or superiors in the workplace. Petit (1989) reported that when he surveyed the alumni of 35 colleges that 85% said that the single most important skill in determining success in their fields was the ability to get along with people. Furthermore, most reported that they had had no classroom experience where this skill was learned. Team learning will help improve your cooperative skills.
- People working in groups have to pull their share of the load. Many students are fearful that they will be hurt if there are group grades. We have to do something to be sure that people do equal work or are compensated for any extra work they do. So we must have a way to let students have a voice in who gets more or less credit for group projects. That's why we have peer evaluation. (I explain this in the first class, but I'll save this until later.)

2. Establish Diverse Groups

Team learning uses permanent groups of students. Cooperative learning experts say the best group size is either 4 or 5. This gives diversity, but still there is enough "air time" available for one and all.

To establish the diversity on the first day of class, I give students small 3x5 index cards to fill out. I ask them to write down their names and major. Also, I ask them to list the science and math courses they have taken. And I ask them to jot down their current grade point average, if they wouldn't mind. Other factors that I find important are their gender and, sometimes, ethnic background; I don't ask for this, but it is usually obvious.

I gather these cards and sort them into groups, trying to get the maximum diversity of background per group. I am trying to avoid putting all of the engineering students in one group and all sociology majors in another, etc.

I establish these groups as soon as practical, within 2 or 3 class periods. If you form the groups too soon, you may have problems with "drops and adds." In the meantime, you don't want to start lecturing though; you should have some temporary group projects for them to work on.

3. Peer Evaluation

There are two schools of thought about group projects and grades. One school, "the don't ever do it group," says that you should never give group grades; only base marks on individual scores. The groups can do projects, but don't grade them. I belong to the other school of thought, "grade 'em, but use peer evaluations." We argue that there is little incentive for the student to take group projects seriously if there aren't grades involved. But you must be sure to evaluate the students' individual efforts so that "social loafers" don't get credit that they haven't earned. This means peer evaluations.

So, how do you go about it? As I explain on day one of class, students at the end of the semester will give points to their teammates. These anonymous evaluations should reflect their relative contributions to group projects.

Suppose the teams have 5 persons, then students are told to list the name of their teammates on a form. They each get 40 points to distribute among the other 4 members of the group. If a student thinks everyone has contributed equally to group work, then he should give each teammate 10 points. If everyone in the group feels the same way, then everyone will receive an average of 10 points. This means that each person will receive all of the group earned points. On the other hand, if Sally receives an average of 8, this means she will receive only 80% of the group score. Clearly, her teammates believe that she hasn't done her share of the group work. So in short, the peer evaluation acts to modify the group score.

As a postscript, let me note that for most of my classes individual scores (quizzes, exams, homeworks) account for 75% of a student's mark, while group work (group quizzes and group projects) account for 25%.

I have some rules that must be obeyed.

1. No student can give any teammate more than 15 points. This stops people from aiding a buddy who hasn't contributed much.
2. Students don't have to use all of their points.
3. Any student receiving an average less than 7 points is clearly hurting the group and will fail the course regardless of their individual score.
4. If there is an unusual score from one student, i.e., out of line with the others, this score will be dropped.

4. Students Set Rules for Groups

It is vital that students take group work seriously. So, within a couple of days of establishing groups, I have the groups set rules that they will live by. They essentially draw up a contract and everybody in the group signs it. The rules they come up with typically state that no group member should be absent without informing the group or everyone should always be prepared, etc. They also set sanctions or penalties for those people who break the rules. These include doing extra work.

I have groups revisit the rules and revise them if need be after a couple of weeks of class.

This process of rule development, along with other self-evaluations and group evaluations, are necessary if you want the teams to bond together. Everyone must look for ways to improve the teamwork.

5. Use Classrooms with Moveable Seats

It is almost impossible to use Team Learning or any other cooperative learning involving permanent groups in a fixed-seat amphitheater. Too many of our colleges and universities are set up for the lecture method. If you're going to use Team Learning you have to have moveable seats where teammates can consult with each other.

6. Individual Quizzes on Reading Material

The first thing that happens in most classes is that I give students a chance to ask if they have any *specific* questions over the reading. This lasts no longer than 15 minutes, and I am very careful not to be suckered into giving a lecture. Immediately following this, I give a quiz to everyone in the class.

The quiz is always a combination of 15 multiple choice or true/false questions. This serves to see if the students have carefully read the text. No tricky questions, just the most important points in the reading. The quiz takes about 10-15 minutes.

7. Group Quizzes

When all of the members of a group have finished taking their individual quizzes, one student picks up their answer sheets and brings them to the front of the room. (I have them lean them up against the blackboard in the chalk tray under their group number

written on the board.) This group representative picks up a blank answer sheet and goes back to the group where they discuss each question and come to a consensus about an answer. They are, of course, answering the same questions that they answered as individuals. The groups are on their own, and do not have to wait for other groups to get ready.

After a group has finished their group exam, these students go to the front of the room and retrieve their individual tests. They then go to the portable electronic scoring machine, the Scantron, which I have wheeled into the classroom, and grade both their individual and group exams. Grading could be handled without the electronics, but the Scantron is jazzier and more fun.

The groups write their group score on the blackboard under their team number so everyone has a good idea of what the other groups are accomplishing. This clearly adds a bit of competition to the enterprise and tends to enhance group cohesion.

Group test scores are almost always higher than the highest individual scores. This is hardly surprising, but tends to alleviate the anxieties of the best students who may feel that they are being exploited. The discussions within the group, as they take the test, are an excellent method of feedback and help students retain the information.

8. Chance for Appeals

After students have graded their exams, there is a time for appeals. Students will be comparing their answers to the “correct” ones given by the Scantron key. They now have a chance to look up the correct answer in the reading material. This is another form of feedback.

If they find a problem with the answer or the question, they can write an appeal requesting that the instructor (that’s you) review their answer in light of their argument.

There are three grounds for appeal.

1. The students can show their reading material says one thing and the key says another. (They must cite page numbers for this.)
2. The students can show that the readings are ambiguous on the point. (They must cite text page numbers.)
3. The students can show that the question is ambiguous. (They must make their argument and re-write the question.)

The appeals must be group appeals, not individual. They must be signed by all members of the group. You do this because you want the teammates to be in agreement; this serves as a filter for unreasonable and emotional appeals. Also, their grades might be affected. Let me explain. I take the appeals home and read them outside of class. (You don’t want to get into arguments about the test questions in class!) If the appeal is at all reasonable, I grant it. (After all, there are many times when I have written a flawed question.) Don’t

fight it, grant it. Here is where the group signing is important: If the appeal is on the basis of #1, the key is wrong, then some group members may actually lose points if the appeal is granted. (They will have answered incorrectly the first time around, but the key gave them credit.)

Another point: If one group makes a successful appeal, only that group receives the points. The other groups don't; after all, they didn't know enough to challenge the grading.

9. Apply Principles From Reading

The mini-test and appeals will take about 45 minutes. This is practically an entire 50-minute class period. Some instructors use only this part of Team Learning. Every class is the same: individual quiz, group quiz, appeal and class is over. Using this approach, Frank Dinan, an Organic Chemistry instructor at Canisius College, reported that he covered two text chapters more and his students had higher grades on the national exams than in his previous lecture approach.

The real Team Learning approach goes farther. The mini-test sequence should be followed by an application exercise. Here students *use* the principles they have read about.

Any practical real-world problem fits in here, including lab exercises. I use case studies that relate to the reading. If I am teaching a section in genetics, I use a case in genetic engineering of crops. For species formation, I use a case set in the Galapagos Islands. For human evolution, I use a case on the Neanderthal and mammoth extinction. In the video, you can see me using a case involving the famous fossil bird *Archaeopteryx*, which links to the students' readings on the fossil evidence for evolution.

Just how you splice in the application (case) depends upon your time frame. In the summer classes, which are long, I can do the mini-tests, have the students take a break, and then return to do a case. In standard 50-minute classes, I do mini-tests for one or two classes, then use the next class for a case.

10. Active Learning is a Must

The application phase of Team Learning is the only real chance that students are challenged to use their learning. And what good is all the information that the students memorize if they can't or don't use it? So, getting the students actively doing something is critical. In the video you see them comparing fossil models with current bird skeletons and writing up a lot of similarities and differences. Having student teams hand in a product (in this case a short report) will give you an opportunity to assess their understanding and give them a group grade.

11. The Best Cases Involve Controversy

There are several keys to writing good cases. Good cases should tell a story, be recent, create empathy with the characters, have dialogue, be relevant to the student, serve a teaching function, have dilemmas that must be solved, have generality, and be short. It almost goes without saying that good cases involve controversy. This automatically raises the interest level. Moreover, the solution to whatever problem your case characters face shouldn't be obvious; reasonable people should differ on the proper approach.

12. Most of the Teacher's Work is in Preparation and Grading

All classes require a lot of time in preparation whatever the method. For Team Learning you must select the reading material carefully. A textbook may be just fine, but since the students are using only this material, you may have to prepare some study tips or a guide on what points and concepts are most important. The size of our texts and their encyclopedic coverage has become ridiculous, as publishers try to satisfy every whim of all faculty. So, I always give students a list of key terms I want them to know in each chapter.

Another place where extra work is involved is in the preparation of the quizzes. Also, there will probably be more grading, depending upon how many group projects you assign. However, since there will be normally only one report per group, this doesn't have to be excessive. Incidentally, it is important to note that I do give midterms and final exams in Team Learning classes. As you will notice, in Team Learning you are especially busy before and after your class. But during the class period you are largely acting as a conductor of activities. This is in contrast to a lecture class where you are the "star of the show." Occasionally, students will interpret this as "you are doing nothing." You should find ways to indicate to them that you are writing the quizzes and grading papers and writing cases. In fact, this can take more effort than lecturing from old yellowed notes.

13. Group Folders

Students keep track of their own grades in Team Learning. This saves you an enormous amount of bookkeeping.

Each team has a folder with pockets in which they place everything they produce. This means their bubble sheets, appeals, homework, projects, etc., are kept there for the team. If the folder gets too bulky, I put some of the material in team envelopes—their archives. Thus, we always have everything together for reference.

Taped on one side to the folder I have an attendance sheet, which the students initial each class. Taped on the other side there is a form for them to record their quiz and homework scores.

Yes, I know about the confidentiality regulations, but I have never had a student have any complaint about this approach. Their grades are only known by their teammates, and they

constantly share this information anyway. In fact, I have had some groups designate a member of the team the role of grade keeper. Anyway, if this approach gives you problems, *don't use it!* But there are powerful reasons to do it, besides relieving you of immense bookkeeping problems. First, it acts as a way of keeping the students honest about their scores; they don't want to be caught by their teammates. Second, if everyone knows everyone else's scores, they tend to help the weaker members of the team.

14. Peer Evaluation Revisited and Practice Peer Evaluations

Not all groups work well. Perhaps 20% will have problems initially. In the first few classes, the students will be tolerant of absences, tardiness, or lack of preparation. In time, unless corrected, their irritation will build to seething resentment. Peer evaluation is the solution to most of these problems. However, if you wait until the end of the semester to use it, you can't fix the problem. It's too late. A practice peer evaluation is the answer.

Practice peer evaluations are just like the real thing. You hand out the forms (see end of text for an example) after one-third or one-half of the semester has passed. By this time, problems within the group will be manifest. Tell the students that this is their chance to make their concerns known. They will have no one to blame but themselves if they give an undeserving student a good score. They should be fair, but reasonable.

Be sure that the students are spread out when they fill out the forms; if they stay within their groups, this will clearly inhibit them. Collect the completed forms, and after class calculate the averages for each student. The next class I give each student a slip of paper with their average score on it. At this time I give them a brief explanation of how they ought to interpret the number.

I remind everyone that an ideal functioning group is one in which all teammates receive a 10 and consequently earn all of their group points, etc. I remind them that if they don't like their score, they must set about fixing the problem. There is no use blaming the group for a low score, they must work harder. The group clearly doesn't think they are pulling their weight. I remind them that anyone with an average score of less than 7 will fail the course, etc. This "lecture" and the score are usually enough to improve the performance of most groups. But I also take the additional step of talking to any poorly performing student personally after class. Almost without exception these steps will correct any problems.

References and Further Reading

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Credits

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Table 1: Peer Evaluation Form

Name _____ Group# _____

This is an opportunity to evaluate the contributions of your teammates to group projects during the semester. Please write the names of your teammates in the spaces below and give them the scores that you believe they earned. If you are in a group of five people, you each will have 40 points to distribute. You don't give yourself points. (If you are in a group of four, you'll have 30 to give away. In a group of six, you'll have 50 points, etc.) If you believe that everyone contributed equally to the group work, then you should give everyone 10 points. If everyone in the group feels the same way, you all will receive an average of 10 points. Be fair in your assessments, but if someone in your group didn't contribute adequately, give them fewer points. If someone worked harder than the rest, give that person more than 10 points.

There are some rules that you must observe in assigning points:

- You cannot give anyone in your group more than 15 points.
- You do not have to assign all of your points.
- Anyone receiving an average of less than 7 points will fail the course.
- Don't give anyone a grade that they don't deserve.

Group members Score

1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____
6. _____	_____

Please indicate why you gave someone less than 10 points.

Please indicate why you gave someone more than 10 points.

If you were to assign points to yourself, what do you feel you deserve? Why?

