

How Do I Get My Students To Work Together? Getting Cooperative Learning Started in Chemistry

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When educating of future scientists we often find ourselves lecturing to our students and encouraging them to perform tasks in a competitive individualistic environment. We ask students to work by themselves, set up reward structures so that cooperation among students is discouraged, emphasize technical competence to the exclusion of all else, and promote or pass students who produce little acceptable work. This does not represent the world in which they will be asked to work and interact. The American Chemical Society Committee on Professional Training presented in their Spring 1996 newsletter the results of an industrial roundtable that was convened to address what industry looks for in new hires (1). Roundtable participants voiced broad agreement that in addition to technical skills, one of the key experiences industry seeks in new hires is team problem-solving. Chemists must be comfortable working with a diversity of people inside and outside their organization. Working on multidisciplinary teams, across departments, and between companies is becoming more prevalent. Modern science, in the academic setting, also increasingly requires teams of people working together to effectively solve problems. Emerging or growing fields such as biotechnology and materials science require teams of people with different areas of technical expertise.

Many undergraduate chemistry programs do not specifically incorporate techniques that promote students working in teams. Often chemistry students are expected to work individually, and working together is considered suspect (1, 2). At the undergraduate level we must include experiences that train chemistry students how to work effectively with other students. The interpersonal skills developed while working in groups may be the set of skills most important to a chemist's employability, productivity, and career success (3, 4).

In response to this problem, colleges have begun exploring ways to improve student learning and team problem-solving skills. Cooperative learning activities promote the development of interpersonal skills and communication skills through face-to-face interactions. During cooperative learning activities a group of students create an environment where they actively engage in the material by sharing insights and ideas, providing feedback, and teaching each other. Major reviews of cooperative learning research (5, 6) have shown that cooperative learning leads to higher achievement, increased positive attitudes toward the subject area studied, higher self-esteem, greater acceptance of differences among peers, and enhanced conceptual development in a wide range of settings and across content areas.

Implementing Cooperative Learning

Some faculty discover cooperative learning through workshops or reading journals (7) and become excited about integrating a new technique into their classroom. They put their students into groups, turn them loose, and wait to see the aforementioned increase in achievement, increased positive attitudes, etc., and become disenchanted and disappointed when those outcomes do not occur.

Implementing cooperative learning requires preparation. Simply placing the students into groups and telling them to work together is not enough because it invokes two fallacies. One, that students actually know how to work together, and two, that students who do know how to work together will actually do so. So the question before you implement cooperative learning is, how do you get your students to work together?

Answers can be found in two texts that are helpful for teachers, especially chemistry teachers, who are trying to understand the principles and applications of cooperative learning. Johnson and Johnson have written dozens of texts and articles on cooperative learning; however, one text focuses exclusively on cooperative learning in the college classroom (8). This text contrasts the perspective of students as passive recipients of knowledge with the perspective of knowledge as constructed in the mind of the learner, reviews cooperative learning research, and outlines the essential elements of cooperative learning. It also provides many applications of different types of cooperative learning activities. A second valuable text, compiled and edited by Nurrenbern (9), is directed towards chemistry instructors who wish to incorporate cooperative learning activities into their classrooms. This text discusses what cooperative learning is and why it should be employed, the role of the teacher within a cooperative classroom, how to design tasks, and how to manage groups, and it addresses the common concerns many practitioners of cooperative learning face.

Accompanying the text are field-tested examples of cooperative learning activities contributed by chemistry middle school, high school, and college instructors. These activities can be adapted to different classrooms and can serve as a catalyst for the development of new activities.

Reading these two texts helped me generate the materials and the approach I now use with my physical chemistry students. At this point, many articles have shaped the way I implement and use cooperative learning in my classroom. However, if I had to recommend a place to start reading about cooperative learning and thinking about how to get students to work together, I would strongly recommend these two texts.

How Do I Get My Students To Work Together?

The first day of class I talk to my students about cooperative learning and the activities they will be engaged in during the semester. I discuss with them why I think it is important to learn to work with other people, and I emphasize that they will learn more by explaining their understanding of concepts and problems to fellow students. From experience, I have found that it is important to do activities that help students in each group to get to know each other and help them craft the operating rules for their groups. The handouts and activities described in this article represent the present incarnation of my course. In the Classroom

Getting To Know You

The first day of class my students fill out a getting-to-know-you questionnaire, which identifies their intended career paths, previous cooperative learning experience, and attitudes towards group work. I collect the questionnaires and form the students into heterogeneous groups based on their responses, academic ability, and gender. It is very important that the instructor form the groups. If the students suggest choosing their own groups (any student who has had a negative experience with cooperative learning might), then take the opportunity to explain why you are forming the groups.

Students need to recognize that in the workplace they will be expected to get along with many different types of people. The workplace of the 21st century will be composed of more women and minorities than ever before. In order to succeed in this type of workplace, students must learn to value and respect diversity—they need to know how to get along with different types of people. Cooperative learning activities can provide the first step in this direction.

Individual and Group Responsibilities Yield Group Covenants

In preparation for cooperative learning activities I want students to think about what they expect from their group and what they expect to contribute to their group. To achieve that end, the students are asked to respond the following four questions before their first cooperative learning activity: (i) list your responsibilities to the group, (ii) list the responsibilities the group has to each member, (iii) describe the advantages of working in a group or as a team, (iv) describe the disadvantages of working in a group or as a team.

The students are asked to bring their written answers to the first cooperative learning activity held during the second day of class.

During their first cooperative learning activity the students assemble in their assigned groups to compare and discuss their responses to each of the above questions. This enables the group to draft “Group Covenants”, which delineate the individual group members’ responsibilities to the group and the group’s responsibilities to each member. In essence, this sets up the operating rules for each group. It helps to define acceptable behavior and how group members are to deal with each other in order to get work done. Each group member keeps a copy of the group covenants, and one copy signed by each group member is delivered to me.

Looks Like, Sounds Like

During the first cooperative learning activity, I direct a class discussion to compare what each group has written as individual responsibilities and group responsibilities in their group covenants. As each group states their group covenants, I record these responsibilities on the board. We find that most groups list similar responsibilities. They expect individuals to arrive prepared and on time, to contribute to the group, to listen to each other, to ask questions, and to be patient and respectful of each other. They expect the group to work together to solve problems, to help each member understand how to solve problems, to encourage each other, to be open to learning from other members, to be respectful and patient with each other, and to make sure everyone understands.

After all the groups have chimed in, I ask the students to operationalize these behaviors by

generating a response to the general question “What does each one of these responsibilities look like and sound like?” (8). This is not a trivial activity. Students need to know that verbal and nonverbal behavior play a role in how people perceive them. For example, in my classroom groups often cite listening to other group members as a responsibility of each individual member to the group. But when asked what does listening “look like” the students appear to be rather perplexed. They ask what do I mean, “look like”? I explain that listening to a person involves actually looking at that person, making eye contact, and holding a facial expression that communicates that you are listening. Students need to realize that behaviors such as not looking at a person who is speaking, doodling, rolling their eyes, or sighing instantly telegraphs a message to the speaker. It declares that what the speaker is saying is not important. Asking students what their group covenants look like and sound like forces the students to think about how they are going to put their group covenants into practice.

Salaries and the Real World

As a final step on the first day of cooperative learning activities I talk about the starting salaries for B.S., M.S., and Ph. D. chemists as reported in the most recent yearly survey of chemists in Chemical and Engineering News (10). I emphasize that many of the most interesting and high-paying jobs in the workplace involve getting people to cooperate, leading others, and coping with complex power issues (3, 8). Thus, the interpersonal and communication skills that the students develop during group work have a profound effect on their future success in the workplace.

How Are We Doing?

Groups need to regularly reflect on how well they are functioning. This feedback loop is known as group processing. It is critical to enhancing group performance and is analogous to evaluation and team-building efforts that occur in industrial settings (8, 11). Processing can be facilitated by an evaluation form on which each team member evaluates others on the criteria outlined in their group covenants and completes the following statements:

1. To operate as an effective team we need to continue to do the following things:
2. To operate as a more effective team we need to start doing the following things:
3. To operate as a more effective team we need to stop doing the following things:
4. To carry out these actions here's what we are going to do (What's your strategy to address the concerns raised in the first three statements?):

The data generated from this activity can be used in two different fashions. First, faculty can use the individual evaluations as a check to make sure that students are functioning effectively in their group. If that is not the case, then action can be taken (easily done if the evaluation scores are factored into the student's grade). Second, by completing the four statements noted above each group can reflect on and discuss what things they do well and what they need to do better to function more effectively. This discourse reminds group members that building an effective group is not a static endeavor; it is a dynamic process, which requires vigilance and effort.

Building Classroom Community

Cooperative learning has many desirable outcomes. It helps students build a feeling of community in the classroom and fosters a warmer classroom climate, which promotes

learning and achievement. This warmer climate expresses itself in the students forming friendships and challenging and encouraging each other to truly understand the material. Cooperative learning activities encourage students to engage in the type of discourse about concepts and problem solving that moves them away from rote learning strategies and toward more meaningful learning strategies. Students strive to understand different ways of explaining concepts and different perspectives on solving problems. When students experience a feeling of community they become more willing to take on tough tasks because they expect to succeed; absenteeism drops; and their attitude toward the course becomes more positive. Their potential for achievement becomes enormous.

Building this community and realizing this potential require that the students know and trust each other. From the faculty's point of view, this implies that facilitating student learning during cooperative learning activities begins by helping students learn how to work with each other.

Performing the activities described in this article will help the students get to know each other, create operating rules for their groups, define and describe these rules, and evaluate and improve how their group functions. Groups that function effectively and thus build a sense of community unlock their potential to achieve and perform at a high level.

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