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Cooperative Learning in Engineering Education: The Story of an Ongoing Uphill Climb

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Abstract

Collaborative projects have been part of engineering practice for as long as the profession has existed, and group projects have been a fundamental part of engineering education for many years. Until the late 1970s, the groups were invariably unstructured: groups of three or four or more students ran lab experiments or designed processes or products with no guidance on effective teamwork. Often the best students in a group did most of the work and every group member got the same grade, whether or not they contributed or learned anything. In other cases, poor project management and interpersonal conflicts among group members led to inefficiency, frustration, and low grades. Beginning in 1981, thanks to the efforts of the two authors and a rapidly growing number of their colleagues, engineering professors all over the world now use structured group work. This chapter reviews highlights of the development and adoption of cooperative learning (CL) in engineering education and summarizes the factors that led to its acceptance by many engineering professors. It also discusses specific strategies for implementing CL in in-person and online courses as well as some engineering students' resistance to it and strategies for minimizing or eliminating that resistance.

Introduction

Group projects have been part of engineering practice for as long as the profession has existed, and team assignments have been an integral part of engineering education since the 19th century. Through the 1970s, however, the assignments were invariably unstructured: groups of three or four students ran lab experiments or designed processes or products with no guidance on effective teamwork. In many cases, the best students in a group did most of the work and all group members got the same high grade, regardless of how much of the work they understood. In many other cases, ineffective project management and interpersonal conflicts among group members led to poor work and low grades.

In the late 1960s, Neil Davidson pioneered the use of small-group learning in mathematics courses (it would not be called cooperative learning for another decade) in his doctoral research at the University of Wisconsin and his first faculty appointment at the University of Maryland (Davidson, 2021, pp. 203–206), and in the ensuing decades the concept started to spread to other STEM disciplines. This chapter reviews the trends and events that led to the introduction and growth of CL in engineering education.

Changing Paradigms in Engineering Education

Engineering education has gone through five major shifts in recent decades (Froyd, Wankat and Smith, 2012). Since the 1980s, systematically applying outcomes of education and social-behavioral sciences research to instructional design and assessment of learning has led to steady increases in the adoption of evidence-based instructional practices in engineering and other disciplines, which is part of a broader paradigm shift in higher education (Barr and Tagg, 1995; Eagan et al., 2014; Johnson, Johnson & Smith, 1991; Waller and Smith, 1997). Table 1 shows a few elements of this shift (Smith and Waller, 1997).

Table 1. Elements of a paradigm shift in engineering education.

	Older paradigm	**Newer paradigm**
Knowledge	Transferred from faculty to students	Jointly constructed by students and faculty
Students	Passive vessels to be filled by faculty's knowledge	Active constructors, discoverers, and transformers of knowledge
Faculty purpose	Classify and sort students	Develop students' competencies and talents
Context	Competitive /individualistic	Cooperative
Climate	Conformity	Diversity
Assumption about teaching	Any expert can teach	Teaching is complex and requires considerable training

In the 1990s, the National Science Foundation funded eight multicampus coalitions of engineering schools to improve engineering education (Coward, Ailes & Barton, 2000). Substantial reforms ensued, including changing the introduction of engineering in the first year of the curriculum from dry descriptions of the different branches of engineering to courses that incorporated traditional first-year mathematics and science course content into hands-on engineering projects (Al-Holou et al., 1999). Considerable development work on cooperative learning was done in the Foundation Coalition, which produced a still-relevant white paper (Foundation Coalition, n.d.). Two additional reforms occurred in the past few years: a shift to emphasizing diversity, equity, inclusion, and justice in instructional design and delivery, and a shift to online learning due to the Covid pandemic (Chavela Guerra and Smith, 2022). All of these developments necessitated the systematic study and improvement of student project team dynamics. (Note: We will not be dealing explicitly with online implementations of cooperative learning in this chapter. A broad paradigmatic approach to online CL is outlined by Ferenc Arató in Chapter 16 of this volume, and Brent et al. (2021) discuss strategies for establishing the five criteria for CL according to the Johnson & Johnson model in an online course.)

In another major development that began near the end of the 20th century, the ABET (Accreditation Board for Engineering and Technology) program accreditation system changed from primarily credit-counting (how many required credits of engineering science, engineering design, general education, etc.) to an outcomes-based system in which engineering degree programs must adopt both technical and professional learning outcomes, formulate methods of assessing how well the students are attaining those outcomes, and document measures taken to remedy deficiencies revealed by the assessments. Variations of this system have been adopted in countries around the world. Among other effects of this change, imparting teamwork skills to students has become a fundamental requirement for accreditation of engineering programs, and the proper use of CL has been shown to promote the attainment of all the ABET-specified learning outcomes (Felder & Brent, 2003). The growing worldwide use of CL in engineering courses may be attributable in large measure to these developments. The shift to outcomes-based accreditation also elevates the importance of alignment among outcomes, assessment, and instruction, which Streveler and Smith (2020) argue are best operationalized as enduring outcomes, feedback, and practice.

The following two sections briefly recount the histories of this chapter's coauthors' involvement with the introduction and growth of CL in engineering education, continuing the narrative of the origins of cooperative learning begun by Davidson (2021).

Karl's Story

I was hired as a researcher in a materials processing lab at the University of Minnesota in 1972 and rarely taught during the first few years. In the mid-1970s I was assigned to teach a third-year course in metallurgical thermodynamics and kinetics. In that course, I used the only pedagogic approach I had seen as a student—lecture, homework, exams—and was shocked when frequent questions indicated that most students had no idea what I was talking about. Instead of following the common practice of blaming them, I decided to look for better ways to help them learn.

I began by exploring courses offered by The University of Minnesota College of Education across the street from the lab where I worked. The first course I took—Social Psychology of Learning, designed by David Johnson—introduced me to CL and the ideas of positive interdependence and individual and group accountability. My "first encounter with cooperative learning" story is available in Smith (2010). As I began implementing CL in my engineering classes, David and Roger Johnson welcomed me into their research group and encouraged me to conduct systematic experimentation on CL. The well-documented success of their methods led me to switch my PhD efforts from metallurgical engineering to educational psychology, which in turn led to a career-long collaboration with the Johnsons.

I introduced CL to the engineering professoriate in a *Journal of Engineering Education* article (Smith, Johnson & Johnson, 1981). Initially, many professors were skeptical about students working together in and out of class, with some even regarding it as cheating. Fortunately, after reviewing the growing body of research on CL, some of them began to experiment with it in their classes, and word of the power of this new teaching approach to improve both students' learning and their development of teamwork skills began to spread throughout the discipline (MacGregor et al., 2000; Smith, 1996, 2014). Since then I have facilitated hundreds of workshops for higher education faculty and graduate students focused on effective implementation of cooperative learning as well as supporting faculty and students' use of teamwork (Cheruvelil et al., 2020; Smith, 2014), emphasized building engineering education research capabilities (Pitterson et al., 2020; Singer & Smith, 2013; Smith, 2011, 2014; Streveler & Smith, 2010), and helped start the engineering education PhD program at Purdue, which has a streamlined course design model at its foundation (Streveler & Smith, 2020).

B. Rich's Story

I joined the chemical engineering faculty at North Carolina State University in 1969 and for the first decade of my academic career I was a conventional instructor, relying entirely on lectures and individual homework assignments in my classes. I enjoyed teaching and got decent ratings, but frequent low exam scores alerted me that many students weren't learning the material I had covered in excruciating detail in my lectures.

In the early 1980s I began using active learning and quickly saw improvements in my students' performance. At about that time I encountered Karl Smith's work on cooperative learning and was impressed by the volume of solid research he cited on the effectiveness of that approach, and soon afterwards I attended a workshop he gave at N.C. State. I started using CL for homework assignments, and my students' average assignment and exam grades rose to a level significantly higher than I had ever seen before.

My experimentation culminated in 1991, when I began an NSF-funded longitudinal study in which I taught a core chemical engineering course in each of five consecutive semesters to the same cohort of students, using CL and other student-centered methods. In collaboration with a cognitive scientist and an educational statistician, I tracked the students' academic performance and assessed their confidence in their skills and their attitudes about their instruction. As the study proceeded, my colleagues and I published articles that included descriptions of the teaching methods I used (Felder, 1995) and results of comparing the experimental cohort's assessment data with that of a traditionally-taught comparison group (Felder, Felder, and Smith, 1998).

Following Karl's role modeling, I have given hundreds of invited workshops on student-centered pedagogy on campuses and at STEM education conferences. In the process, I have become quite familiar with STEM faculty skepticism about using cooperative learning in their disciplines. Fortunately, unlike in the years when Karl and I first started on this path, the skeptics are now a steadily decreasing minority.

Research Case for Cooperative Learning

The theoretical and empirical research case for cooperative learning was strong in 1981 when Karl introduced CL to engineering educators in an ASEE/IEEE *Frontiers in Education* conference paper and a *Journal of Engineering Education* article (Smith, Johnson, and Johnson, 1981a, 1981b). The case was based on Deutsch's (1949a) and Johnson and Johnson's (1974) theoretical foundations and research and systematic studies such as Deutsch (1949b) and Haines and McKeachie (1967), and higher education research continued to support the case (Johnson, Johnson, and Smith, 1991).

A concern was that only a small subset of that research was conducted in STEM classrooms. James Cooper, Jean MacGregor, and Karl recommended to leaders in the National Institute for Science Education at the University of Wisconsin that they support a meta-analysis of studies comparing CL with traditional education in STEM disciplines. The study was conducted (Springer, Stanne, and Donovan, 1997, 1999), and the results made a compelling case for CL in engineering: mean effect sizes for its effect on students' achievement and persistence were found to be 0.51 and 0.46, respectively. The authors observed that "The 0.51 effect of small-group learning on achievement reported in this study would move a student from the 50th percentile to the 70th on a standardized test. Similarly, a 0.46 effect on students' persistence is enough to reduce attrition in STEM courses and programs by 22%." Several subsequent studies supported those conclusions.

The Johnson, Johnson, & Smith CL Model

Of the different CL models described in the education literature, the one designed by David and Roger Johnson has been used most frequently in engineering education (Davidson, 2021, Ch. 3; Johnson & Johnson, 1974; Johnson, Johnson, & Smith, 1991a, 1991b). Social interdependence theory (Deutsch, 1949) is at the heart of the model, which specifies five essential elements that must be in place for team assignments and projects to qualify as cooperative learning:

(1) **<u>Positive interdependence</u>.** All team members must believe that they cannot individually succeed unless the other members of the team succeed, and they should all work diligently toward the goal of group success.

(2) **<u>Individual accountability/personal responsibility</u>**. A basic goal of CL is for all team members to acquire both content knowledge and technical and teamwork skills. To this end, all members are held individually accountable for all the learning the team assignments are designed to impart and for doing their fair share of the work.

(3) **<u>Promotive interaction</u>.** Rather than group members separately completing parts of an assignment and then assembling and submitting those parts without attempting to understand what their teammates did (a common practice in unstructured groupwork), a cooperative team maximizes learning through synchronous interactions—face-to-face or online—in which members explain to one another the concepts, methods, and solutions the completed product contains.

(4) **<u>Appropriate use of social/teamwork skills</u>.** Successful cooperative effort requires skills including leadership, decision-making, trust-building, communication, and conflict management. These skills do not come naturally to most students—they must be taught as purposefully and precisely as academic skills.

(5) **<u>Group processing</u>.** Team members periodically discuss how well they are achieving their goals and maintaining effective working relationships. After identifying member actions that have been helpful and unhelpful, they decide what to continue or change.

The presence of these five elements distinguishes cooperative learning from traditional groupwork. The strong research and theoretical support for the model is summarized by Johnson & Johnson (2021), and details for putting the model elements in place are given by Felder & Brent (2016, pp. 256–263), Johnson, Johnson, & Smith (2006, 2014), and Smith (1996, 2000b).

Implementing CL in Engineering Courses

Although engineers must learn how to compete effectively, learning how to cooperate effectively is equally—if not more—important (Smith, 2011). Unfortunately, engineering education has historically emphasized competition far more than cooperation, and so most engineering students have failed to develop the mindset and teamwork skills needed by successful engineers that are engendered through cooperative learning.

To successfully implement CL, engineering instructors must assign challenging tasks to learning teams that consistently adhere to the five defining CL conditions. The instructors should carry out the following steps (Smith, 1996):

1. Make pre-instructional decisions—for example, formulate learning outcomes and objectives and criteria regarding team size and composition.
2. Clearly explain to the students their assigned task, the CL structure they will follow, and the measures that will be taken to establish positive interdependence and individual accountability.
3. Monitor each learning group and intervene when needed to improve their taskwork and teamwork.
4. Assess the quality and quantity of student learning and the effectiveness of the teamwork, providing affirmation and corrective feedback when appropriate.

Following are some of the common cooperative learning structures that have been used in engineering.

Team Homework Assignments

Some problem-solving assignments are carried out by instructor-formed student teams, while others are done individually. The team assignments are first graded, and the team grades are then individually adjusted for each team member based on how well they fulfilled their responsibilities to the team, thus providing individual accountability. We discuss a well-validated method to assess team member performance later in this chapter.

When teamwork first begins, the students should be cautioned not to simply meet with their teams and complete each assignment together. The reason for this warning is that one team member is usually the fastest problem solver and begins almost every problem solution, and the other members must then figure out how to start the solutions for the first time on the individual exams, which is a terrible time for them to have to do it. Instead, team members should be encouraged to outline solutions individually before meeting to work out the details. To help them acquire the habit, we recommend asking them to sign and hand in their individual outlines for the first few assignments. The outlines should not be graded, but points should be deducted if they are not turned in.

In-Class Problem-Solving Teams

An approach particularly well suited to recitation sessions and flipped classrooms is to have students work in teams of two to four in class to solve problems. The instructor circulates to monitor and assess how the students are progressing and what challenges they face, and periodically calls on teams to present and discuss their work.

Laboratory Experiments and Other Projects

Teams submit reports on lab experiments and other team projects. As with the problem sets, the reports are first graded, and the team grade is then adjusted for individual team member performance. If a rubric is to be used for grading the reports (which makes the grading both reliable and efficient), it should be discussed with the students before the reports are written (Smith, 1998). During the discussion, the teams might be asked to grade one or two sample reports (including one poor one) using the rubric and then to compare their grades with grades the instructor would have given those reports. This strategy helps the students quickly understand what the instructor is looking for, and the high quality of many of their first efforts reflects that understanding (Felder & Brent, 2010; 2016, pp. 180–181).

Jigsaw

Jigsaw is a CL structure ideally suited to engineering team projects that call for knowledge in several distinct areas (Aronson et al., 1978; Davidson, 2021, pp. 146–164; Johnson, Johnson, & Smith, 1991b; Smith, 2000b). In a laboratory exercise, for example, areas of required expertise might include experimental design, equipment calibration and operation, data analysis (including statistical error analysis), and interpretation of results in light of theory. In a design project the areas might be conceptual design, process instrumentation and control, safety and environmental impact evaluation, and cost and profitability analysis.

If four such areas are identified for a project, the students form teams of four and the team members each assume primary responsibility for a different area. They all then receive specialized training in their areas of expertise in the form of handouts or presentations by the course instructor or a knowledgeable colleague or graduate student, after which they return to their home teams and complete the assignment, relying on one another to contribute their specialized knowledge when appropriate. If an expert does a poor job, the quality of the final project is compromised, and everyone’s grade suffers (positive interdependence). Moreover, if the students are tested on all the areas of expertise, their learning increases substantially since they must now understand the entire project and not just the parts they were primarily responsible for (individual accountability).

Cooperative Problem/Project-Based Learning (PBL/PrBL)

Common cooperative learning implementations in engineering education include two kinds of challenge-based learning (Bransford, Vye, & Bateman 2002): problem-based and project-based. The formats for both approaches are similar; however, the goals are different. In problem-based learning, the goal is to solve a challenging and usually open-ended problem, while in project-based learning the goal is to complete a project and produce a report.

These approaches require a great deal of planning by the students. Team tasks include three different areas of emphasis: (1) developing ideas, approaches, alternatives, initial models and estimates, and completion strategies, (2) formulating and reaching agreement on a problem solution or a project report, and (3) making sure all team members participate and can explain the strategies used to solve the problem or complete the project. Instructors generally use rubrics to grade team products and can provide individual accountability through individual assessments such as exams and quizzes and/or randomly choosing one member from each group to explain problem solutions or the rationale for design decisions. Additional suggestions for grading cooperative projects are available in Smith (1998), and Mohd-Yusof et al. (2011) and Smith (2000b) provide more information on cooperative problem/project-based learning.

What Problems Can Arise in Teamwork?

In CL workshops, current and future faculty members invariably raise concerns about team assignments, often based on problems they experienced when they taught using groupwork or they were in student groups themselves. Cooper, MacGregor, Smith, and Robinson (2000) discussed several common challenges—reduced content coverage, reduced amount of learning, need for prerequisite learning, importance of solitary learning, colleagues' challenges, student resistance, logistics, evaluation, use of teaching assistants, and the question of time— with responses from the faculty they interviewed. Here are some common concerns in engineering education:

- Students will be nervous, resistant, or outright hostile to the idea of working in teams, especially if they cannot choose their teammates (Andrews et al., 2020; Felder, 2007, 2011; Felder & Brent, l996; Tharayil et al., 2018).
- Planning and implementing effective team assignments and projects and establishing the five essential elements of cooperative learning will add an inordinate additional load to the already extreme time demands placed on instructors by their research, teaching, and service responsibilities.
- Teams will become dysfunctional due to poor leadership, ineffective project and time management, and conflicts arising from irresponsible or overly dominant team members or interpersonal differences. Some instructors argue that they were trained to be engineers, not psychologists or social workers: they have no idea how to deal effectively with such problems and having to deal with them will make an already unmanageable time load even worse.

As with any other pedagogical method, the ability of cooperative learning to produce the learning and skill development promised by the research depends heavily on how well the instructor implements the method. The next section offers suggestions for effective implementation.

Making Cooperative Learning Effective

Effective teamwork provides a good balance between high expectations, which promote high-level skill development but place stress on many students, and high personal and social support levels, which mitigate the stress and improve students' performance (Pelz, 1976; Pelz and Andrews,1966; Edmondson, 1999, 2008). Achieving and maintaining this balance is important in both face-to-face classes (Felder & Brent, 2016, pp. 255–261; Oakley et al., 2004, 2007; Smith, 1996, 2011; Smith et al, 2005) and online classes (Brent, Prince, and Felder, 2021; Prince, Felder, and Brent, 2021; Streveler and Smith, 2020).

As previously noted, students unaccustomed to cooperative learning do not always welcome the challenges it presents, and they may show resistance or hostility when they are first introduced to it, which if not quickly addressed can lead to an instructor losing control of the class. To minimize the duration and severity of the resistance without lowering expectations, the instructor should take several steps before beginning to implement CL in a course and as the course proceeds:

- ***Define course learning outcomes*** (the knowledge and skills the students are intended to acquire or improve, including communication and teamwork skills) ***and learning objectives*** (the observable tasks the students should be able to complete if they have achieved the specified outcomes). The outcomes and objectives should provide the basis for selecting the course content, choosing specific pedagogical methods, and designing the assignments and assessments (Felder and Brent, 2003; 2016, Ch. 2). (<u>Note</u>: This terminology is standard in engineering education. In other disciplines, outcomes, objectives, and competencies have different meanings and are sometimes used interchangeably.)
- ***Formulate policies.***
  - *Course grading policies*. Instructors should avoid norm-referenced grading ("grading on the curve"), wherein students' letter grades in a course are directly determined not by their academic performance but by their position on a list of weighted average numerical course grades. This unfortunately common approach to grading makes it difficult to motivate top students to work cooperatively. Many of them worry that if they help their classmates too much, they could lower their own position on the list and get a lower course grade than they would have if they had worked individually. If, on the other hand, instructors use criterion-referenced (absolute standards) grading, in which students' final grades are based entirely on their weighted average test and assignment grades and not on their class ranking, all students are incentivized to work together and to help one another learn, thus establishing positive interdependence (Bloom, 1984; Felder & Brent, 2016, pp. 49–51; Grant, 2016; Smith, 1986, 1998).
  - *Policies regarding adjustment of team assignment grades for individual team member performance.* Recommended adjustment procedures involve team members assessing their teammates' and their own performance, focusing more on how well they fulfill their responsibilities to the team and support their teammates than on their intellectual contributions. The *CATME Smarter Teamwork* suite of online teamwork tools (CATME, n.d.; Felder & Brent, 2016, pp. 250–251) includes a well-validated rubric for conducting that assessment (CATME originally stood for Comprehensive Assessment of Team Member Effectiveness) and an algorithm for making the corresponding grade adjustment. As of November 2020, CATME had about 1.6 million student users taught by 3814 instructors in 3400 institutions in 53 countries.
  - *Team formation policies.* Most students would prefer to form their own teams, either teaming with friends or, if they are top students, teaming with other top students to maximize their grades. Instead, instructors should form the teams, among other reasons because engineers (and most other professionals) must learn to work with teammates who may have different ability levels and work ethics, and college students should routinely get practice in the skills required in their future professions.

Instructors must also select the criteria they will use to form the teams (Felder & Brent, 2016, pp. 248–250). Common criteria include teams of three or four, members diverse in academic ability measures such as GPA and grades in prerequisite courses, members with common blocks of time to work together outside class, and no isolated members of underrepresented groups historically at risk of failure.

Gathering the information needed to sort the students into teams using specified formation criteria and then manually doing the sorting can take many hours if the class is large. To drastically reduce the required time, instructors can use *TeamMaker*. a component of the *CATME Smarter Teamwork* suite of online teamwork tools. At the beginning of the course, the students register in the course CATME account and *TeamMaker* prompts them to enter the instructor-specified information (e.g., times during the week when they are available to meet with teammates), and then the program instantly sorts them into teams using the criteria.

  – *Team dissolution policies.* Instructors should also specify when and how teams may dissolve and reform or fire uncooperative team members, and when and how team members may quit uncooperative or otherwise dysfunctional teams (Felder & Brent, 2016, pp. 260–261, Smith, 2014, pp. 58–62).

- ***Motivate working in teams***. Students' initial resistance to cooperative learning can be reduced or eliminated by showing them that working in teams on assignments is in their best interests. For example, instructors can refer to extensive research showing that CL leads to more learning and higher grades than the individual/competitive model of traditional education and offer to share that research with any students who want to see it. Students will rarely if ever ask to see the research and will generally participate in teamwork long enough to start seeing the benefits for themselves. Felder & Brent (1996) and Felder (2007, 2011) offer other motivational arguments.
- ***Have teams create and endorse a team charter*** (Smith, 2014). Common features of team charters include team name, members, mission statement, goals, ground rules (guiding principles for team participation), and shared aspirations and expectations. Periodically during a course, the teams should be asked to reflect on how well they have adhered to the commitments they made in the charter and how they can strengthen their adherence.
- ***Take measures that help establish one or more of the five elements of cooperative learning.*** Any of the measures suggested in the section defining the five elements will contribute to the quality of team products and the students' development of high-performance teamwork skills, and they will also decrease the occurrence of most common teamwork problems.
- ***Provide training in individual team member assessment using CATME*** (CATME, n.d.; Ohland et al., 2012). CATME provides descriptions of hypothetical team members' behavior that students can evaluate using the team member performance rubric and then get feedback on the appropriateness of their ratings. Once such training has been provided, students' subsequent ratings of their own team members and themselves tend to have high levels of reliability and validity.
- ***When interpersonal conflicts among team members create problems, give the members tools to resolve the problems themselves, and take remedial steps when they are unable to do so.*** Instructors can hold brief in-class *crisis clinics* where students in small groups brainstorm possible team responses to common problems such as an uncooperative or overly dominant team member or a member whose teammates are unwilling to contribute to the team effort. Put the complete list of brainstormed solutions in front of the class, and

then have the groups choose the best first response, the best second response if the first one is unsuccessful, and the best last resort response. The troubled teams will leave that session armed with excellent strategies for dealing with the problem in question, and the offenders may anticipate some unpleasant moments ahead and decide to change their offending behaviors.

Another common problem occurs when a team is split into two contentious factions that have been unable to resolve a disagreement. The instructor can then use *active listening* to seek a resolution, in which one side makes its case with no interruptions, the other side repeats the first side's case with no rebuttals, the process is reversed, and finally the two sides work out a compromise solution (Felder & Brent, 2016, pp. 264–266).

Above all, be patient and persistent

When implementing cooperative learning, instructors must be patient and persistent because all students do not immediately see the benefits of this approach when they are first introduced to it. Within two or three weeks most, if not all, student resistance disappears if the steps outlined in the previous section are taken (Andrews et al., 2020; Tharayil et al., 2018). Even if a few students remain unhappy or a few teams remain dysfunctional, don't let it discourage you. No teaching method will always succeed for all students. Continued use of cooperative learning will allow most students to get the research-proven benefits of increased learning and teamwork skill development, and that is all a teacher can realistically wish for.

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Note: Many of the cited journal articles and columns authored or coauthored by Karl Smith can be found at <*karlsmithmn.org*>, and those by Richard Felder at <*www.ncsu.edu/effective_teaching*>.

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