Evaluating students' collaborative work requires a variety of diagnostic and formative assessments.

Grading Cooperative Projects

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Successful cooperative group projects require an environment in which the conditions for joint project work and the requirement of a single product are carefully integrated and are seen as fair (and we hope beneficial) by the students. Many students have had unpleasant experiences working on poorly structured group projects. A common problem is that the workload is very uneven, so some students do most of the work while others do very little. Another common tension in group project work is students' uncertainty about how good is "good enough," since views about quality typically vary widely. Many problems related to cooperative projects can be eliminated through carefully structured groups and diagnostic, formative, and summative assessment. In essence, we must build quality into the process before assigning and grading cooperative projects.

Keys to Success in Cooperative Group Projects

The key to success in using cooperative group projects is to prepare yourself and the groups. The most important thing faculty can do to minimize problems in grading cooperative projects is to carefully structure the five basic elements of formal cooperative learning groups—positive interdependence, individual and group accountability, face-to-face promotive interaction, teamwork skills, and group processing. The professor's role in this process is first and foremost to make sure that there are good reasons for using the cooperative group work (complex task, multiple perspectives, divisible responsibilities, and so on), that there is sufficient time to complete the task successfully, that students possess the necessary skills and experience for successful group work, and that the instructional goals specify that a cooperative group or groups are required. If several of these conditions are met, then there is probably sufficient reason to use a formal cooperative learning group.

The professor's role in using formal cooperative groups involves the following steps:

1. Specify the objectives for the lesson.
2. Make a number of instructional decisions.
3. Explain the task and the positive interdependence.
4. Monitor students' learning and intervene within the groups to provide task assistance or to increase students' teamwork skills.
5. Evaluate students' learning and help students process how well their group functioned.

The basic elements and professor's role are presented in much greater detail with numerous examples in Smith and Waller, 1997; Smith, 1996; and Johnson, Johnson, and Smith, 1991.

Criterion-Referenced Assessment of Cooperative Group Projects

An underlying foundational requirement for successful use of cooperative learning is criterion-referenced assessment. Assessment is often done using norm-referenced grading, or "grading on a curve," rather than criterion-referenced grading, or an "absolute grading scale." In a norm-referenced grading scheme, students are compared with one another, lined up and given grades A-F relative to one another. In this scheme, no matter how good or poorly the students do in an absolute sense, there are fixed percentages of each grade category (10 percent A's for example). In a criterion-referenced grading scheme, absolute criteria are set (90 percent for an A, for example) and anyone and everyone who meets or exceeds this criterion receives that grade. In this scheme it is possible for everyone (or no one) to get an A.

Norm-referenced grading is often assumed to be the "norm" in higher education, but a national survey conducted by Astin (1993) indicates only about 22 percent of all faculty grade "on the curve." He noted that engineering faculty have the highest percentage of use of this scheme (43 percent), but that it is not used by the majority of faculty.

One of my favorite comments by Milton, Pollio, and Eison (1986) on norm-referenced grading schemes is, "It is not a symbol of rigor to have grades fall into a 'normal' distribution; rather, it is a symbol of failure—failure to teach well, to test well, and to have any influence at all on the intellectual lives of students" (p. 225).

The use of criterion-referenced evaluation is absolutely essential in classes where a high level of student cooperation is structured (group projects, for example). There is nothing more destructive than asking students to work together on projects (and perhaps share a grade) and then pit them against one another by grading them on the curve at the end. One of the most common reasons that cooperative learning, or more broadly, group work, fails is that

faculty put students in a fundamentally incompatible situation—working together cooperatively and being pitted against one another at grading time. Perhaps this high percentage of "grading on the curve" is why many faculty have difficulty using cooperative learning.

Using a Variety of Diagnostic and Formative Assessment Formats

Grading students' projects is a summative assessment process. Faculty can ease the pain associated with that process by building in diagnostic and formative assessment.

We can learn a lot about students when they enter a course by having them complete a student information form. In my courses, during the first week of class, students complete a "course information form" on the Internet that surveys their expectations and motivations for the course and checks on their background and preparation. The previous course work of a student enrolled in a freshman engineering course is shown in Table 6.1.

Similar results were collected for a computer course: see Table 6.2. Seven students were most familiar with Macintosh computers, and twenty-three students were most familiar with IBM-compatible computers. Three reported that this is the first time they used the Internet; thirteen said they had used it a few

Table 6.1. Freshman Engineering Course, Fall, 1996

*Level**	*Probability*	*Statistics*	*Linear Algebra*	*Calculus*	*Analysis*	*Modeling*
1	14	21	10	3	17	28
2	8	3	0	2	1	0
3	4	4	3	5	8	2
4	6	2	4	13	4	0
5	1	0	13	7	0	0

Key: (1) I have never had a course in this area, (2) I had a course but don't remember much, (3) I had a course and remember some of it, (4) I had a course and remember most of it, (5) I had several courses and remember most of them.

Table 6.2. Computer Course, Fall, 1996

*Level**	*Graphing Calculator*	*Email*	*Spreadsheet*	*Word Processor*	*Statistical Package*	*Program Language*	*Computer Algebra*
1	1	3	4	0	26	12	22
2	2	11	11	0	2	9	6
3	8	4	14	6	0	7	1
4	19	12	2	24	0	2	1

Key: (1) I never have used one, (2) I know a little about them, (3) I have used them some, (4) I am very comfortable using them.

times; twelve said they could find their way around fairly easily; and two said they had their own web page.

At the end of the course, each student completes a review form using the Internet. All aspects of the course are surveyed, and this information is considered in revising the course for subsequent offerings. We also, of course, administer a standard form for students to evaluate teaching.

Another level of diagnostic assessment is building quality into the class through the use of continuous improvement processes, such as a student management team. A student management team is used by many faculty to operationalize Total Quality Management (TQM) principles. The operation of these teams is based on shared responsibility: "Students, in conjunction with their instructor, are responsible for the success of any course. As student managers, your special responsibility is to monitor this course through your own experience, to receive comments from other students, to work as a team with your instructor on a regular basis, and to make recommendations to the instructor about how this course can be improved" (Nuhfer, 1995, p. 3).

Typical attributes of student management teams are as follows:

- Teams are composed of three to four students plus a professor (I have had teams of up to twelve members in classes of eighty).
- Students have a managerial role and assume responsibility for the success of the class.
- Students meet weekly; the professor attends every other week. Meetings generally last about one hour.
- Team meets away from classroom and professor's office.
- Students maintain log or journal of suggestions, actions, and progress.
- Team may focus on the professor or on course content.
- Team utilizes group dynamics approach of TQM.

The members of the student management team meet weekly and distribute the minutes of the meeting via email to the teaching team and, when appropriate, to the entire class. Members take turns facilitating the meeting and recording the minutes. A representative of the team reports to the class each week.

Many problems typically encountered by faculty using groups may be eliminated or lessened through careful structuring of the groups and the professor's expectations of the groups. Carefully designed assessment plans also lead to success.

Assessment of Cooperative Group Projects

There are three principal phases—before, during, and after the lesson—in the design of assessment plans for cooperative group projects. Before the lesson, evaluation criteria such as those listed in Exhibits 6.1 through 6.3 must be developed. Be sure to inform students of the criteria, preferably in the course syllabus. Plan how to collect information on students' progress. Define the

Exhibit 6.1. Group Project Report Evaluation Form

Category	*Possible Points*	*Points Received*	*Comments*
Executive summary	20		
Problem	10		
Method	10		
Results	20		
Discussion	20		
References and appendix	10		
Organization Cover page Table of contents	10		
Total	100		

Exhibit 6.2. Dichotomous Scale for Evaluating Writing

	Yes	No		
Substance	___	___	1.	Paper addresses the issue.
	___	___	2.	Paper has a focus, a central idea.
	___	___	3.	Paper develops major aspects of the central idea.
	___	___	4.	Paper shows awareness of importance of main ideas.
Organization	___	___	5.	Structure or pattern of the paper is clear.
	___	___	6.	Paper has an introduction, development, and conclusion.
	___	___	7.	Each paragraph is coherent.
	___	___	8.	Transitions from one idea to next are logical.
Mechanics	___	___	9.	Sentence structure is coherent.
	___	___	10.	Sentences are not awkward.
	___	___	11.	Sentences are varied.
	___	___	12.	Errors in use of verbs are few.
	___	___	13.	Errors in use of pronouns are few.
	___	___	14.	Errors in use of modifiers are few.
	___	___	15.	Errors in word usage are few.
	___	___	16.	Punctuation errors are few.
	___	___	17.	Spelling errors are few.
Evidence	___	___	18.	Statements are accurate.
	___	___	19.	Opinions are adequately supported.
	___	___	20.	Sources are identified and documented appropriately.
Mechanics (alternative)	___	___		Paper shows control of grammar.
	___	___		Paper shows control of syntax.
	___	___		Paper has few misspellings.

Exhibit 6.3. Persuasive Argument Composition Rubric

Name: _____ Date: _____

Title of Composition: _____

Scoring Scale: Low 1–2–3–4–5 High

Criteria	*Score*	*Weight*	*Total*
Organization:		6	
Thesis statement and introduction			
Rationale presented to support thesis			
Conclusion logically drawn from rationale			
Effective transitions			(30)
Content: Topic addressed		8	
Reasoning clear with valid logic			
Evidence presented to support key points			
Creativity evident			(40)
Usage:		4	
Topic sentence beginning every paragraph			
Correct subject-verb agreement			
Correct verb tense			
Complete sentences (no run-ons or fragments)			
Mix of simple and complex sentences			(20)
Mechanics:		2	
Correct use of punctuation			
Correct use of capitalization			
Few or no misspellings			(10)
Scale: 93–100 = A; 87–92 = B; 77–84 = C			(100)

process of learning, especially the number and type of iterations permitted on students' work.

During the lesson, observe and sample groups, or interview individual students. In addition, collect interim group products or informal products such as "minute" papers, a one-minute opportunity for students to write a response to a particular issue.

After the lesson, collect the group product and evaluate it using the format and rubrics outlined before the lesson began. A single product, such as a group report, is a common part of cooperative group work. The procedure I use for reviewing and grading cooperative group projects is a table such as the one reproduced in Figure 6.3. A copy of this form is included in the syllabus along with specific suggestions for items to include in each section.

In addition to using a clearly defined grading form such as the one in Figure 6.3, it is also important to provide rubrics indicating what you're looking for in each of the categories. This information is also included in the syllabus in my courses. A simple, dichotomous scale for evaluating writing from Moss and Holder (1998) is presented in Figure 6.4. A more complex rubric from Johnson and Johnson (1996) for grading a persuasive argument composition is presented in Figure 6.5.

Making Assessments Meaningful

According to Johnson and Johnson (1996) three components lead to meaningful assessment: (a) significant purpose, (b) student involvement, and (c) future learning.

To be Meaningful, Assessment Must Have a Purpose That Is Significant. For instance, assessment should give students and other stakeholders accurate and detailed feedback both on the process students are using to learn and the quality and quantity of their learning. Assessment should also improve learning and instruction.

Assessments Are Meaningful When Students Are Involved in Conducting the Assessment. In meaningful assessments students understand the assessment procedures, invest their own time and energy in making the assessment process work, take ownership of assessing the quality and quantity of their work, and want to share their work and talk about it with others.

Meaningful Assessments Provide a Direction and Road Map for Future Efforts to Learn. Meaning is created through involvement that leads to commitment and ownership. Professors must ensure students are involved in these five steps for making assessment meaningful:

1. Setting learning goals
2. Planning how to achieve their learning goals
3. Determining progress and success in achieving their goals

Assessment results help students

4. Take pride and satisfaction in their efforts to learn.
5. Set new learning goals and repeat the first four steps.

Assigning Students' Grades

Most faculty who make extensive use of cooperative learning use a combination of group and individual assessment. I have done show-of-hands surveys of hundreds of faculty during cooperative learning workshops that revealed that the percentage of individual students' grade based on the evaluation of group work typically ranges from 5 to 20 percent. Some faculty use higher percentages in project-based courses, such as senior design projects in engineering. For example, Exhibit 6.4 shows grade breakdown from a recent senior-level civil engineering class I taught.

Conclusions

Assessment, especially grading, is fraught with problems, and the grading of cooperative projects is no exception. Indeed, it adds more complexity. These

Exhibit 6.4. Grade Breakdown in Civil Engineering Course

Grades will be based on the following:

Group	*Maximum*
Group Projects (4 at 100 points each)	400 points
Final Examination	100 points
Individual	
Homework (10 points each)	50 points
Midquarter Examination 1	100 points
Midquarter Examination 2	100 points
Brief Reviews (2 at 25 points each)	50 points
Heuristics Project	75 points
Review or Application Project/Paper	125 points

Course Grades:

A 900 points and above
B Between 800 and 899 Points
C Between 700 and 799 Points

A grade of D or F is available upon request. Although students will be given grades of I if necessary, it is highly discouraged. Absolutely no incompletes will be given for uncompleted group work.

problems are not new, but have been debated throughout the history of education. The problems inherent in giving students grades have led some to study grading and marking (Becker, Geer, and Hughes, 1995), others to advocate abandoning grades (Sager, 1995), and has led many others to advocate focusing on learning and not on grading (Deutsch, 1985; Smith, 1986). Cooperative learning is an extraordinarily effective way to help students learn (Johnson, Johnson, and Smith, 1991) even in science, math, engineering, and technology (Springer, Stanne, and Donovan, 1997). Grading cooperative projects, although challenging and difficult, can, if done carefully, help students and faculty reap the benefits from and with one another through cooperative interaction.

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