Getting a Grip on Groups

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Introduction

Teamwork: industry wants it and ABET 2000 requires it. But effectively implementing and managing student groups for class projects, lab work, and presentations is a complex affair, one that requires organization, understanding, and tact. This paper offers a general overview of the current state of group work in technical classes by examining ASEE literature for the past three years and comparing that information with the results of a survey of Oregon Institute of Technology technical faculty, aimed to pinpoint practices and problems involving student work groups.

Literature Trends

The literature regarding student groups is rich and varied. Even a small snapshot of focused journals and conference proceedings yields dozens of resources, with content ranging from a variety of study results to classroom methodologies. To determine the current state of affairs, I searched ASEE publications for 1996-1998, specifically the *Annual Conference Proceedings*, *FIE Conference Proceedings*, *Prism*, and the *Journal of Engineering Education*. Articles which discuss student groups appear under a variety of general subject headings: cooperative learning, collaborative learning, active learning, group work, teamwork, interactive learning. Despite the diversity and number of articles, most tend to fall into one of the themes explained below: enhanced learning, course applications, group formation, interpersonal skill development, and assessment.

Enhanced Learning

Most of the articles that detail positive experiences with group work note an important side benefit: students tend to learn more in groups because the members develop what Johnson and Johnson have dubbed a "positive interdependence,"[22] resulting in enhanced "short-term memory, long-term retention, understanding of course material, critical thinking, and problem solving skills."[34]

A 1996 study by Jones and Brickner compared two sections of a sophomore basic mechanics course, one traditional lecture and the other cooperative learning. In the three areas evaluated, the cooperative learning class consistently fared better, scoring 7-10% higher on exams and averaging half a letter grade higher. In addition, the experimental section displayed a better attitude towards study habits and rated teachers higher on faculty evaluations. The authors further note that 90-95% of students in the cooperative learning section "expressed positive comments towards this approach."[23]

Other studies cite similar dramatic results of incorporating cooperative learning techniques[9, 11, 18, 20, 36, 37, 51, 55, 56] and explain that students not only learn more about course content; they learn more about each other and their instructor, thereby enhancing overall class quality[42] and facilitating transfer of skills to the workplace.[16]

Course Applications

The bulk of articles on student groups, especially the conference proceedings papers, tend to detail applications to specific courses. Many authors bemoan the old method of lecture and frequently begin their papers by noting, for example, how "the profession is dominated by the same learning paradigm that has educated engineers for the last several decades, namely, passive classroom lectures, individual homework assignments, and problem-solving exams."[26, 38] From the perspective of a literature reviewer, however, it is refreshing to note how many instructors across the country, and some internationally, are experimenting with students groups in a wide array of courses:

- chemical[9]
- civil[6]
- computer integrated manufacturing[11]
- computing[5, 33, 50]
- construction technology[45]
- design[40]
- electronics[35, 49, 57, 58]
- engineering economics[30, 31]
- engineering ethics[56]
- environmental[17, 26]
- fluid dynamics[15]
- freshman orientation[10]
- industrial and systems[52]
- international research[4, 7]
- labs[19]
- machine design[55]
- manufacturing management[46]
- mechanical[24, 44]
- statistical process control[47]
- writing[39, 54]

Judging from this small sampling of articles, exciting things are happening.

Group work is not limited to the traditional classroom setting; several instructors are experimenting with multidisciplinary groups, in response to ABET 2000.[6, 8, 28, 53] Other groups are inter- and cross-disciplinary.[1, 17] And at least three faculty are using the Internet and various instructional technologies to experiment with cooperative learning in virtual environments.[3, 12, 27]

Group Formation

According to the literature, group formation is a result of either random selection, student selection, instructor selection, or personality-type testing. The purpose of the activity may dictate the method for group formation. For facilitation of class discussion, randomly dividing the class into small groups is efficient and useful.[19] For more complicated, long-term projects, instructor selection may result in a more productive group.[50] Some authors are adamantly against student-selected groups; Schultz, for example, cautions, "Whatever you do, do not allow the groups to self-select" and offers several horror stories to illustrate his point.[41]

Class size poses no obstacle to implementing cooperative learning. In fact, using groups in classes with enrollments of 75 or more is as effective, or even more so,[21] as in smaller classes. Two articles discuss using groups in large classes: Mehta (1998) uses a flashcard method and explains that "groups serve as a break when students' attention falters."[34] Jones and Brickner state that cooperative learning techniques are very beneficial in large classes where students feel isolated from each other and their instructor: group activities "increased interpersonal interaction among students, promoted greater social support, and improved student self esteem."[23]

Still other articles report that personality-type tests are useful for forming groups which must function over long time spans (the "base" groups). In an insightful and useful 1996 *Prism* article, Richard Felder examines four learning styles models and offers small case studies of usage by faculty across the country. "Whether educators are designing a course or curriculum; developing instructional software; forming cooperative learning teams; or helping students develop interpersonal, leadership, and communication skills," concludes Felder, "they will benefit from using any of these models."[14]

Another 1996 article, reporting the initial stage of a projected five-year longitudinal study, examined student thinking preferences at the University of North Carolina, Charlotte. Researchers used the Hermann Brain Dominance Instrument (HBDI) and the Myers-Briggs Type Indicator (MBTI) to profile 487 entering freshman and form student project teams in two courses. Teams were balanced by academic discipline and HBDI quadrant type. Preliminary data indicate that HBDI "has significant value as a self-awareness tool in developing team and individual skills."[48]

Interpersonal Skill Development

All of the literature examined indicates that cooperative learning techniques have a dramatic effect on students' "people" skills, an important professional attribute. For a group to function productively, individual members must relate well to each other and learn effective methods for conflict resolution. "Trust," notes Robert Martinazzi, "is the key ingredient...of good team communications."[31]

Several articles provide details of exercises to help groups ward off dysfunction before it occurs. At the University of Oklahoma, for example, students take RATs (readiness assessment tests) both individually and as a group.[25] At the University of Pittsburgh, Johnstown, student groups write mission statements, identify work roles, and develop "operating processes" to guide their work.[31] At Tennessee Technological University, senior mechanical engineering students participate in three team-building sessions over the course of the semester and develop documents to maximize group effectiveness: one that lists factors which help groups function well, another that lists "group rules" detailing expectations of group members and providing rules of conduct, and a third that re-examines the group rules.[55]

These articles also emphasize that students must receive preparation for group work and learn techniques for effective interaction.[43] As Goodwin and Wolter explain, "We can not [*sic*] expect students to learn the principles of team dynamics at home with the family anymore than we could expect them to learn the principles of thermal dynamics in the garage....”[18]

Assessment

Evaluation of group work is another important area addressed in many articles, and the range of methodologies is indeed broad. Instructors wrestle with equity, and the issue of what to do about students who coast along on the achievements of others is an important--and frustrating--one. The literature offers several possibilities.

Some instructors rely on traditional or collaborative quizzes and exams to test group effectiveness,[1, 9, 23, 48, 58] and many incorporate some sort of peer review.[1, 22, 29, 32, 48] Robert Martinazzi has been particularly active in the latter, developing a peer review instrument which includes 10 items, developed from student input, for evaluation. Items include such statements as “Shows up for team meetings”; “Demonstrates respect for other team members”; “Willing to help other team members in and out of class”; and “Has positive attitude towards the team.” Students rate team members on a Likert scale, and results are equivalent to one quiz grade.[29] “Peer evaluations,” notes Shellnut et al., “were often the most significant determining factor in overall team member’s grade differentiations.”[48]

The weight given to group work as a part of the overall grade varies quite a bit. For one instructor, the team project is the final exam,[13] while for others, group work counts as a percentage of the term grade, such as 25%[11] or 62.5%.[32] No instructor, at least in the articles examined, has used group work to determine a student’s entire grade for a course.

Other instructors conduct focus group interviews intermittently and at the conclusion of a project.[1, 23] These sessions are illuminating and have led to formal recommendations for more faculty involvement in student groups.[1]

An examination of the literature about student groups in technical classes indicates that engineering and technology instructors find that group work improves class dynamics and makes students more amenable to learning. Even though some problems are apparent, they are not irresolvable; in fact, these difficulties allow for pedagogical creativity in problem solving.

Faculty Practices

Do faculty classroom practices actually reflect what the literature recommends? In an attempt to answer this question, short surveys were sent to 44 technical faculty at Oregon Institute of Technology in civil engineering and several engineering technology programs: mechanical/manufacturing, electronics, lasers, surveying, and computer systems, both hardware and software; 25 (56.8%) were returned. The survey included a variety of multiple-choice questions relating to classroom use of student groups, such as how instructors form groups, what students do in their groups, how groups are evaluated, whether outcomes are satisfactory, what problems have emerged. The survey also included open-ended questions, such as “If you could change one thing about student groups, what would that be?”

Of the surveys returned, 84% indicated that they use student groups in classes; only four faculty noted that they do not and cited these reasons: the course is incompatible with group work (straight lecture class), faculty are dissatisfied with outcomes, or, as one instructor noted, it's "too easy for individuals to get lost in the cracks."

Most faculty use groups to better prepare students for careers, as shown in Figure 1. They cited reasons such as "Teamwork is valued by industry," "discipline [surveying] requires it." Two pointed out interpersonal and pedagogical benefits: teamwork "facilitates bonding" between students, especially at the freshman level, and groups can result in "increased learning for students and instructors." Only one faculty member uses groups because it is less work for the instructor, and very few use groups because collaboration is a popular pedagogical technique or because ABET 2000 lists multidisciplinary teams as a criterion. Four faculty use groups because of a resources shortage, so students perform their lab experiments as teams or small groups. This is the only time these four instructors include group work.

OIT instructors tend to allow students to choose their own groups (see Figure 2). Although one noted that this is "not a good method," it seems to be most efficient, especially for short in-class exercises or class discussions. A few assign groups in order to ensure a mix of abilities, and fewer still use random selection. Faculty do not use learning styles tests, such as MBTI or Kolb, for group formation. Informal conversation indicates that time may be a factor; a 10-week quarter passes very quickly, and many instructors feel pressured to "cover" required content, allowing little time to devote to preliminary testing.

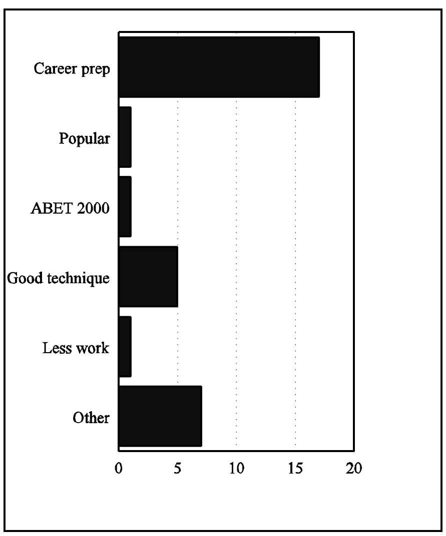

Figure 1. Why use groups?

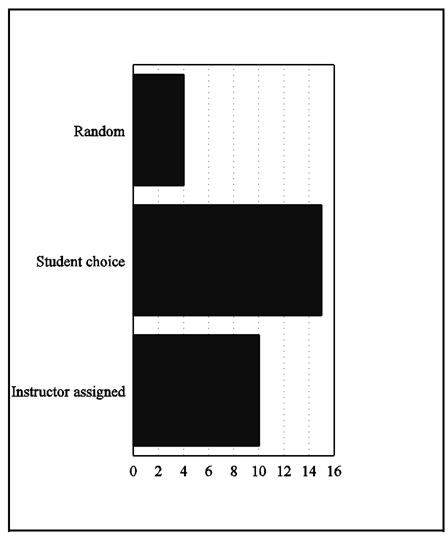

Figure 2. How are groups formed?

Students perform a variety of tasks in their groups (Figure 3). By far the most popular group assignments are term-length projects, followed by shorter assignments, such as reports or memos. Several instructors link longer projects and oral presentations, while others use groups primarily to promote class discussions or respond to questions raised in class. One department requires that senior projects be a group activity.

Faculty noted a number of problems associated with student work groups, with non-participants being the most serious and most detrimental to the group's productivity. Other problems are illustrated in Figure 4 and include scheduling difficulties, especially with non-traditional students who are trying to simultaneously attend school, work full-time, and raise a family; personality clashes among group members; one group member doing all of the work; and a belief that students "want to do their own work" and not be involved in group activities.

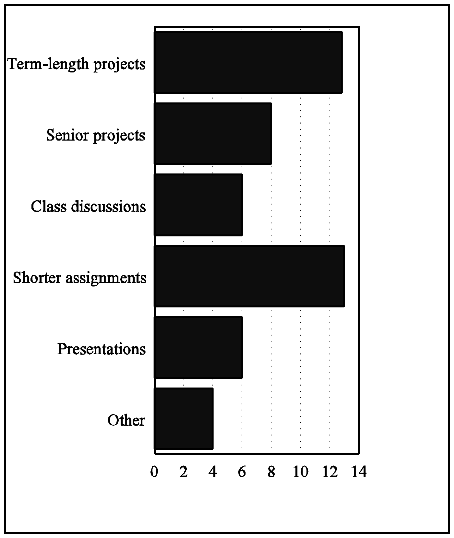

Figure 3. What do students groups do?

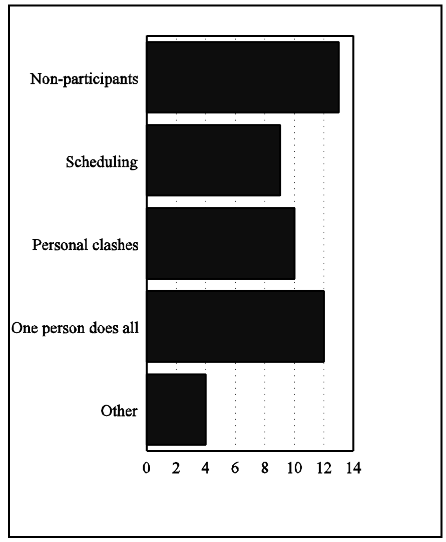

Figure 4. What problems emerge?

Fairly evaluating group work poses a problem for faculty who want to ensure equity. OIT faculty use an assortment of assessment methodologies, as shown in Figure 5. All respondents indicated a combination of evaluation techniques, with peer review being an essential component. The comment of one instructor, who indicated that he would change his grading system to "group grade plus individual component" as a result of completing the survey, indicates a certain level of confusion about assessment methods that will preserve group integrity yet allow for exceptional or poor individual performance within the group.

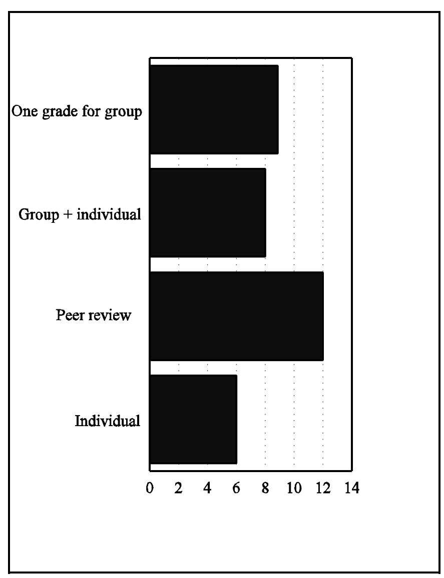

Figure 5. How is work evaluated?

One further problem that a number of respondents noted involves preparing students for group work. Even with a required course at OIT in group discussion and conflict resolution, some groups are dysfunctional. While most instructors try to prepare their students for collaboration by discussing it in class, many do not and cite a lack of time as the reason. One instructor noted, “I will use groups in future classes, but feel that students need a firm foundation before entering into a group project.”

Even with these problems, however, the benefits of student groups apparently outweigh the disadvantages: 64% of respondents noted that they were satisfied with outcomes, and 76% indicated that they would use groups again. Several faculty commented that they felt students learn better in groups because “they learn from each other.”

In response to an open-ended question, “If you could change one thing about student groups in your classes, what would that be?” answers fell neatly into three categories.

Several faculty expressed concern about slackers within groups: “Non-participants bring down the group morale. I don’t think it is fair for a student to ride on the shoulders of their group’s success/effort!” One faculty member noted that he would like to “devise a method to ensure that all students contributed to the group’s goals,” and two noted that they “would like to set up student motivation to more fully participate” to ensure “even participation amongst the group members.”

Other faculty indicated a desire to be more involved in group selection: “I would choose groups based on my understanding of the class cross-section. My judgment may not be perfect, but I have discovered that student self-selection often times goes with little-to-no judgment (mainly based on friendships),” and “I think that if the same situation arises, I will select some of the pairings so that there are leaders in all groups. Some groups, by default, had no leadership and suffered some from lack of initiative.”

And still others indicated that they wanted to be more prepared: faculty long for “more time to do a better job” and to allow for “better organization, tasking, brainstorming & use of e-mail to communicate.”

One telling comment from a female instructor pointed out gender differences in assumed roles: “[There are] frequent problems when lone or few women [are] in the group--or international students! They aren’t expected to contribute ideas as much and often *are* expected to do ‘secretarial’ chores for the group.”

Despite the difficulties encountered, survey respondents overall recognize the importance of group work as career preparation and apparently try to make the group experience a successful one for students.

Conclusions

Classroom collaborative learning practices among the technical instructors at Oregon Institute of Technology bear witness to trends indicated in the literature. In particular, three concerns seem prevalent: group formation, problems with dysfunctional groups, and assessment methodologies. While the literature offers advice for all three areas, the highly individualized character of specific courses and students obviously colors practice: what “works” in one class is not necessarily successful in another.

What is painfully apparent is that some groups are simply dysfunctional. Whether this is due to individual personalities or lack of preparation, this situation is extremely frustrating for both students and the instructor and can cause a great deal of resentment among group members. Fall quarter, for example, I received some alarming e-mail from three students in a group of four; one example follows:

> "I am writing in regards to our project. Along with Susan and Joan, I am concerned about our project. We have been working our tails off to get our paper completed by Mon., and have met several times. However, Mary has not shown up to any of our get togethers (we have even scheduled them around her, not to mention immediately following class today). We have been putting her [name] on our memos, because we have been taking her word that she is doing well and is on schedule with ourselves. We found out today that she has not finished her section, we have no idea what she has done. All she had to say was 'Don't worry, it will be good.' We have no idea what we should do, and I am so frustrated!
>
> I hate to have to bring you into this, but I don't think it is fair that we have been working so hard on this project to have our grade possibly dropped by one person.
>
> Thanks you for your time, it helps just to vent!"

E-mail from the other two group members was equally frantic. After a short discussion with the group, resolution was simple: the main problems were miscommunication and panic as the deadline approached. This group was willing to work out their difficulties, and they completed their project and the associated presentation with ease.

How could this situation have been averted? Based on the advice in the literature, I could have implemented a number of quick fixes had I known about this situation in advance: spent more time discussing group dynamics in class, conducted informal peer evaluations at critical points during the project, and met with the groups more often. Including a formal peer review as part of the final project evaluation would also help to identify individual involvement.

Will I use groups again? Yes, even with a 30% dysfunction rate last quarter. While interpersonal skills are an essential career attribute, it is important that students have the opportunity to practice and refine those skills in a relatively non-threatening environment such as the classroom. And, of course, four minds working on a problem yield better results than one. As Johnson and Johnson state, "[W]e are witnessing a quiet revolution at colleges and universities across the United States. ...[M]any professors are placing a renewed emphasis on teaching quality. They no longer see their students as empty or passive vessels but as active constructors, discoverers, and transformers of knowledge."[22]

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