

## POWER GROUPS FOR ENGINEERING STUDENTS

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Student retention can be improved through a variety of strategies. One such strategy, the *community building* model,<sup>1</sup> has produced impressive results for minority student success. This model promotes a high level of collaborative learning by clustering students in common sections of courses and offering a freshman orientation course, structured study groups, and a student study center. Given the overwhelming success that has been achieved in minority engineering programs nationwide, the University of Wyoming has implemented components of the community building model for all students.

According to Landis<sup>1</sup>, the single most effective and essential component of the community building model is common course scheduling. Even though it is generally agreed that common scheduling is a key component, few institutions implement the scheduling. This paper addresses how common scheduling has been implemented at UW through Power Groups, clusters of approximately 20 freshmen students. Results show that Power Group students achieve higher GPAs, higher course grades in engineering classes, and are retained within engineering at higher rates.

Additional components of the community building model have also been implemented at UW. Two orientation courses, the Introduction to Engineering Orientation and an Introduction to Engineering, expose students to computer tools to improve their academic productivity, provide academic survival skills, and introduce them to the engineering profession. Structured study groups have been to guide students in using cooperative learning techniques. Students participating regularly in the study groups have improved exam scores and report increased self confidence with the course material.

### POWER GROUPS

Students entering the university the fall of 1995, were given the opportunity to participate in a pilot project, adopted from the *community building model*. This model advocates clustering students, i.e. enrolling groups of students in common sections, so the students have the same homework, exams, and course preparation. Students in common sections can conveniently share information, and thus benefit through collaborative learning.

All new engineering students at UW are required to take Introduction to Engineering Computing, which is offered in 10 sections to approximately 250 students. Half of these sections were targeted for Power Groups (clustered scheduling for groups of 20 students),

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providing 100 “seats” for students who wished to participate in the groups. Sixty-seven students selected this option. The Non-Power Group students, the “control group”, were randomly placed in other sections of the same course.

Along with the Introduction to Computing course, the common scheduling also included Calculus I, Chemistry, Composition, and Orientation to Engineering. The cooperation of the Mathematics, Chemistry, and English departments, which was essential in developing the clustered scheduling, was obtained through joint meetings to address issues and problems. In response to concerns from the English department that the sections would not result in a heterogeneous group of students, no more than 10 students were clustered together, hence each Power Group was divided into two different Composition sections.

Most of the 67 students who initially enrolled in the Power Groups did so during New Student Orientation, held in the summer. These students were given extensive information on the groups and their advantages. Since registration occurred continuously over the summer, the registrar set up a procedure to “block” the Power Groups for students who elected to participate; and these students were registered manually. This is relatively easy to do for 67 students, but presents a bigger challenge for large schools. Last fall, five sections were again reserved for Power Groups, and the number of students electing to register for these groups increased to 87.

For most institutions, implementing a common course scheduling system for new students is a relatively low-cost, low-maintenance intervention for increasing retention rates. The advantages include not only the increased levels of cooperative learning that occur spontaneously among the students, but also the opportunity for the faculty to gain a more complete picture of student progress. When a student is struggling in one course, he/she may also be experiencing difficulty in another course. At UW, the faculty teaching the courses in a Power Group have met periodically and shared common concerns, and solutions, for individual student situations.

## Results

Data for students entering Fall 1995 has been analyzed; however, analysis of the data for the Fall 1996 students has not been completed. In 1995, 217 students completed New Student Orientation, and 5 students chose to not enroll at UW. A subset of these students, those taking Calculus I, was chosen for analysis. Of the 212 students who enrolled at UW, only 206 were enrolled in a math class: 114 in Calculus I, and 92 in other math courses. Of the 114 that were enrolled in Calculus, 67 elected to participate in Power Groups, while 47 designed their individual schedules. The following table illustrates the difference in performance between the students in Power Groups and Non-Power Groups.

	<i>Power Groups</i>	<i>Non-Power Groups</i>
Average GPA <sup>1</sup>	2.82	2.72
Average credit hour load	14.7	14.3
Retention -- Fall to Spring	95.5%	85.1%

<sup>1</sup>Fall 1995

The average grades for the five courses included in the Power Group scheduling are presented in Figure 1. The grades for each course, except for English / Honors, reflect all 67 of the students in the Power Groups; however, not all of the remaining 47 students in the Non-Power Group cohort enrolled in each of the courses. The average grade, for Non-

Power Group students, is based on the following number of students: Orientation - 45, Engineering Computing - 45, Chemistry - 44, Calculus I - 45. Not all students in the study registered for English / Honors; this course average is based on 56/67 Power Group students and 22/47 Non-Power Group students. All of the remaining 11 students in the Power Groups had transfer or AP credit; but in the Non-Power Groups, only 6 had transfer or AP credit and 19 opted to take English at a later date.

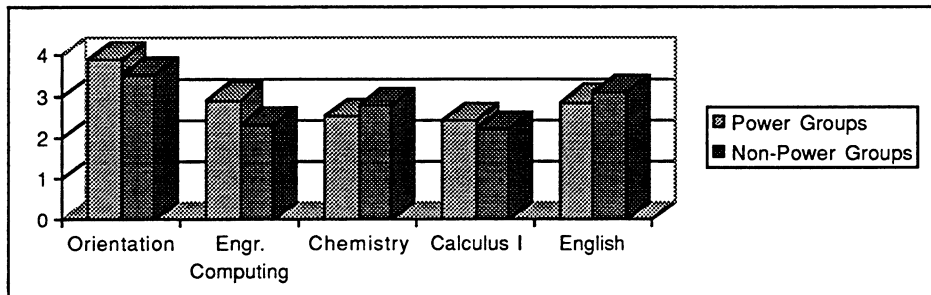


Figure 1, 1995 Fall Semester Course Grades

While the semester GPA was only slightly higher for Power Group students, the retention within engineering was considerably higher, as was the grade for the Introduction to Computing course. Anecdotal reports from students indicated that they did develop study groups on their own and jointly developed identical spring semester schedules.

### ORIENTATION COURSES

Entering students at UW enroll in two engineering courses: Orientation to Engineering and Introduction to Engineering Computing. These two courses are designed to improve retention of students by introducing them to the engineering profession.

The orientation course is offered in conjunction with a University Studies course aimed at providing entering students with skills and strategies that contribute to college success. In addition to the "survival skills" incorporated in the university course, the orientation course includes topics and activities germane to engineering. The activities give the students a picture of each of the departments at UW and an introduction to each of the engineering disciplines. Students regularly comment that these activities help them select a major. Other engineering topics presented include ethics, professionalism, electronic network use, and laboratory safety.

Two years ago, peer assistants were recruited to assist with the Orientation course. These students are engineering upperclassmen, who can relate first-hand perceptions and survival skills to the new freshmen. The peer assistants help focus the students on developing better study skills, impress on them the importance of communication skills, provide empathy for the changes that many of the students are undergoing, and generally provide a positive presence in the classroom. This team approach has proved to be extremely successful.

In the second course, Introduction to Engineering Computing, students gain experience in using a variety of computer tools, for applications in a range of engineering areas. The course also introduces students to open-ended engineering design problems, conducted in a cooperative environment.

## STRUCTURED STUDY GROUPS

Formal cooperative learning (CL) strategies have been incorporated by engineering faculty members with noted successes.<sup>1,2</sup> Felder reports that students have greater intrinsic motivation to learn and achieve and express deeper understanding of course material, they achieve higher grades and greater persistence to graduation, they develop better teamwork and leadership skills, and they enjoy higher self esteem. The methods employed by these educators generally follow a formal, structured approach, involving five essential components: positive interdependence, individual accountability, face-to-face promotive interaction, appropriate use of teamwork skills, and group processing.<sup>3,4</sup>

In a formal approach, students are organized into groups of generally 3 to 4 students for a semester (or a portion of the semester). The instructor ensures homogeneity of the groups, i.e. a range of abilities, ethnicity, and gender, and structures positive interdependence and individual accountability by assigning roles and carefully monitoring group functioning. The instructor intercedes to develop teamwork skills and to evaluate learning and assists with group processing for continuous improvement in the CL experience.

Adapting the elements of cooperative learning to the classroom environment may seem daunting to the typical engineering educator. However, an informal approach that does not necessarily incorporate all five of the elements of CL to the level found in activities led by CL experts will still improve student learning. Students benefit from enhanced learning and from increased teamwork skills.

Cooperative learning strategies can be informally introduced in the classroom by asking students to turn to their neighbor and recall the main points from the previous lecture, to do the next step in a problem solution, to think of an example, or to do any of the analytical, evaluative, or creative thinking associated with learning in the classroom. These tasks involve a group of 2-3 students in a temporary assignment that lasts from a few minutes to an entire class period and can be interspersed in a lecture to maintain higher student involvement.

At the University of Wyoming, cooperative learning groups were initially offered in the Spring 1995 semester to students enrolled in the Introduction to Engineering Computing course.<sup>5</sup> General tenets of cooperative learning were included in the design of the study groups; however, the engineering faculty for the course were not experienced with formal CL techniques.

Students in the computing course were invited to participate in study groups, following the first exam in the course, and were given extra homework credit as an incentive to attend the sessions. The objectives for both the intellectual mastery and for teamwork skills, along with expectations for the students, were specifically discussed with the study group participants.

The study groups were held twice weekly and concentrated on developing the students' problem solving skills. Students were randomly assigned to a group of three at each session, thus group membership changed each time. At the session prior to an exam, however, students formed their own groups of 3 - 4 members.

Positive interdependence was built into the groups in several ways. At the end of the session a group was randomly picked to present a problem solution. Individual accountability was ensured by randomly choosing the student to make the presentation.

The exam review sessions were conducted as contests, with individual students presenting a group's solution and all members of the group receiving a prize. A single set of instructional materials was provided to each group and each member of the group was given a particular role -- coordinator, checker, recorder, monitor, etc.

Team building skills were not specifically addressed in the initial implementation of the study groups. In a more formal approach, with longer group tenure, leadership skills can be incorporated along with decision making and conflict management strategies. In the informal groups, communication by all group members was emphasized during the semester.

Room arrangement was probably the biggest barrier to implementing the cooperative learning groups. Several seating options were tested over the semester, with none being entirely acceptable. The optimum arrangement is a small table that provides seating for 3-4 group members; a round table provides equal access to materials for all members.

## Results

The academic performance of students participating in the cooperative study groups has been analyzed, along with their evaluation of the sessions. On a scale of 1 (high) to 5 (low) the students reported that due to the study groups, they:

- Did better on exams 1.6
- Became more confident about computing 1.7
- Were more able to solve problems on own 1.6
- Would attend for enrichment 1.8

Half of the students voluntarily participated in group study for the final exam.

The study groups have excited the students about their engineering coursework, and the instructors have seen greatly increased levels of student interaction in their classrooms. Thirty percent of the students coordinated their fall semester registration in order to continue the use of cooperative study groups and eighty-five percent requested similar groups be established in two engineering science courses: statics and dynamics. Many students reported increased self confidence with the course material. These results are evidence of the positive impact of the cooperative study groups on students' academic success.

Student performance on examinations (for a single section) is plotted in Figure 2; 26 students belong to the study group, 12 to the non-study group, for a total of 38 students. The first exam was conducted prior to implementing the CL groups, and hence serves as a pretest; the last exam, #5, is a comprehensive final. The average test scores are plotted for the non-study group students, the study group students and the class as a whole. The graph illustrates that the study group average for the pretest (Exam #1) was 13 points lower than the non attenders; however both group averages were essentially the same for the final (Exam #5). Some of the irregularities in the graph may be explained by the relatively small sample size. For the same reason, the results from this group of students should not be generalized; however, these results do compare with national longitudinal studies.<sup>2</sup>

Subsequently, similar groups have been established in two additional engineering science courses: statics and dynamics. The students meet twice weekly and are guided in cooperative learning techniques by student teaching assistants. Increased learning has occurred as a result of these sessions and is contributing to the increasing retention rates for engineering students at UW.

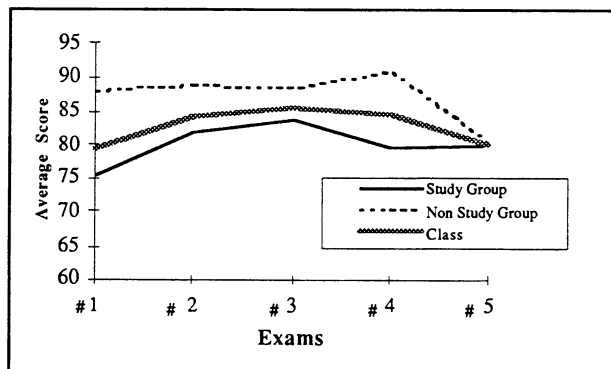


Figure 2, Engineering Computing Exam Scores

When cooperative learning groups are implemented for the first time, an initial resistance is generally encountered. This can be somewhat alleviated by discussing the objectives with the students, for both the course material and for the teamwork skills, that will be developed through study group activities. Since CL will increase the level of learning acquired by the students, criteria-referenced evaluations are essential; instructors must rethink grading policies that are based on a normal distribution.

## CONCLUSIONS

Since the first component of the community building model was implemented at the University of Wyoming, the retention of freshmen engineering students has continuously improved. Each of the components discussed have contributed to this success. However, the Power Group concept is significantly strengthened when coupled with cooperative learning techniques, ensuring more frequent interaction between students. Informal cooperative study groups lend themselves very appropriately to problem courses, the mainstay of engineering curricula. These interventions have indeed proven to be effective mechanisms to increase student retention in engineering and are extremely successful strategies for improving individual student academic success.

## ACKNOWLEDGMENT

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