A Method for Adjusting Group-Based Grades

A.M. Vollstedt
Truckee Meadows Community College

and

E.L. Wang
Department of Mechanical Engineering
University of Nevada, Reno

Abstract

Instructors have long sought a method of assigning credit for group work equitably. The Department of Mechanical Engineering at the University of Nevada, Reno offers two first-year engineering courses and each contains large group work components. For assessment purposes, the instructors felt that the individual course grades needed to be adjusted to accommodate for the portion of the grade that is defined by group work in these courses. Individual grades are a reflection of a student's actual work, whereas the group grade is easily confounded by the effects of their team mates (positively and negatively).

Assigning grades to individuals for a group project is important because instructors want to assign grades based on effort. Since all students in a group typically receive the same grade for a group assignment (e.g. a group report), group grades have the undesirable effect of obscuring a student's true performance, especially if group work constitutes a large portion of the final grade. Thus, it is desirable to develop a method which could be used to more accurately reflect the true contribution of each student within a group.

The instructors tried using several methods to determine the distribution of effort within the teams including merit pay (a form of extra credit based on peer evaluations), team journals (where teams self report the distribution of effort), and computerized team evaluations (e.g. CATME, which won the 2009 Engineering Pathways Premier Software award). All of these methods can be used by the instructor to redistribute the group grade based on individual effort. In this research, an automated method of adjusting the group grade is proposed and tested.

The new method was developed to adjust grades within each group based on the residual of the individual grades within the group and the portion of the course grade defined by group work. It was found that the grade adjustment method agreed 78% of the time with the manual grade changes instructors made in 2009, and also increased the correlation between group grades and individual grades.

It is recommended that the adjustment method only be used for assessment purposes and not for the actual computation of a student's grade for several reasons. First, the method is difficult to explain to students. Secondly, students would not be able to calculate their grade without knowing the grades of their teammates (a violation of privacy laws). Lastly, students already dislike having their grade dependent on the performance of their teammates and the proposed grading scheme would lead to a competitive rather than collaborative team environment.

Introduction

A method of assigning credit for group work that accurately represents individual effort within a group has been long sought out by instructors. The Department of Mechanical Engineering at the University of Nevada, Reno offers two first-year engineering courses and each contains large group work components. Individual grades are a reflection of a student's actual understanding of the course material, whereas the group grade is easily confounded (positively and negatively) by the effects of the work done by their team mates. In order to gain a true perspective of student performance for assessment purposes, the instructors of these courses felt that the individual course grades needed to be adjusted to accommodate for the portion of the grade that is defined by group work.

Assigning grades to individuals for a group project is important because instructors want to assign grades based on effort. When group work (e.g. a group report) constitutes a large portion of the final grade, the group grade can easily obscure the final grade, which makes the final grade an inaccurate measure of individual student performance. Thus, developing a method which could be used to more accurately reflect the true contribution of each student within a group is desirable.

The instructors tried using several methods to determine the distribution of effort within the teams including merit pay (a form of extra credit based on peer evaluations), team journals (where teams self report the distribution of effort), and computerized team evaluations (e.g. CATME, which won the 2009 Engineering Pathways Premier Software award). These methods are time consuming; however, all of these methods can be used by the instructor to redistribute the group grade based on individual effort. In this research, an automated method of adjusting the group grade is proposed and tested.

Methods

Sampling

The grade adjustment method presented in this paper was evaluated using two introductory engineering classes (ENGR 100 and ME 151) at the University of Nevada, Reno. The College of Engineering at the University of Nevada, Reno is comprised of five departments, four of which participate in ENGR 100: Mechanical Engineering (ME), Civil Engineering (CE), Electrical and Biomedical Engineering (EBME) and Chemical and Metallurgical Engineering (CME). ENGR 100 is a required multi-disciplinary first-year engineering course that was developed with funding from the William and Flora Hewlett Foundation[1]. This course is taught once per year (fall semester) and traditionally has a combined enrollment of approximately 300 students.

Students attend a large 1-hour lecture twice a week and then break up into small sections of 24 students for a 1.5 hour weekly lab. The overall goal of ENGR 100 is to teach students about the various aspects of the engineering design process via completion of a semester long design project. The project consists of students working in groups of 5-9 to design and build either a vibration monitor (2005-2007) or a hovercraft (2008-present).

The Mechanical Engineering (ME) and Material Science Engineering (MSE) Departments at the University of Nevada, Reno are also participating in a multi-disciplinary first-year project funded

by the William and Flora Hewlett Foundation[1]. As part of this project, an interdisciplinary freshmen-level course (ME151/MSE102) is taken by all mechanical engineering and material science engineering undergraduates. Traditionally, these two courses have a combined enrollment of approximately 125 students.

As stated in the course syllabus, the overall goal of the course is for the student to learn the fundamentals of structured computer programming, the design process, and creative thinking. In order to accomplish this goal, students work in pairs to create autonomous robots with LEGO bricks and a computer program called ROBOLAB.

Procedure

It is reasonable to assume that a team consisting of members, whom all received C's on their individual assignments would earn a low grade on their group work when compared to a team consisting entirely of A students (as measured by their individual grades). This assumption is based on the fact that the group work in most classes requires that the students display a mastery of the skills learned from the assignments completed as an individual.

The premise put forth is that as the range of individual grades within a team increased, the group grade would be less correlated with the individual grades. Figure 1, Figure 2, and Figure 3 show the relationship between individual and group grades categorized by the range among individual grades within a group being less than 25; between 25 and 50; and greater than 50 respectively for ENGR 100 in 2005.

Based on this, a method was sought to adjust grades to reflect individual ability that would not impact a team consisting of similarly performing students (e.g. Figure 1) but would adjust the grades of students on a team that displayed a large variation in individual performance (e.g. Figure 3).

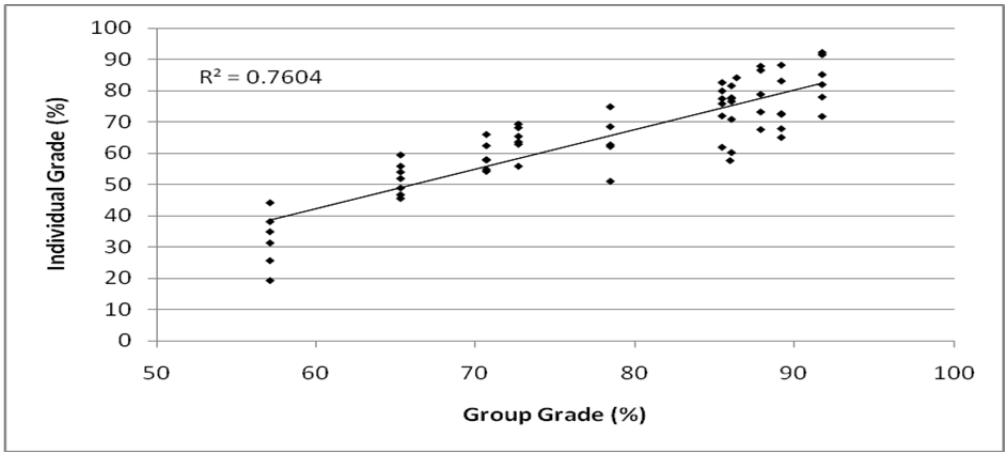

Figure 1: The relationship between individual and group grades categorized by the range among individual grades within a group being less than 25 for ENGR 100 in 2005.

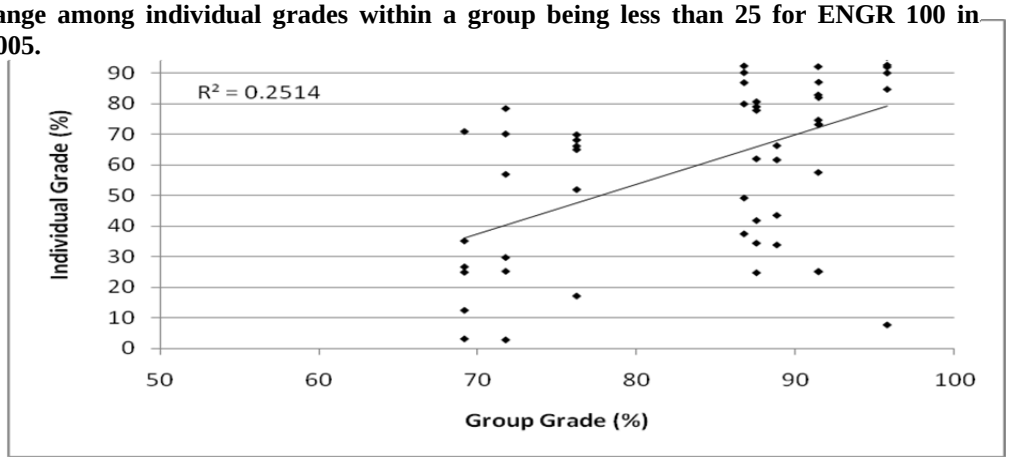

Figure 3: The relationship between individual and group grades categorized by the range among individual grades within a group being greater than 50 for ENGR 100 in 2005.

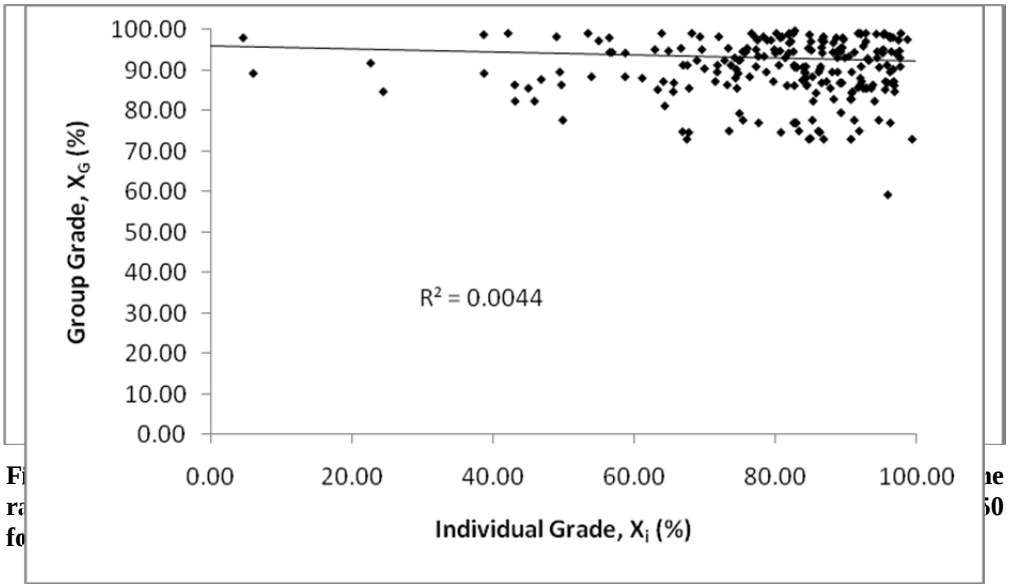

Figure 4: The relationship between individual grades and group grades for ENGR 100 in 2009. The correlation between individual and group grades is 0.004 indicating that the two grades are unrelated.

Traditionally a student's grade, G, is defined by the sum of their group (X_G) and individual score (X_i) as shown in Eq. 1

$$G = X_G + X_i \tag{1}$$

Figure 4 shows the relationship between individual grades (X_i) and group grades (X_G) for ENGR 100 in 2009. The correlation coefficient between individual and group grades is 0.004 indicating that the two grades are essentially unrelated even though one would expect some correlation for the reasons discussed above. Notice in Figure 4 that the leftmost students have comparatively low individual grades, yet they have high group grades.

In order to adjust the traditional group grade to the adjusted group grade, G*, the following steps were implemented:

1. Calculate the mean, $\overline{X}_i$, for individual grades within each group.
2. Convert individual scores into residual scores within their respective groups($X_i - \overline{X}_\iota$).
3. Multiply each individual's residual score by a constant, *m*, which is equal to the weight of the group grade as a percentage of the total grade (i.e. *m*=0.10 would reflect 10 of the total grade is based on the group grade). Add this number to the individuals group score to obtain an adjusted group score (Eq. 2).

$$X_G^* = m(X_i - \overline{X}_\iota) + X_G \tag{2}$$

4. Next add the adjusted group score to their individual score as shown in Eq. 3.

$$G^* = X_G^* + X_i \tag{3}$$

Eq. 4 summarizes steps 1-4, which adjusts an individual's final grade to reflect both the individual grade and the group grade.

$$G^* = m(X_i - \bar{X}_i) + X_G + X_i \tag{4}$$

The residual score ranks the group members scores from negative to positive according to their performance in comparison to their group (Eq. 2), so it adjusts their group score in both directions as well. Since the work associated with individual grades provide students with the skills they need to contribute to the project that determines their group grade, it was believed the group grade is not a fair representation of the work that each individual contributed to the project. Thus group grades were adjusted using the steps listed above. Figure 5 shows the relationship between individual grades and adjusted group grades. The correlation between individual and adjusted group grades increased to 0.264.

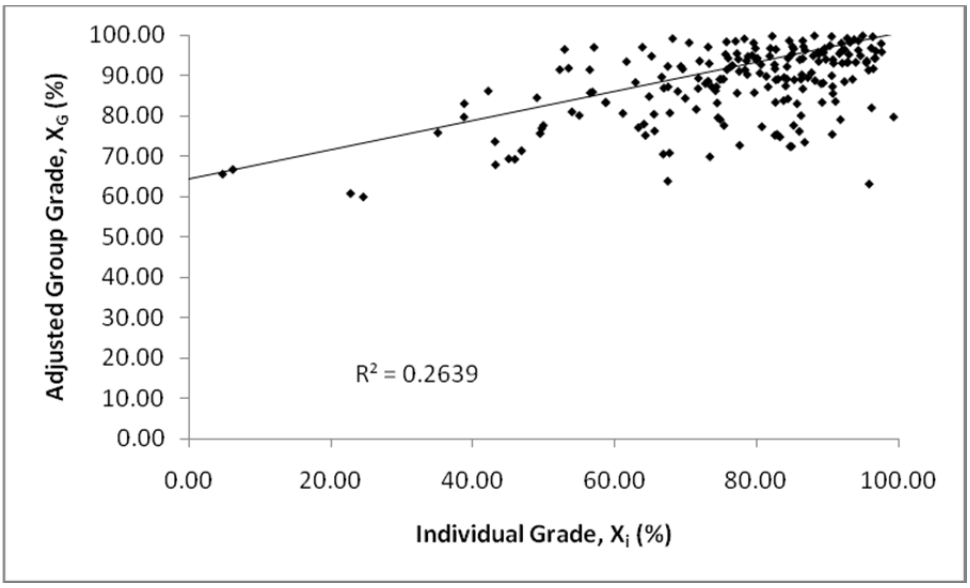

Figure 5: The relationship between individual grades and group grades for ENGR 100 in 2009. The correlation between individual and adjusted group grades increased to 0.264.

Results and Discussion

Table 1 and Table 2 list the correlation coefficients between individual grades and original and adjusted group grades when m=0.5 (in both ENGR 100 and ME 151, 50% of the grade is based on team work). Individual and adjusted group grades have a much higher correlation coefficient in all cases, which is expected since the adjusted group grade is dependent on the individual grade.

The grade adjustment method provides a more realistic range of data, since group grades are adjusted based on individual performance. It also improves the correlation between individual grades and group grades and seems to provide a more accurate course grade. Additionally this method provides a means to automate the grade adjustment method that instructors currently attempt to accomplish manually.

Table 1: The correlation coefficients between individual and group grades for ENGR 100 grades when m=0.5. The correlation coefficient is much greater when data is treated with Eq. 4.

Year	Original	Adjusted	Team Size
2005	0.358	0.861	6
2006	0.262	0.738	6
2007	0.262	0.737	6
2008	0.108	0.721	9
2009	0.004	0.264	6

Table 2: The correlation coefficients between individual and group grades for ME 151 grades when m=0.5. The correlation coefficient is much greater when data is treated with Eq. 4

Year	Original	Adjusted	Team Size
2005	0.132	0.961	2
2006	0.000	0.972	2
2007	0.126	0.960	2
2008	0.062	0.960	2
2009	0.030	0.965	2

Anecdotally, the proposed method of adjusting the group grades correlates with what instructors are attempting to accomplish manually. In 2009, for example, the instructors adjusted group grades based on review of team journals, which included self-reported effort distribution forms that all team members are required to sign. Based on these forms, the instructors adjusted the final grades of about 10% of the teams. In 78% of the cases, the automated method described

above altered the individual's grade in the same direction (upwards or downwards) as the instructors' manual method. This correlation is surprisingly good in light of the fact that student are notorious for not reporting effort truthfully on self-reported forms.

Despite these preliminary results, validation of the grade adjustment will necessitate much more work. An extensive amount of data would need to be collected to corroborate the results of the grade adjustment technique. Interviewing each member of a group would provide a much more accurate view of how the group is performing and who is responsible for the work being completed. Journals would need to be reviewed for indicators of work distribution as well. Comprehensive Assessment for Team-Member Effectiveness (CATME) allows students to anonymously evaluate themselves as well as their teammates for performance within their group and contribution to work load[2]. CATME results could be collected and reviewed to try to prove that the grade adjustment method is effective as well.

Conclusion

This paper outlines a new method developed to adjust grades within a group based on the residual of the individual grades within the group and the portion of the course grade defined by group work. It was found that the grade adjustment method agreed 78% of the time with the manual grade changes instructors made in 2009, and also increased the correlation between group grades and individual grades.

The grade adjustment method has strong potential as a prequel to evaluating course changes. It is recommended that the adjustment method be used for assessment purposes and not for the actual computation of a student's grade for several reasons. First, the method is difficult to explain to students. Secondly, students would not be able to calculate their grade without knowing the grades of their teammates (a violation of privacy laws). Lastly, students already dislike having their grade dependent on the performance of their teammates and the proposed grading scheme would lead to a competitive rather than collaborative team environment. Although distributing adjusted grades to students may be troublesome, using this grade adjustment method could be ideal when using grades to assess courses since it provides a view of student performance that is not confounded by group grades.

References

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Biographical Information

Ann-Marie Vollstedt is an instructor in the Department of Physical Sciences at Truckee Meadows Community College. Dr. Vollstedt recently completed her dissertation at the University of Nevada, Reno, which focused on exploring the use of statistical process control methods to assess course changes in order to increase student learning in engineering. Dr. Vollstedt teaches courses in engineering design as well as renewable energy and continues to conduct research in engineering education.

Eric L. Wang is an Associate Professor of Mechanical Engineering at the University of Nevada, Reno. Dr. Wang has won numerous awards including the Regents Distinguished Teaching Award, Nevada's most prestigious teaching award. In addition to his pedagogical activities, Dr. Wang conducts research on sports equipment, biomechanics, robotics, and intelligent materials.