



A Method for Adjusting Group-Based Grades

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Abstract

Grades for assignments completed as an individual are a reflection of a student's actual work, whereas the grade for a group assignment is easily confounded by the effects of their teammates (positively and negatively). Assigning grades to individuals for a group project is important because instructors want to assign grades that reflect effort as well as content. Since all students in a group typically receive the same grade for a group assignment, group grades have the undesirable effect of obscuring a student's true performance. 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 authors 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 paper, an automated method of adjusting the group grade is proposed and tested.

A key assumption was 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. Based on this assumption, a 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.

The method was tested on about 2500 student grades from a first-year engineering course. The key assumption was tested and verified. It was found that the automated grade adjustment method agreed about 80% of the time with the manual grade changes made by the instructors at the end of semester (based on journals, CATME, etc.). The grade adjustment method has strong potential as an automated tool to give the instructor a non-behavioral glimpse at team performance.

It is recommended that the adjustment method only be used for flagging dysfunctional teams and not for the actual computation of a student's course 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 FERPA 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. Students also desire an equitable method of assigning group grades. Having a teammate that is a "hitchhiker" is one of the major reasons for

students' dissatisfaction with group work¹. The College of Engineering at the University of Nevada, Reno offers a first-year general engineering course that contains a large group work component. 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 teammates. In order to gain a true perspective of student performance for assessment purposes, the instructors of the course 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 and content. When group work (e.g. a group report) constitutes a large portion of the final grade, the final grade may be an inaccurate measure of individual student performance. In a small class it is often possible for the instructor to deduce which students are "carrying the load" versus those that are "hitchhiking." However, in classes with a large enrollment it is very difficult for the instructor to know how individuals are sharing the workload within each team. Thus, developing a method which could be used to more accurately reflect the true contribution of each student within a group is desirable.

Over the past decade, the authors have tried using a variety of peer evaluation methods to determine the distribution of effort within a team. Adopting a corporate approach, teams were asked to allot merit pay to individual team members. The amount of merit pay was a fixed percentage of the number of points received for a group task (e.g. a group presentation). The concept of merit pay was to provide students with a realistic (i.e. corporate) and formative method of peer evaluation (a similar method is described by Clark et al.²). The authors tried having team leaders distribute the merit pay as well as having the merit pay based on peer evaluations.

Almost without fail, teams would distribute merit pay uniformly amongst the team members. This partly could be due to the fact that first-year students are unable to accurately evaluate their teammates cooperative skills due to inexperience³, because merit pay was viewed as a competitive⁴, and/or because students used the merit pay forms to evaluate academic ability rather than "team citizenship"⁵. Additionally, the merit-pay system did not ask students to evaluate specific skills or behaviors and, thus, was not able to provide students with formative feedback^{2,6}.

In an effort to institute a more formative method of peer evaluation, the authors tried using team journals where teams self reported weekly objectives, tasks and progress along with the distribution of effort for each group activity. The journals and effort reporting forms were then used at the end of the term to adjust individual grades.

Again, often teams would report an even distribution of effort amongst team members (despite the fact that many individual students complained about their teammates). Unbeknownst to the authors, the team journal approach shared many commonalities with two studies published a decade before our implementation: project diaries⁷ and the "autorating" system developed at the Royal Melbourne Institute of Technology (RMIT)⁸.

We also have tried using computerized team evaluations. Comprehensive Assessment for Team-Member Effectiveness (CATME)^{9,10}, which won the 2009 Engineering Pathways Premier Software award¹¹, has been extremely effective at flagging teams and individuals that are having

social or behavioral problems. CATME has the advantage of being a behaviorally anchored rating scale (BARS) and, thus, should be a more reliable form of peer evaluation than the autorating-like system previously employed^{9,12}. However, there still exists significant anecdotal evidence to suggest that many first-year students are not willing to give their teammates low peer evaluations¹².

All of the methods tried thus far were based entirely on peer evaluations and have been relatively time consuming for the instructors. With this in mind, we sought out an automated method that is not based on peer evaluations to help the instructors determine if an adjustment to an individual's grade was necessary.

Methods

Sampling

The grade adjustment method presented in this paper was evaluated using an introductory freshmen engineering course (ENGR 100) at the University of Nevada, Reno. The course is a required multi-disciplinary first-year engineering course that is taken by all engineering majors and was developed with funding from the William and Flora Hewlett Foundation¹³. This course is taught once per year (fall semester) and has had an enrollment ranging from 200-500 students (the large range reflects growth over the past decade).

Students attend a large 1-hour lecture twice a week and then break up into small sections of 24 students for a 2 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 requires students to work in groups that have ranged in size from 4-9 students over the past decade.

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.

While it is true that effective group work also requires many "soft skills" (e.g. teamwork and communication), a mastery of the "hard skills" is a necessary condition to be an effective teammate. Other studies found a relatively strong correlation between peer evaluations and individual test scores^{5,14}, which supports this notion.

For obvious reasons it is difficult to create teams in a first-year, first-semester course with heterogeneous distributions of GPAs as is often recommended^{1,5,15}. Thus, we expected to have distribution of GPAs amongst the teams vary widely. 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 (in this study, "individual" and "group" grades refer to grades earned for assignments within the course). 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 a recent offering.

Figure 1 clearly shows that a homogeneous group that consists entirely of students who did well on their individual assignments also did well on their group assignments. Likewise, a group that all did poorly on their individual assignments also earned a low score on their group assignments. While the explanations may vary, previous studies have also found evidence of groups of high achieving students tending to do well while a group of low achieving students tended to struggle^{1,5}.

Contrast this to Figure 3, where each group consists of a heterogeneous mixture of students with a wide range of individual grades. In some instances it appears that the C student's performance was enhanced by the presence of an A student (i.e. the "hitchhiker effect"), while in other cases the A student was "dragged down" by poor performing teammates.

Based on these results, 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). Unlike our previous attempts with peer evaluations, we sought an automated method for adjusting an individual student's grade at the end of the semester that was not dependent on peer evaluations¹⁶.

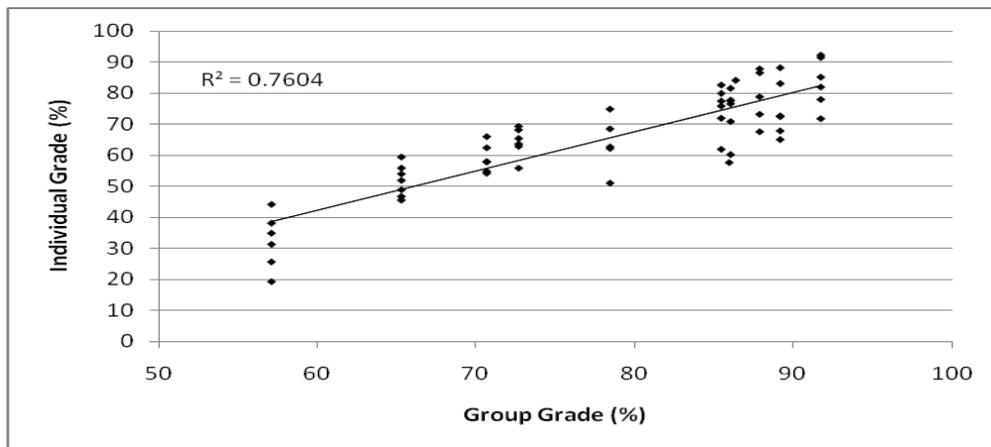


Figure 1: The relationship between individual and group grades categorized by the range among individual grades within a group being less than 25%.

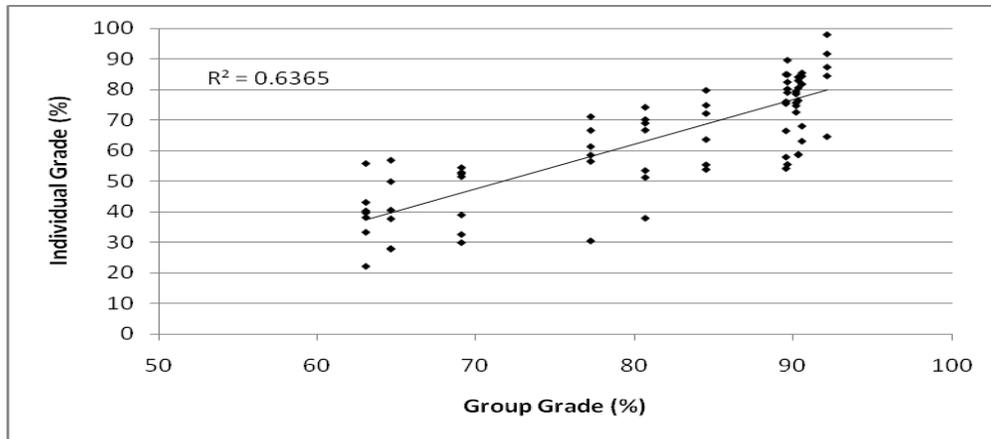


Figure 2: The relationship between individual and group grades categorized by the range among individual grades within a group being greater than 25 and less than 50%.

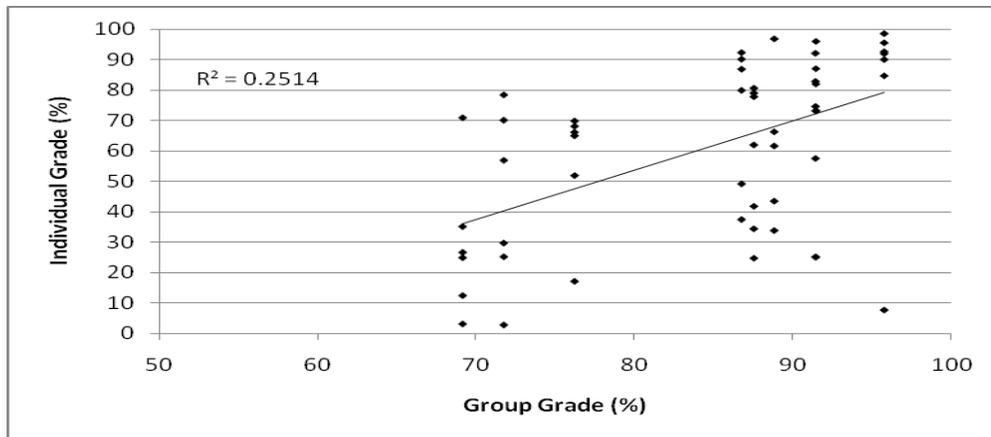


Figure 3: The relationship between individual and group grades categorized by the range among individual grades within a group being greater than 50%.

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

$$G = X_G + X_i \quad (1)$$

Figure 4 shows the relationship between individual grades (X_i) and group grades (X_G) for the 2012 offering. The correlation coefficient between individual and group grades is 0.056 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 there are many students that have comparatively low individual grades (<70%), yet they have high group grades. Likewise, there are a few students who did very well on individual assignments, but very poorly on group assignments (<70%).

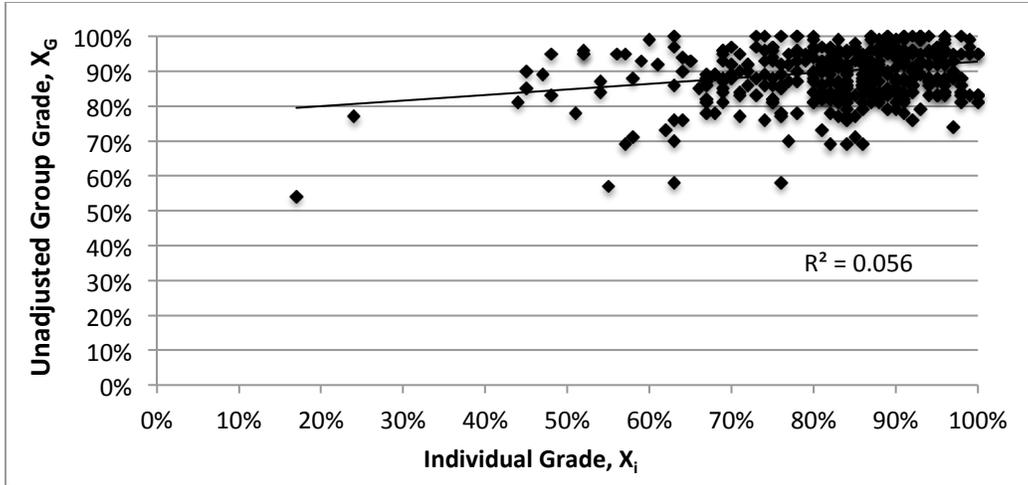


Figure 4: The relationship between individual grades and group grades for the 2012 offering. The correlation between individual and group grades is 0.056 indicating that the two grades are unrelated.

In order to adjust the traditional group grade to the adjusted group grade, G^* , the following procedure was devised:

1. Calculate the mean, \bar{X}_i , for individual grades within each group.
2. Convert individual scores into residual scores within their respective groups $(X_i - \bar{X}_i)$.
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 individual's group score to obtain an adjusted group score (Eq. 2).

$$X_G^* = m(X_i - \bar{X}_i) + X_G \quad (2)$$

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

$$G^* = X_G^* + X_i \quad (3)$$

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

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

The residual score, $(X_i - \bar{X}_i)$, 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 process listed above.

Results and Discussion

Equation 4 was used to adjust the group grades for the past 8 years. Figure 5 shows the relationship between individual grades and adjusted group grades for a recent offering. Since the adjusted group grade includes a significant influence from the individual grades, it is not surprising that the correlation between individual and group grades went up from 0.056 to 0.853. The grade adjustment method has also achieved the desired outcome of reducing the number of low achieving students that appear to be being carried by their teammates and the number of high achieving students that are being dragged down by their teammates.

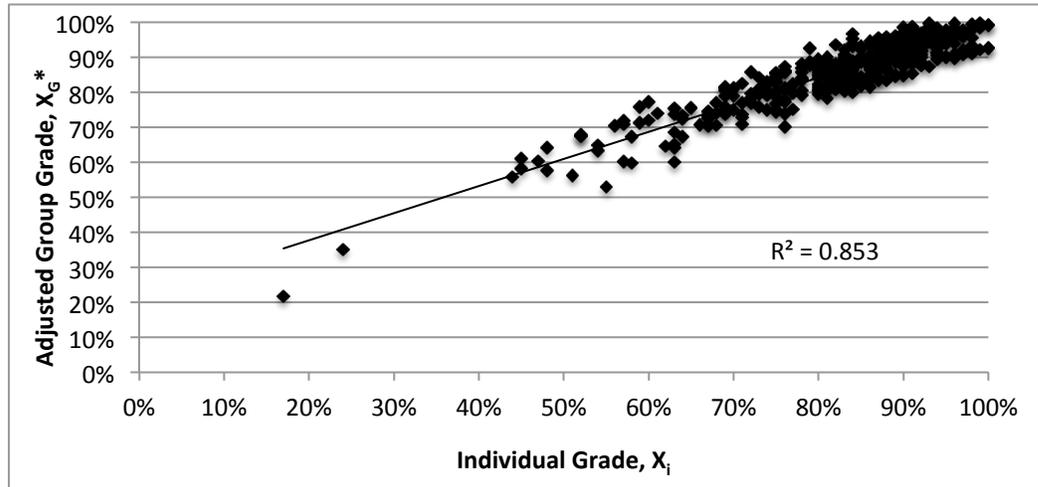


Figure 5: The relationship between individual grades and group grades for the 2012 offering. The correlation between individual and adjusted group grades increased from 0.056 to 0.853

Table 1 lists the correlation coefficients between individual grades and original and adjusted group grades (m indicates the percentage of the overall grade was based on teamwork) for the past 8 years. 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.

By design, the proposed grade adjustment method improves the correlation between individual grades and group grades since group grades are adjusted based on individual performance. The method was designed to automate the grade adjustment method that instructors currently attempt to accomplish manually. However, the method developed ignores important “intangible” factors such as teamwork and communication (which are some of the main reasons group work is assigned in the first place).

At the end of each term, the instructors adjusted individual grades based on review of team journals, peer evaluations, and CATME reports, which included self-reported effort distribution forms that all team members are required to sign. While not completely based on the “intangibles,” this review process does take into account many of the group work soft skills.

Based on the end of term reviews, the instructors adjusted the final grades of about 10% of the students on average, per term. Starting in 2009, the authors began tracking how often the automated method described above altered an individual’s grade in the same direction (upwards or downwards) as the instructors’ manual method. The automated method agreed 78%, 73%,

87% and 84% of the time between 2009 and 2012. Thus, while the automated grade adjustment method does not take into account any of the soft skills, it agrees with the instructors' manual (and tedious) grade adjustments about 80% of the time. This correlation is surprisingly good in light of the fact that students are notorious for not reporting effort truthfully on peer evaluation forms.

Table 1: The correlation coefficients between individual and group grades. The correlation coefficient is much greater when data is treated with Eq. 4.

Year	Original X_G	Adjusted X_G^*	m	Team Size
2005	0.358	0.861	0.5	6
2006	0.262	0.738	0.5	6
2007	0.262	0.737	0.5	6
2008	0.108	0.721	0.5	9
2009	0.004	0.264	0.5	6
2010	0.134	0.625	0.5	5
2011	0.211	0.926	0.5	5
2012	0.056	0.853	0.6	4

Admittedly, the proposed grade adjustment method would be very difficult to explain to students. Additionally, because the method relies on the residual, students would not be able to calculate their own grade without knowing the grades of their teammates (a violation of FERPA laws).

Thus, while the goal of this study was to develop an automated grade adjustment method, in the end it is not recommended that it be used for adjustments in individual grades. Rather, the proposed grade adjustment method can be used to automatically flag individual students by making grade adjustment recommendations. CATME, which allows students to anonymously evaluate themselves as well as their teammates for performance within their group and contribution to work load is useful specifically because it flags individuals and teams that may be having problems^{9,10}. Whereas CATME is a behavior-based tool, the automated grade adjustment method described herein could be used as tool that flags dysfunctional teams based solely on the residual grade data that is independent of peer evaluations.

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 about 80% of the time with the manual grade changes instructors made, and also increased the correlation between group grades and individual grades.

The grade adjustment method has strong potential to give the instructor a quantitative grade-based glimpse at team performance that does not depend on peer evaluations. It is recommended that the adjustment method be used to flag dysfunctional individuals/teams and make grade adjustment recommendations. By combining with behavior-based assessment tools like CATME, the grade adjustment method can provide instructors with better insight into an individual's true contribution to the group's work.

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