ASSIGNING INDIVIDUALS CREDIT TOWARDS GRADES FOR A UNIFIED SUBMISSION: THEORY AND APPLICATION

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ABSTRACT

A theory of how to assign individual credit towards grades for a unified submission is presented, together with a computerized teaching management application, GroupMaker, that implements the theory. Data on the choices students make and exploration of the reasons for those choices would extend this research.

Keywords: grading, GroupMaker, learning management system, peer evaluation, preceding assignments, social autonomy, teaching management system, unified submissions

INTRODUCTION

Most professors may see themselves as teachers who grade rather than as graders who teach, a distinction often made by Richard Vatz, winner of many higher-education teaching awards who has argued against plus-and-minus grading and for ending student evaluations of professors (Vatz, 2019). Even Vatz should concede, however, that grades matter very much to students. Students expect the grading formula to be transparent, the better to secure for themselves the highest possible grade if not the best possible learning. Some assignments, such as a test taken individually, lend themselves to a simple formula. For assignments that require collective efforts, however, the simplest formula may be unsatisfactory, for it could incentivize counterproductive behavior.

The issue of grading students who collaborate on a unified submission is especially vexing. Following U.S. copyright law (Copyright Law, 2021, p. 2), which distinguishes between collective and unified submissions, a collective submission is a compilation of separately authored items, as in the case of a newspaper. In a unified submission, however, the parts of the multiple-authored submission are not identified by author, as in the case of a novel. A presentation whereby the presenting students banter extensively with each other would constitute a unified submission. A paper that the authoring students edit on a shared basis also would constitute a unified submission. The distinguishing characteristic of a unified submission is that the contributions of the collaborating students are mixed such that they cannot be separated into parts attributable to single contributors.

The discussion that follows begins by presenting an inclusive grading formula for a unified submission. The formula requires weights; a unified submission requires leadership. How computer assistance resolves the issues of weights and leadership is then explained. A numerical example is presented. The paper closes with a data-gathering suggestion and the anticipation that helping teachers grade better will ultimately help students learn better.

GRADING FORMULA

Consider an assignment wherein groups of students make competitive presentations to a panel of judges. The judges rate each group's presentation, so each group's presentation receives a unitary score. Inasmuch as the score is a score for the group, the instructor must apply a formula to assign credit towards grades to the individual members of each group.

The simplest formula assigns equal credit to all members of each group proportional to the group's presentation score. Thus, the points (Y_j) received by Student j is equal to the points allotted to the presentation (X) multiplied by a scoring ratio (q), $0 \le q \le 1$, derived from the presentation's unitary score. Thus,

$$Y_j = qX. \tag{1}$$

Equal credit may be counterproductive, however, because equal credit incentivizes free riding. The student who views the assignment as uninteresting will see advantage in exerting less than best efforts, because the reward of each student's effort is diluted in its effect on credit towards grades. Commonly, instructors attempt to address free riding by requiring students to submit summative peer evaluations (SPE) for computing a member-specific peer evaluation ratio (e_j), $0 \le e_j \le 1$, that modifies the formula (Scherpereel, 2010). Thus,

$$Y_j = e_j qX. \tag{2}$$

Yet, peer evaluations incentive students to engage in transactional relationships where flattery, threats, and other signals of evaluation intent become quid pro quo of contractual agreements. Such agreements would give rise to commodified peer ratings that are not veridical.

As alternative to SPE, consider performance on preceding assignments (PPA), which differentiates by including scoring ratios from related preceding assignments (p_j) in the scoring formula of the subsequent unified submission. The preceding assignments must be assignments for which the students receive individually differentiated scores. The preceding assignments should be causally related to the unified submission, so that if the preceding assignments are performed poorly, the unified submission would be of poor quality also. The preceding assignments could be research reports required of every group member or affirmation of engagement at group meetings, among other possibilities.

By itself, PPA incentivizes individual efforts in preceding activities. If those activities require collective action, as group meetings would, then PPA may magnify conflicts among group members over the collective action. In the case of group meetings, for example, conflict can arise over the meeting schedule because no single meeting schedule may be the most convenient schedule for everyone.

To ameliorate the conflicts that may arise from simple PPA, p_j could be averaged across all members to arrive at $\bar{p}$, a score that would reward collective efforts in the preceding assignments. Then PPA could be included in the grading formula by applying a weighting factor (ω), $0 \leq \omega \leq 1$, to weigh between p_j and $\bar{p}$, as shown in Equation 3.

$$Y_j = [p_j \omega + \bar{p}(1 - \omega)]qX. \quad (3)$$

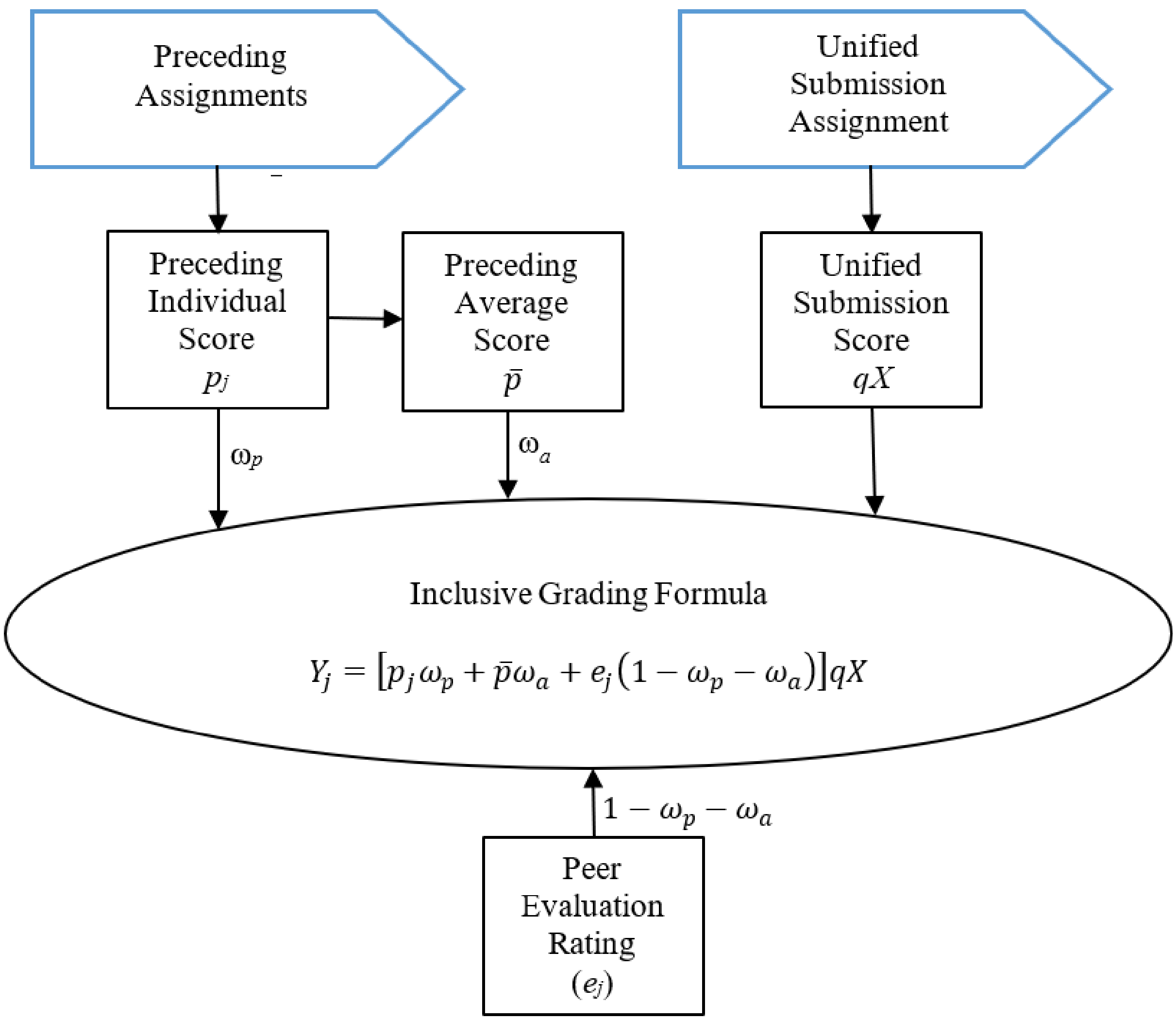

Figure 1 Diagram of Inclusive-Formula Relationships

Effectively, ω compromises between p_j and p, between those whose aggregated performances are above and below average on preceding assignments. Losers gain at the expense winners, but when the gain to the losers is felt more keenly than the loss to the winners, an established finding of prospect theory (Kahneman & Tversky, 1979), the aggregated emotional well-being of the collective rises.

SPE and PPA are not mutually exclusive. In the case when group membership changes from assignment to assignment, contractual agreements would be difficult to establish, so peer ratings are more likely to be veridical. To allow for cases such as this one, the grading formula can be augmented by including the peer evaluation ratio e_j along with splitting ω into two weights, ω_p and ω_a, applying respectively to p_j and $\bar{p}$, where $0 \le \omega_p + \omega_a \le 1$. The weight remaining, $1 - \omega_p - \omega_a$, would apply to e_j. The inclusive grading formula is shown in Equation 4. Relationships are diagrammed in Figure 1.

$$Y_j = \left[p_j \omega_p + \bar{p}\omega_a + e_j\left(1 - \omega_p - \omega_a\right)\right]qX. \quad (4)$$

As Figure 1 shows, preceding-individual, preceding-average, and unified-submission scores of the inclusive grading formula are direct consequences of assignments. The peer-evaluation rating, however, is context dependent. The instructor adapts the formula to context by setting the weights.

SETTING WEIGHTS

The simplest approach to setting the weights is for the instructor to decide first on the equation that suits each assignment, and then set the weight or weights of the selected equation to midpoint values. Thus, for Equation 3. set ω = 1/2; for Equation 4, set $\omega_p = \omega_a = 1/3$.

An alternative that follows from the learner empowerment principle (Saye, 1997) is to allow students to vote among the three score-modifying measures: simple PPA, average PPA, and SPE. The votes would be tallied, and the weights computed proportionately. Thus, if n_p, n_a, and n_e are the numerical votes for simple PPA, average PPA, and SPE, respectively, then the weights would be computed following Equations 5 through 7.

$$\omega = \frac{n_p}{n_p + n_a}. \quad (5)$$

$$\omega_p = \frac{n_p}{n_p + n_a + n_e}. \quad (6)$$

$$\omega_a = \frac{n_a}{n_p + n_a + n_e}. \quad (7)$$

IMPLEMENTATION

Collecting votes and computing formulas are tedious operations that can be computerized to save time and reduce errors. GroupMaker is a computerized application customized for the task. GroupMaker is presented as a *teaching* management system (TMS), differentiating it from the more common *learning* management system (LMS). Whereas an LMS primarily serves students, a TMS primarily serves instructors. The difference between LMS and TMS is most apparent in how the two systems handle students' work. Whereas a good LMS makes it easy for students to submit work in any format through any channel, a good TMS constrains the format and channel, so that students can only submit work in the format the instructor requires and through a channel that delivers the work to the instructor in the form most expeditious for grading. Thus, an LMS makes learning easier; a TMS makes teaching easier.

GroupMaker is an internet-based Windows application, not web based (Pillutla, 2003). Internet based applications have better responsiveness because they bypass the web browser to link directly to the computer's operating system, but less accessibility because web browsers are available for a wider range of computing devices. In the balance between saving time because the internet-based application is more responsive and saving money because the web-based application does not require a Windows-installed computer, saving time may have more value than saving money, for instructors if not also for students.

But ownership of data is perhaps the most compelling reason for favoring an internet-based application rather than a web-based one for a TMS. The internet-based application can be packaged together with its data as a fully functional set that can be delivered to the instructor for local storage and access at the end of the term of study. Effectively, this means that the instructor can own the gradebook. The same is process is less viable with web-based applications because the server side of the application requires third-party software that cannot be packaged with the data.

STUDENT INVOLVEMENT

GroupMaker supports student involvement in setting the weights for grades by having students vote on their score-modifying preferences. The ballot for changing votes appears on the computer screen as a choice of one among three bulleted items, as shown in Figure 2.

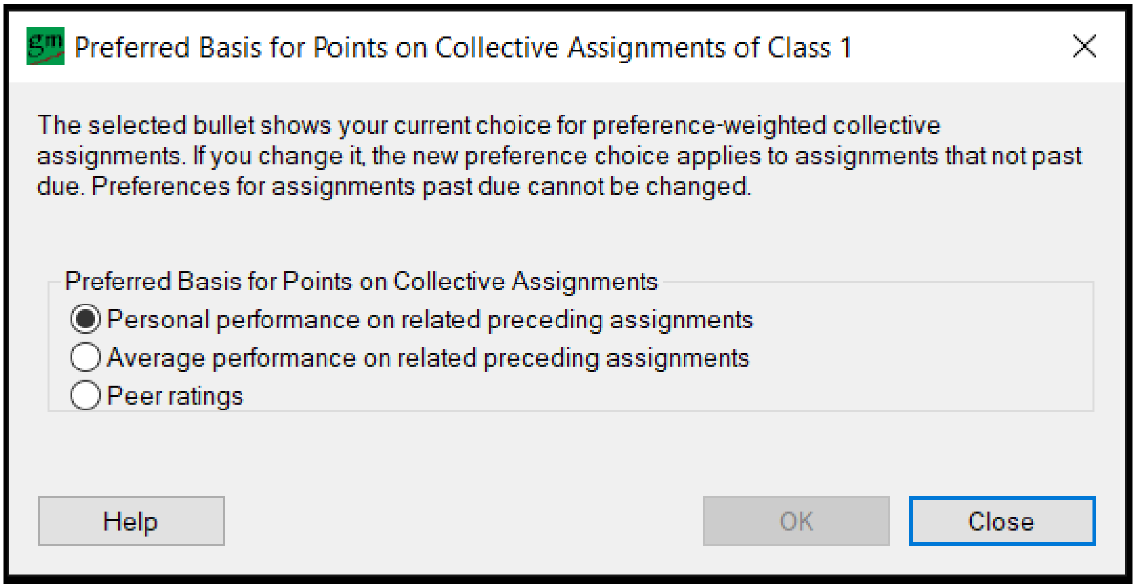

Figure 2 Screenshot of Preference-Weight Voting Panel

GroupMaker uses the votes to compute weights (Equations 6 and 7) and grading factors, as follows:

f_p: Preceding performance factor, $p_j \omega_p$
f_a: Average preceding performance factor, $\bar{p}\omega_a$
f_e: Summative peer evaluation factor, $e_j(1 - \omega_p - \omega_a)$

For transparency, GroupMaker shows students their assigned points together with the grading factors used to compute the points, following the form of Equation 8.

$$Y_j = (f_p + f_a + f_e)qX. \quad (8)$$

LEADERSHIP

Serious work on a unified submission cannot proceed without leadership. Should the instructor not designate a leader for each group on a group assignment or a class leader for a class assignment, GroupMaker grants, by default, leadership powers to the first member of the collective (group for a group assignment; class for a class assignment) who acknowledges the assignment by clicking the OK button of the panel displaying the assignment. Leadership powers supported by GroupMaker include the following:

1. Protective power. The power to downgrade and deny selected members the privilege of modifying the submission.
2. Punishment power: The power to affirm that selected members are engaged with the assignment, therefore eligible to receive points towards grades for the submission.
3. Promotion power: The power to upgrade selected members to the position of leader.

The first power is protective because it prevents the selected member from damaging the submission, the second is punishing because it prevents the selected member from receiving credit towards grades for the submission, and the third is promotional because it grants the three powers to some other member.

Power is essential for leaders, but power might also be abused. To guard against abuse, GroupMaker allows the instructor to deny selected leadership powers to selected leaders, but denial of powers has consequences. Thus, if the instructor denies the leader protective power, then any member of the collective can modify the submission in a way unacceptable to other members, giving rise to the possibility of uncontrolled conflicts. If the instructor denies punishment power, then any member can shirk without incurring an individually disadvantageous loss. If the instructor denies promotion power, then a leader unable to lead and unable to promote another member to the position of leader would leave the collective leaderless. Thus, GroupMaker reduces tedium in handling the usual case and retains options for the instructor to address the exceptional case.

EXAMPLE

For an example, consider a case-intensive course in which students are divided into groups of four or five to work collaboratively on cases. The instructor directs the students to meet in groups twice to discuss each case, and then to submit a written analysis of the case for grading as a unified group submission. Before each case assignments, the students are told the following:

1. Members have been assigned to groups.
2. Before the start date of the case assignment, everyone can choose one among the three options for their preferred basis for points on the unified submission. Their choices will be used to compute the weights, following Equations 6 and 7 of the inclusive grading formula of Equations 4.
3. Work on the case is divided into two meeting assignments and one unified submission assignment. The two meeting assignments constitute the p_j and $\bar{p}$ of Equation 4. For those affirmed as engaged in both meetings, $p_j = 1$. Otherwise, p_j equals .5 or 0 for those affirmed as engaged in only one meeting or no meeting, respectively.
4. The group leader of each assignment affirms the engagement of each group member by checking the *engaged* box associated with that member on GroupMaker.
5. The first group member to OK acceptance of the assignment on GroupMaker becomes the group leader of the assignment.
6. The instructor will score the unified submission.

Table 1 shows constructed data for five student, A through E, of one group. In this example, three students, A through C, selected personal performance as their preferred basis for points on the unified submission, one student, D, selected average performance, and one, E, selected peer rating. Their aggregated selection gives rise to weights of .6, .2, and .2 for ω_p, ω_a, and $1 - \omega_p - \omega_a$, respectively.

TABLE 1
Constructed Data of Numerical Example

Student	Preference Choice			No. of Meetings Engaged	Personal Performance on Preceding Assignments (p_j)	Peer Evaluation Ratio (e_j)
	Personal Performance (n_p)	Average Performance (n_a)	Peer Rating (n_e)			
A	1			2	1.0	1.0
B	1			1	.5	.8
C	1			2	1.0	1.0
D		1		2	1.0	.7
E			1	1	.5	.7
Sum	3	1	1			
$\omega_p = \frac{n_p}{n_p+n_a+n_e} = \frac{3}{3+1+1} = .6$						
$\omega_a = \frac{n_a}{n_p+n_a+n_e} = \frac{1}{3+1+1} = .2$						
$1 - \omega_p - \omega_a = 1.0 - .6 - .2 = .2$						
$\bar{p} = \frac{1.0 + .5 + 1.0 + 1.0 + .5}{5} = .8$						

The group leader affirmed that three members, A, C, and D, were engaged with both meetings, and that two members, B and E, were engaged with only one of the two meetings. Thus, the scoring ratios for personal performance on preceding assignments are 1.0 for the three affirmed as engaged with both meetings and .5 the two affirmed as engaged in only one meeting. The peer evaluation ratios occupy the last column of the table. As constructed, they range from .7 to 1.0.

Table 2 shows the computed results in points towards grades when the instructor assigns the score of 10 ($qX = 10$) to the unified submission. The results are shown in both the full form of Equation 4 and the simplified form of Equation 8. The simplified form highlights the reality of this case, that differences in points towards grades are primarily due to differences of engagement in the two meetings.

TABLE 2
Inclusive Grading Results of Numerical Example When the Unified Submission Receives the Score of 10

Student	Result (Y_j)
A	$[(1.0)(.6) + (.8)(.2) + (1.0)(.2)]10 = (.6 + .16 + .2)10 = 9.6$
B	$[(.5)(.6) + (.8)(.2) + (.8)(.2)]10 = (.3 + .16 + .16)10 = 6.2$
C	$[(1.0)(.6) + (.8)(.2) + (1.0)(.2)]10 = (.6 + .16 + .2)10 = 9.6$
D	$[(1.0)(.6) + (.8)(.2) + (.7)(.2)]10 = (.6 + .16 + .14)10 = 9.0$
E	$[(.5)(.6) + (.8)(.2) + (.7)(.2)]10 = (.3 + .16 + .14)10 = 6.0$

CONCLUSION

Presenting a theory of grading and showing its application in a TMS are steps towards reducing the burden of grading. The TMS does not make judgments in assigning grades unnecessary, but the TMS does save time for instructors to redirect towards better teaching. Moreover, easing grading makes the work of teaching more attractive, which should result in instructors allocating more energy to teaching, an expectation consistent with established studies of work fatigue (Maier, 1973).

Further research on teaching management might involve gathering data on the choices students make when their votes are solicited on simple PPA, average PPA, and SPE. If students never vote for one of these, then that option can be dropped, and if they always vote for only one, then that one should be operationalized without voting, as voting would be superfluous. In all cases, why students vote the way they do would itself be an interesting issue.

Teachers must grade, so the dichotomy between teachers who grade and graders who teach is a false one. Whereas many studies have been published on how teachers might teach better, fewer studies have apparently been published on how teachers might grade better. Teaching teachers to teach better is difficult, because the best way to teach depends on subject, students, and circumstances. As a result, the surfeit of findings from studies of teaching effectiveness are often ignored (McMurtrie, 2022).

Enabling teachers to grade better may be easier, because grading depends, as shown here, on technology that can be more easily molded to requirements. Certainly, when teachers grade better, they may be more inclined to teach better and their students may be more inclined to learn better.

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