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Combined Student Evaluation and Competition Class Work

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Competitive Teamwork Assessment of Class Work in Electrical Engineering

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Abstract

The authors applied an innovative testing method in three different electrical engineering courses that benefited the students' learning and evaluation. The testing is called Class-Work (CW) and is designed for assessing two-student teams for better understanding the content, answering questions efficiently, and working as teams in a competitive in-class environment. The evaluation method is a function of accuracy and speed. The grades from the test reflect the participants' knowledge on the content, their ability in team working and their skills for fast investigation. The results are discussed for three separate electrical engineering courses. The proposed method added some enjoyment to the class and reduced the stress of the quiz. Because of its completive nature, it discourages possible cheating.

Class work assessment

Assessment is one of the three major tasks of all educators [1]. The other two are "Motivation" and "Education". The classical assessment is based on grading the knowledge, indifferent of the speed. Considering the time given for a certain task could give the instructor another dimension to students' assessment. Speed is a more tangible element of competition than grading that motivates many students. The motivation for learning is an output of many other inputs, such as achieving higher GPA, gaining of knowledge, and of course, graduating from school. The existing evaluation methods motivate most of the students, but can also cause unexpected results, such as discouraging student-to-student interaction. Moreover, it may discourage team working and sharing of ideas and knowledge. The standard evaluation method in our current education system – which includes regular tests and quizzes – is a single variable function between student and teacher. The author of this paper proposes a method of assessment that changes the single variable function to a multivariable function of the teacher, student, and class. In the proposed method of assessment, the teacher combines evaluation and competition in a form of Class Work (CW). Unlike simple assessment, CW is a function of the team working, speed, and the participation of all the students in the class. The combination of competition and evaluation creates excitement, which amplifies the motivation. The authors applied this idea by randomly assigning the students into groups of two members and letting them work together on a quiz during the class. The students obtain extra credit inversely proportional to the time they spend on the CW. Hence, the faster they submit the quiz, the greater bonus points they achieve. In Equation 1, the bonus points decrease exponentially from its maximum to zero based on the order (rank) of submitting the quiz to the instructor. The authors chose an exponential distribution of the bonus point as a function of the rank of the teams because it has similar nature to the popular *Poisson* probability distribution time between events [2,3].

$$Final\ Grade = Grade\left[1 + Max\_Bonus * \left(e^{\left(\frac{\pi\left(1-\left(\frac{Class\ Average\ Grade}{Grade} * rank\right)\right)}{Number\ of\ teams}\right)}\right)\right] \quad (1)$$

The mean number of events per interval in Poisson probability distribution is equal to one in this paper, which is equal to the rank of the team [4,5]. The act of submitting a completed quiz to the instructor is considered as the "event" in Poisson probability distribution. The authors have proposed a modification to Poisson probability distribution by modifying the rank by the factor of the grade achieved by the team over the average grade of the class for the same quiz. That means the rank is weighted by the average class grade of the quiz. It normalizes an individual grade with the average grade of the same quiz in the same class. For example, in Table 1, the fourth team (Team D) out of 16 participating teams, achieved full grade of 10/10 in the quiz, while the average grade was 8.0/10. Using Eq. 1, the rank of Team D was upgraded to 3.2, i.e. 3.2= (4) (8.0/10). For the same Team D, the final grade is:

$$Final\ Grade = 10\left[1 + 20\% * \left(e^{\left(\frac{\pi\left(1-\left(\frac{8}{10}*4\right)\right)}{16}\right)}\right)\right] = 11.1 = 10 + 1.1(Bonus)$$

The rank modification is applied to prevent the students to rush in submitting incomplete answers. In case a team achieves an initial grade equal to the average of the class, then its rank is not modified.

Sample Tests and Numerical Results on Three Courses

Tables 1,2 and 3, and figures are the results of three different CWs in three courses in Electrical Engineering department. The tables show the related data for each CW, and the figures show the maximum grade for each rank. Table 1 shows the grades of CW 1 in ee255-01-W2017. Max Grade includes the maximum initial grade (same for all students) plus the maximum bonus achievable for a rank. For example, Team C with a rank of 3 has achieved 10/10 plus 1.4/1.4 bonus. As it shows in the table, Team C achieved a higher bonus than Team B with a rank of 2. For Team B, the initial grade is 5/10 and the bonus is 0.6/1.6 .It means speed and accuracy are both important factors to gain a greater bonus.

Table 1: ee255-01-W2017 CW1

ee255-01-W2017 CW1 Max. Grade is 10

Teams	Rank	# of Teams	Your Initial Grade	Max Available Bonus	Max Grade With Bonus	Your Bonus	Your Final Grade
A	1	16	8	2.0	12.0	2.0	10.0
B	2	16	5	1.7	11.7	1.3	6.3
C	3	16	10	1.5	11.5	1.5	11.5
D	4	16	10	1.3	11.3	1.3	11.3
E	5	16	10	1.1	11.1	1.1	11.1

F	6	16	10	0.9	10.9	1.0	11.0
G	7	16	10	0.8	10.8	0.8	10.8
H	8	16	9	0.7	10.7	0.6	9.6
I	9	16	6	0.6	10.6	0.2	6.2
J	10	16	5	0.5	10.5	0.1	5.1
K	11	16	10	0.4	10.4	0.5	10.5
L	12	16	7	0.4	10.4	0.2	7.2
M	13	16	8	0.3	10.3	0.2	8.2
N	14	16	5	0.3	10.3	0.0	5.0
O	15	16	5	0.2	10.2	0.0	5.0
P	16	16	6	0.2	10.2	0.0	6.0

Average of Initial Grades is **7.8**

Average available Bonus is **0.8**

Average Obtained Bonus is **0.7**

Average Grades W Bonus is **8.4**

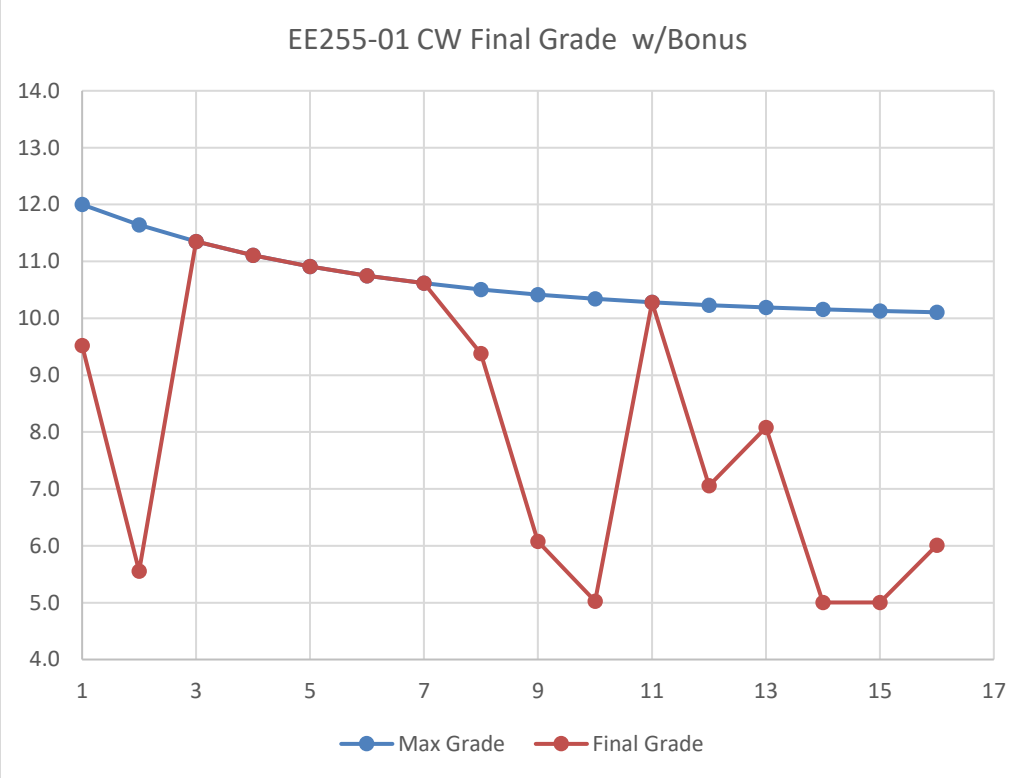

Figure 1: Final Grade for Each Team & Max. Grade for Each Rank

Table 2 shows the grades of CW 1 in ee211-01-W2017. The maximum initial grade without any bonus point is 20 and the average grade of the class is 17.

Table 2: ee211-01-W2017 CW1

ee211-01-W2017 CW1 Max. Grade is 20

Teams	Rank	# of Teams	Your Initial Grade	Max Available Bonus	Max Grade With Bonus	Your Bonus	Your Final Grade
A	1	14	20	2.0	22.0	2.0	22.0
B	2	14	17	1.6	21.6	1.5	18.5
C	3	14	17	1.3	21.3	1.2	18.2
D	4	14	20	1.1	21.1	1.1	21.1
E	5	14	18	0.9	20.9	0.8	18.8
F	6	14	18	0.8	20.8	0.7	18.7
G	7	14	20	0.6	20.6	0.6	20.6
H	8	14	16	0.5	20.5	0.4	16.4
I	9	14	14	0.4	20.4	0.2	14.2
J	10	14	18	0.4	20.4	0.3	18.3
K	11	14	14	0.3	20.3	0.1	14.1
L	12	14	18	0.2	20.2	0.2	18.2
M	13	14	16	0.2	20.2	0.1	16.1
N	14	14	12	0.2	20.2	0.0	12.0
Average of Initial Grades is			**17.0**				
		Average available Bonus is		**0.8**			
					Average Obtained Bonus is	**0.7**	
						Average Grades W Bonus is	**17.7**

The results have two dimensions and provide a better view of the students' performance. For example, Team N with a rank of 14 among 14 teams achieved no bonus and the lowest grade. The results provide more information about the performance of the students. For example, Team N shows significantly low performance in knowledge and speed.

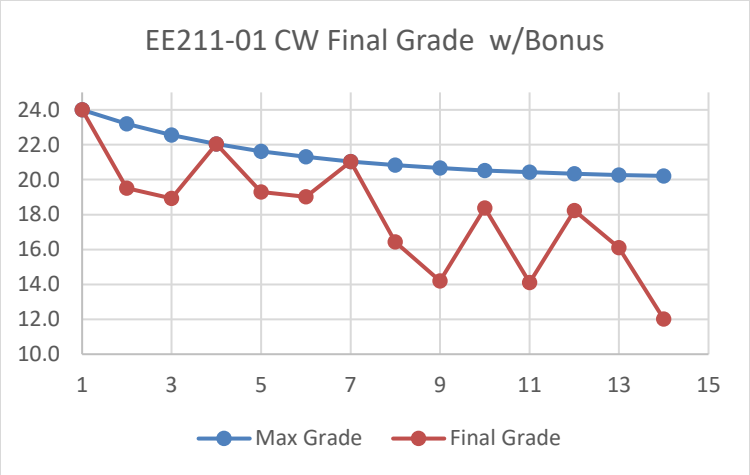

Figure 2: Final Grade for Each Team & Max. Grade for Each Rank

Table 3 shows the grades of CW 1 in ee211-02-W2017. The maximum grade without any bonus is 20, the average class grade is 17.1, and the maximum grade with bonus is 24.

Table 3: ee211-02-W2017 CW1

ee211-02-W2017 CW1 Max. Grade is 20

Teams	Rank	# of Teams	Your Initial Grade	Max Available Bonus	Max Grade With Bonus	Your Bonus	Your Final Grade
A	1	10	20	2.0	22.0	2.0	22.0
B	2	10	20	1.5	21.5	1.5	21.5
C	3	10	18	1.2	21.2	1.1	19.1
D	4	10	15	0.9	20.9	0.6	15.6
E	5	10	18	0.7	20.7	0.6	18.6
F	6	10	20	0.5	20.5	0.5	20.5
G	7	10	19	0.4	20.4	0.4	19.4
H	8	10	18	0.3	20.3	0.2	18.2
I	9	10	15	0.2	20.2	0.1	15.1
J	10	10	8	0.2	20.2	0.0	8.0
Average of Initial Grades is			**17.1**				
		Average available Bonus is		**0.8**			
				Average Obtained Bonus is		**0.7**	
					Average Grades W Bonus is		**17.8**

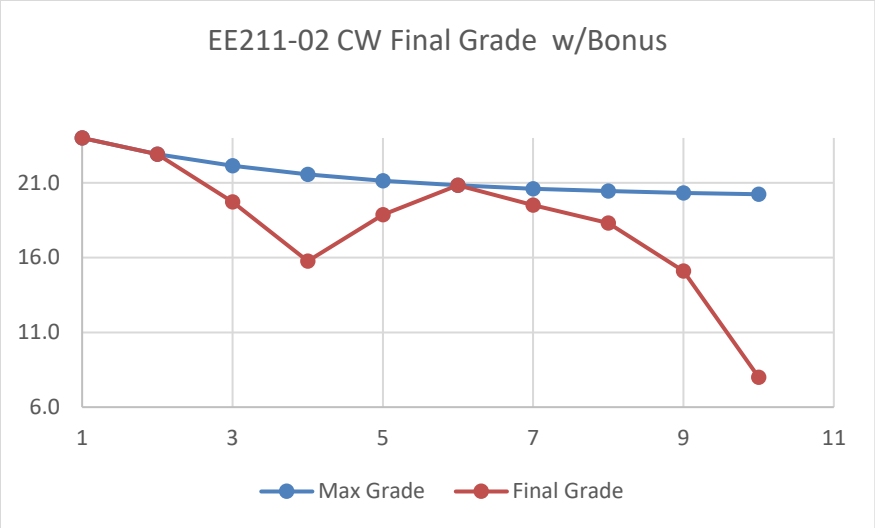

Figure 3: Final Grade for Each Team & Max. Grade for Each Rank

The assessment encourages diligence as well as it tests time-management skills. The problems given for CW are usually selected from the most recent subject that has been discussed during the previous lecture. The subject needs to be reviewed and practiced by the students for a credit with the same weight as a normal quiz described in the syllabus. The CW is slightly different than normal quiz in the sense that it is a group work and the teams can use their notes and textbooks. Other than the competition for a quick submission, there are other benefits in CW. The given problems are designed such that the students will gain some self-education skills. The CW's is given in the following class after the lecture on the subject. Students are aware of the subject to be asked and the date. Hence, this requires preparation for the quiz as well as complete attention to the lecture. There is usually a small part in CW that is not covered in the lecture but is discussed in the textbook. This part incentivizes individual students to read through the chapter and become well-acquainted with the textbook, rather than rely solely on the professor and class notes. In summary, the CW is a multiple-part and team-working task. It contains an individual reading assignment, choosing a teammate, attending the following lecture, listening carefully to the lecture, understanding the problem, getting help from the text, and solving the problem in the shortest possible time. The CW is submitted before the end of the class time and has no make-up option for absentees. The CW grades clearly reflect the students' team-working skills, their understanding of the subject, their responsibility in reading the text, and their dedication to the class, and speed. There is no reason for cheating because of the competitive nature of CW. It also allows the instructor to know the students better and observe their performance as a judge and not as an evaluator. It minimizes the requests for grade changes or make-ups. Students can clearly see that lack of preparation would cause damage to themselves as well as to their teammates. Teammates check each other and communicate effectively to ensure their success. In addition to the bonus point, the first three winning teams are introduced to the class and receive an acknowledgment from the instructor. The other byproduct of CW is a realistic feedback of the teaching quality of the instructor. It illustrates how effective the lecture is to the success of the competition. Keeping the record for class attendance is another byproduct of CW, which holds the students accountable for missing one. The ranking may be remodified again in case one or two members of a team have disabilities. The modification for

students with a disability is based on the recommendation from the university disability resource center.

Conclusion

The effect of CW was examined against normal quiz, by including one question from the normal quiz, and one question from CW1 in the first midterm in ee255-01-W2017. It has been observed that the average grade of the students on a question from CW1 was higher than one from the Quiz1.

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