Research Papers/Extended Abstracts

Scaling marks distribution of underperformed assessments to avoid higher failure rates

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Abstract

Scaling assessment marks of underperformed assessments provide a temporary solution for unforeseen anomalies in student's letter grade distributions of a course unit. In this work, a model of linear mapping is employed to scale the marks of an underperformed assessment of a course unit. The mapping process is based on shifting the average of raw marks to an expected average. It is demonstrated that the effect of such a scaling process on higher GPA value letter grades (A, A+) are minimal. It is confirmed that the shifting of letter grades is only short range in the middle and lower letter grades. The increment of the number of lower and middle range letter grades is mainly due to satisfying the condition on passing the continuous assessment. The imposed condition on passing the continuous assessment is to obtain 50% marks from the continuous assessment components of the course unit. Further, this analysis suggests having a minimum of class average of 60% marks for each component of continuous assessments is sufficient to achieve a reasonable number of passing grades for a course unit.

Keywords: *Assessments grades, Average marks, Letter grades, Scale marks distribution,*

Introduction

Students' performance in assessments and true evaluation of student's knowledge is complex. As a result, grade inflations and deflations are commonly observed in newly introduced course units (Wetzler, 2019; Swart & Hertzog, 2016). The problem is critical in newly introduced degree programs for students with different background. For instance, the recently introduced technology degree programs can be considered. In such cases, various ad hoc procedures are commonly in practice to remedy the unprecedented grade deflations. However, a proper scaling mechanisms of assessment marks are virtue in such situations to systematically rescale the marks distributions of underperformed assessments without losing the credibility of the final grades of the course unit (Kulick & Wright, 2008; University of Oxford, 2020; Cardiff University, 2020; Loughborough University, 2013; Univerisity of Bath, 2014).

In common practice, students are purely assessed against a given question paper. The students' development during the teaching learning activities of the course unit and its efficiency are generally disregard in assigning the grades. In STEM disciplines, student centered teaching learning methods are highly encouraged. In this concept, students are expected to work as a group in achieving the intended learning outcomes of the course unit. On this context, it is important to consider student's performance with reference to the group it belongs as a factor, when assigning the letter grades. Thus, rescaling the entire mark distribution is a meaningful act to meet the fixed letter grade cutoffs and institutional policies (Univerisity of Bath, 2014). On this context, an underperformed assessment could be a critical factor in ruling out the passing percentage of students in a course unit.

The main objective of this study is to demonstrate the efficacy of a marks scaling process on the distribution of final letter grades of a course unit having higher failure rate. In this work, First, a model of linear mapping is implemented to scale the entire mark distribution of an underperformed assessment. Next, it is discussed how would the proposed method influence the pass/fail conditions and final letter grades of a course unit. Finally, some suggestions are made to better plan the teaching/learning activities and assessments to overcome the issues in grade inflation and deflation.

Methodology

A linear model

The raw mark distribution of a given assessment can be represented by x_R, where the subscript *R* refers to the raw mark distribution. The class average of the raw marks distribution x_R can be denoted by $\overline{x_R}$. The entire mark distribution of the assessment can be scaled to a new distribution x_S, where the subscript S refers to the scaled mark distribution. The class average of the scaled mark distribution x_S can be denoted by $\overline{x_S}$. A linear model can be employed to map the raw mark distribution x_R to the scaled mark distribution x_S as described below. Assuming the maximum marks possible for the given assessment is x_R^{max} and no student will be entitled to receive marks above x_S^{max}. Thus, the maximum possible mark in the scaled distribution is also x_S^{max}. With above conditions, a linear mapping between the raw marks (x_R) and the scaled marks(x_S) can be defined as below.

$$x_S - x_S^{max} = \frac{(\overline{x_S} - x_S^{max})}{(\overline{x_R} - x_R^{max})} \times (x_R - x_R^{max}) \qquad (1)$$

The standard deviation of x_R and x_S can be denoted by σ_{x_R} and σ_{x_S} respectively. According to the above liner transformation, the standard deviation transforms as,

$$\sigma_S = \frac{(\overline{x_S} - x_S^{max})}{(\overline{x_R} - x_R^{max})} \times \sigma_R. \qquad (2)$$

In Figure 1, it is shown that the linear mapping of a mark distribution having an $\overline{x_R} = 40$ to $\overline{x_S} = 60$ using the above equation (1). The horizontal axes represent the raw marks, and the vertical axes is the scaled marks according to the linear model.

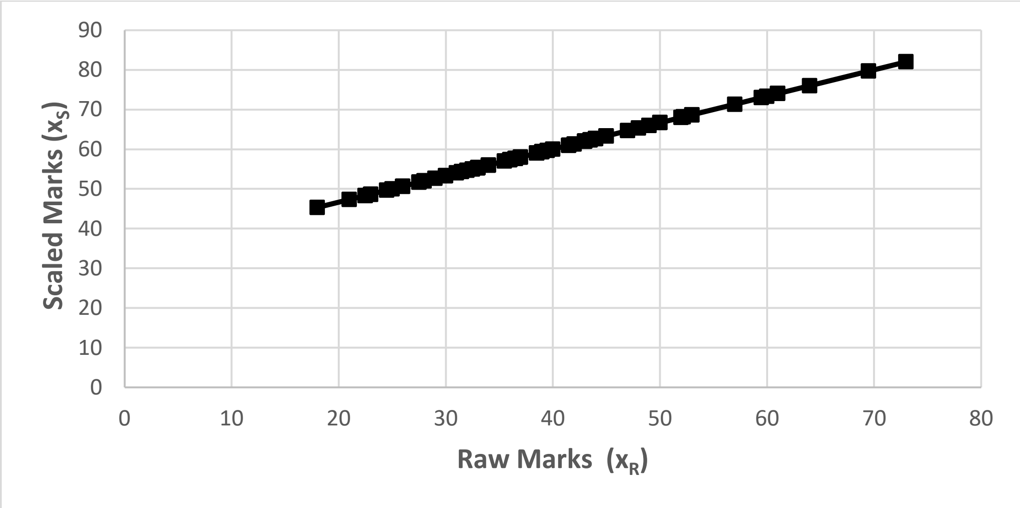

Figure 1: The scaled marks against the raw marks of a mid-semester assessment. The raw marks are scaled using a linear mapping (Eq. 1) and represented on the vertical axis. In this linear mapping, the class average of the raw marks (40) is mapped to a scaled mark distribution having an average of 60.

Results

A course unit consists of several components of assessments. Mainly it is divided in to two parts: the continuous assessment (CA) and the end semester examination (ESE). The CA component consists of several components of formative and summative assessments. For instance, the mark allocation of 40 and 60 are adapted for CA and ESE components of a course unit. The 40 marks of CA is distributed among several components of assessments. It is commonly adapted 5 marks for the weekly assigned tutorials, 10 marks for 2 quizzes (5 marks from each), and 25 marks for the mid-semester assessment. Moreover, the policy decision on passing criteria of the course unit is to obtain a minimum of 50% mark from the CA component.

In the Figure 2 below it is depicted the total CA mark distribution of students for 4 new course units (Named as A, B, C, and D). These course units are taught to the students for the first time. The number of students in the class is 81. The class averages of the CA components of course units A, B, C, and D are 15.44, 21.70, 18.73, and 23.40 respectively. Thus, the implementation of the condition of passing the course unit (obtain more than 20 marks) would lead to fail a significant number of students in course units A, B, and C. In this scenario, the number of failing students of course units A, B, C, and D are 69, 32, 45, and 7 respectively. As a percentage, they are 84%, 39%, 55%, and 8%. Thus, it is essential to analyze the students' performance on underperformed assessments causing the problem. The major summative component of all 4 course units is the mid semester assessment which contributes 25 marks for CA. In course units A, B, and C the mid semester assessment was the underperformed assessment which rules out the passing percentage.

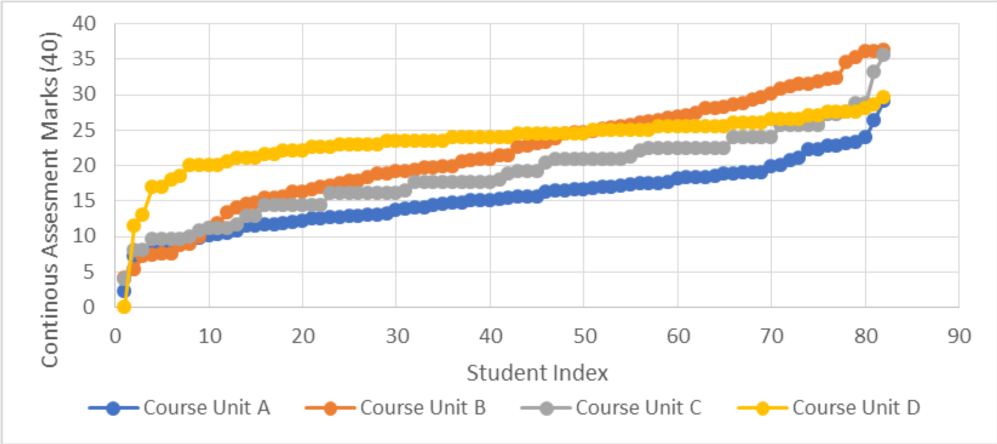

Figure 2: The total of continuous assessment marks is plotted in ascending order for the course units A, B, C, and D.

In proceeding, the assessment marks of course unit A is considered for this analysis. In the Figure 3a it is plotted the mark distribution of the mid-semester evaluation of course unit A. The class average of the mid-semester assessment is $\overline{x_R} = 40$. It is used linear mapping (Eq.1) to scale marks to shift the class average to $\overline{x_S} = 60$. In Figure 3b, it is depicted the distribution of the scaled marks obtained from the linear mapping. The marks distribution is represented in bins of width 10 units. In Figure 1, it is plotted the linear mapping of the marks of the mid-semester assessment. Due to the linear model, it can be noted that the shifts of marks in higher ranges are small compared to that in lower ranges. This supports the requirement of improving the passing percentage having the lowest impact on the results of the high performing students. The maximum change of mark in the mid-semester assessment is 30 points which occurs at the students having the lowest mark. The minimum change in the mid-semester assessment marks is 10 which is added to the student having the highest mark. It must be noted that the contribution of these changes to the final total mark is 25% of the above values. Thus, the effective adjustment of the marks ranges from 2.5 to 7.5. It is confirmed that this adjustment of marks mainly influences the passing condition on continuous assessments. If the passing condition on continuous assessment is removed, 86% of students receive passing grades according to the total marks of the course unit. This is due to the students has performed well in the end-semester examination. In this case, the number of students having grades A and above is 3. Moreover, the number of students having grades B and above is 18.

In Figure 4, the red bars represent the grade distribution with the scaled marks of the mid-semester assessment. A considerable improvement of the grades in the middle ranges are observed. The percentage of students receiving passing grades is 65%. As a result, a student receives a grade “A+” whereas the number of students receiving “A” grades has not been changed. The increase of the intermediate grades (A-, B, B-, C+, and C) are mainly due to fulfilling the passing criteria of the course unit. Moreover, short-range boundary crossing of the grades are also observed. It is confirmed that this number is small. In the absence of the passing criteria on CA, there are 12 number of C+ grades. This number reduces to 8 and increases the B- grades by 6 after rescaling the mid-semester assessment and imposing the passing criteria on the continuous assessment (See Figure 4). The number of students having grades B+ and above are 18, whereas the number having grades B or above is 18 without scaling marks and imposing the passing criteria on CA. Thus, it is confirmed that the shifting of grades are short-range and does not contribute grade inflations.

The above analysis suggests that a minimum class average of each assessment should be at least 60% to pass a fair number of students in the course unit. The teacher can plan in subsequent years to improve the teaching/learning activities and to optimize the course unit learning outcomes and content in curriculum revisions to rectify the anomalies. The two quizzes (quiz 1 and 2) of this course unit have class averages 50% and 30% respectively. Thus, the class average of quiz 2 is well below the expected. The mark distribution can be scaled to shift the class average to 60% marks. In figure 4, the gray columns represent the grade distribution with the scaled marks of the mid-semester assessment and quiz 2. It is observed that only an A- grade switches to A. Further, the observed gain of 3 B's, 5C's, and 2 D+ are due to passing the condition of 50% requirement on CA. At this stage the failing percentage is reduced to 22%.

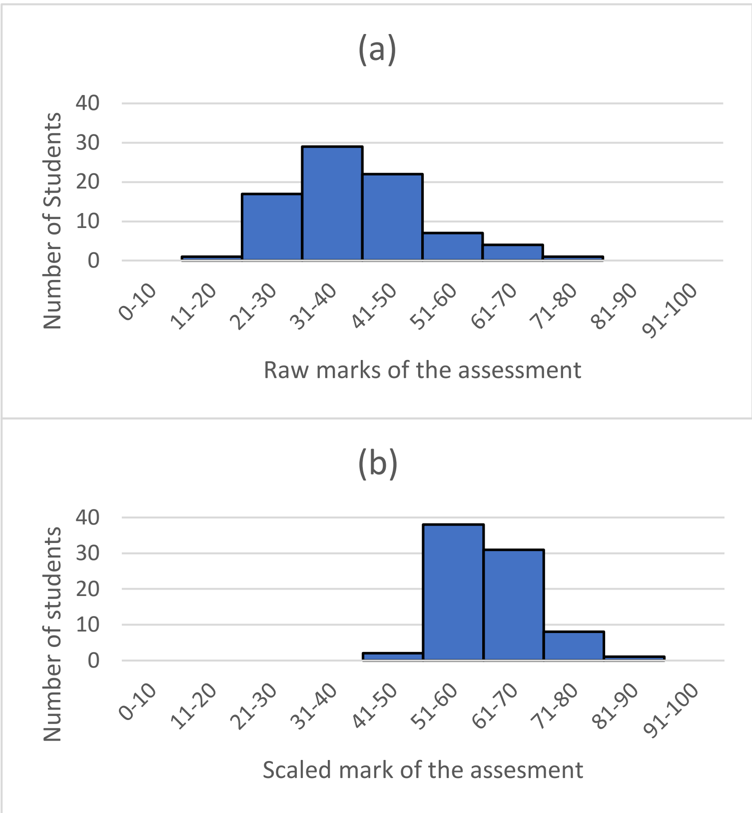

Figure 3 The marks distribution for the mid semester assessment of course unit A is plotted in the histogram. The subfigure (a) shows the raw marks distrubution and the (b) is the distribution of scaled mark as shown in the Figure 1.

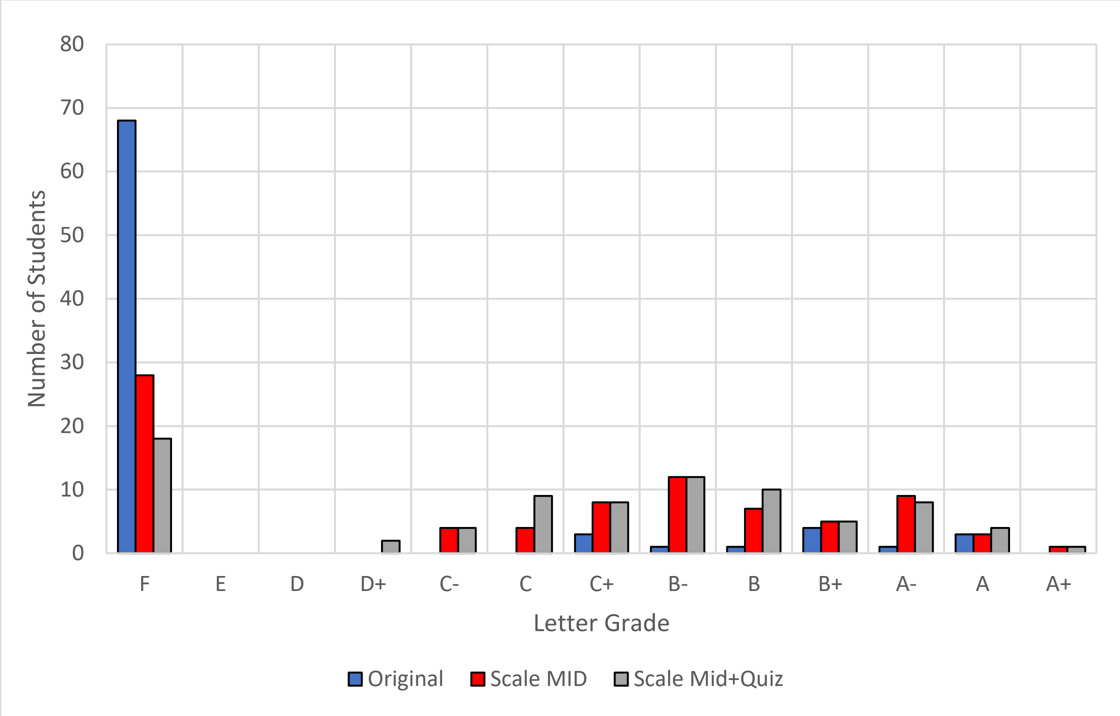

Figure 4: Letter grade distribution for course unit A. The letter grades are issued according to the total marks obtained for the course unit. The grade boundaries for grades A+ to D are 85,70, 65, 60, 55, 50, 45, 40, 35, 30, and 25, respectively. The grade "F" is assigned for students who do not meet the 50% requirement of the continuous assessment component.

Conclusion

In this work, assessment marks of a selected course unit are analyzed statistically. A model of linear mapping is implemented to scale the entire mark distribution of an underperformed assessment. The mapping process is based on shifting the average of raw marks ($\overline{x_R}$) to the expected average ($\overline{x_S}$). The adjustment to the assessment marks due to the employed linear mapping is small at higher marks and larger in the lower mark regions. As a result, the effect of such a scaling process on higher GPA value letter grades (A, A+) are minimal. Further, it was confirmed that the shifting of letter grades is only short-range. The increment of the lower and middle range grades is mainly due to satisfying the passing condition on the continuous assessment. Further, this analysis suggests having a minimum of 60% class average for all the components of continuous assessments is sufficient to achieve a reasonable number of passing grades for a course unit.

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