Article

Interrogating CGPA: In Search of the Missing Links—Suggested Alternatives

Vivek Kumar Jain¹ and Sanjeev Bakshi²

Abstract
The system of teaching and assessment in the higher education in India is passing through a phase of transition. Many of the universities in India have adopted the semester system with credit- and grade-based evaluation of students. These systems are functionally different from the annual system of teaching and evaluation based on marks and percentage. The grade-based system of evaluation is recommended for its virtues and is accepted as a progressive step toward reforms in the higher education system. However, a critical evaluation of the new system vis-à-vis the older one is necessary. The objective of this article is to focus on some of the issues associated with the calculation of grade point average (in absolute grading), to focus on the anomalies created thereby in conversion of grade point average to percentage, and to suggest alternatives to minimize the arbitrariness so that the examinee is not penalized. The present work illustrates the problems inherent in the grading system using examples from Indian universities. Subsequently, the probable reasons for the problems are discussed. Finally, simple alternative measures are suggested to overcome the shortcomings of the grading system.

Keywords
CGPA, CGPS, evaluation, GPA, grades, percentage, weighted percentage

Introduction
Higher education system in India is passing through a phase of transition. The semester system with credit- and grade-based (letter grades) based assessment is replacing the annual system where the percentage of marks was the criterion of assessing performance. In a letter addressed to the vice-chancellors of universities in India, the chairman of the University Grants Commission (2009) emphasized the need to move away from marks and division system in evaluation and need to introduce grading system—preferably on a 9 point scale and cumulative grade point score (CGPS) in order to make the evaluation system at par with the best practices.

It has also been mentioned in the letter that

it will be useful if universities try to go beyond “marks” and “divisions” and, in keeping with the global trend, give CGPS which would place students into overlapping broad bands. The CGPS may be based on a five-point or ten-point scale and it could vary from institution to institution.

It is opined that new system of evaluation will minimize misclassification of students on the basis of marks, eliminate unhealthy competition among high achievers, and also facilitate joyful and stress-free learning. Grades matter because they have a substantial impact on learners and their learning, influencing students’ sense of achievement and their motivation. However, the proposed method of evaluation is expected to possess some desirable properties as enunciated in the criteria that follow:

i. The cumulative grade point score (CGPS) should not discriminate between two students if their performances differ by a small percentage of marks.

ii. The CGPS should be able to discriminate between two students if their performances differ by a large percentage of marks.

iii. The order of two students, in terms of performance, should be preserved when percentages are transformed to CGPS and vice versa.

iv. At times, it is required to convert CGPS back into percentage. For this purpose, the conversion formula should be unambiguous.

Despite the desirability and appeal of the grading system, higher education institutions have different conceptions of what it means in theory and in practice. Consider a simple hypothetical situation where there is only one paper in a course. The system of grading in this simple situation would work well as it would satisfy most of these criteria including preservation of the order of performance. However, in

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practical situations, more than one paper are offered in a semester. Thus, an aggregate measure of performance is needed to gauge the performance of a student. Until recently, the percentage of marks obtained by a student was used as an aggregate measure for the purpose.

However, the system based on grades uses grade point average (GPA) as an aggregate measure of student’s performance (Figure 1). GPA has been criticized for its inherent fallacies (Stroup, 1963). These fallacies are attributed to the loss of information (Das, 2007; Stroup, 1966) when marks are transformed into grades. Therefore, a comparative study of the two systems of evaluation keeping in view the above mentioned criteria is necessary. In the present work, this is done by analyzing the grading systems of selected Indian universities and by taking hypothetical examples of marks of students. Nonetheless, the inferences that can be drawn from the study are universal.

In what follows, a brief introduction to technical terms is provided. It is followed by a critical analysis of the grading system. Furthermore, in the third section, the “Shortcomings of the Grading System” are illustrated through counter examples. The section “Percentage and Weighted Percentage” introduces the need of weighted percentage (WP). The section “Why the CGPA Cannot Be Converted Back Into a Percentage/Weighted Percentage” dwells on the problem of converting back cumulative grade point average (CGPA) into equivalent percentage. The sixth section carries a “Discussion” on dilemmas of the grading system, and finally, some simple alternatives are proposed in the concluding section.

**Basic Terminology**

In an annual system, a course in an academic year consists of different papers. The syllabus of each paper is designed in such a way so that to complete it, equal amount of effort (student–teacher interaction in terms of contact hours) is required. According to Academic and Administrative Reform for Indian Universities (University Grants Commission, 2009), the annual system in all the universities in India has to be replaced by the semester system. Unlike the annual system, the papers that are offered in a semester may have different credits. Credits are assigned to a course depending on the number of contact hours required to complete the syllabus. Credits also indicate the relative importance of a paper. Therefore, credits are used as weights in computing the GPA as discussed below.

**Grade Point Average**

The GPA for the $j$th semester is calculated as follows:

$$
GPA_j = \frac{\sum_{i=1}^{n} m_i c_i}{\sum_{i=1}^{n} c_i},
$$

(1)
where \( n \) is the number of courses (arranged in an order 1 to \( n \)) in a semester, \( m_i \) denotes the numerical value of the grade obtained in the \( i \)th course of the semester, \( c_i \) denotes the credit for the \( i \)th course of the semester (Central University of Bihar, 2013).

**Cumulative Grade Point Average**

The CGPA for \( k \) semesters is given as follows:

\[
\text{CGPA} = \frac{\sum_{j=1}^{k} \left( \text{GPA}_j \times C_j \right)}{\sum_{j=1}^{k} C_j},
\]

(2)

where \( C_j \) is the total number of credits in the \( j \)th semester (Central University of Bihar, 2013). Clearly, CGPA is the GPA of all the courses in all the semesters. Qualitatively, the CGPS and the CGPA are equivalent. Henceforth, CGPA will be used instead of CGPS.

**Weighted Percentage**

The WP for the \( n \) number of courses (put in an order 1 to \( n \)) is calculated as follows:

\[
\text{WP} = \frac{\sum_{i=1}^{n} p_i c_i}{\sum_{i=1}^{n} c_i},
\]

(3)

where \( p_i \) denotes the numerical value of the marks (out of 100) obtained in the \( i \)th course, \( c_i \) denotes the number of credits for the \( i \)th course (Thyagarajan, 2004).

**Shortcomings of the Grading System**

**Student’s Performance and the GPA**

Suppose in a course, there are four papers of equal credit. For our purpose, the grading scheme as per Table 1 is utilized. A student obtains 76, 74, 59, and 51 marks out of 100, in four papers. The average mark of the student is then 65, and the grade of the student is A− or its numerical equivalent, that is, 8. However, using (1), the GPA of the student is calculated to be 7. It is clear that a student obtains different GPA/grade depending on the method followed to administer the grades. In other words, the GPA fails to reflect his or her performance. Furthermore, when CGPA is computed by aggregating weighted GPAs, a higher order discrepancy creeps in.

**GPA May Not Discriminate a Large Difference in Percentages**

**Example 1.** Let us take a simple example (Table 2) where four students appear in two courses of equal credits and the grades are assigned as per Table 1.

**Observations from Table 2**

a. The identical GPA of 6.5 represents both, a student with 58% of marks and a student with 66.5% of marks.

b. Similarly, a GPA of 7 represents both 62.5% of marks and 72.5% of marks.

It is obvious from the above example that a GPA represents a broad range of percentage of marks. Therefore, it is not possible to convert GPA into percentage by some formula. It can at most represent an interval of percentage. Keeping in view these observations, questions naturally arise regarding the discriminatory power of GPA and further, if a given GPA represents a range of marks, is it justified to convert CGPA into a fixed percentage? The following example will further illustrate the shortcomings of the CGPA.

**Order of Performance Between Students May Not Be Preserved by GPA**

**Example 2.** Consider the performance of eight students A, B, C, D, E, F, G, and H in six courses C1, C2, C3, C4, C5, and C6 with credits four, four, four, three, three, and two respectively. The marks obtained by each student in a paper, the GPA, WP, and percentage are shown in Table 3. The GPA and WP are calculated using Equations 1 and 3, respectively.

**Observations from Table 3**

a. It is clear that B performs better than A except in Course C6 of two credits. The weighted percentages of A and B are 53.55 and 55.25, respectively. However, the GPA of B is found to be lower than the GPA of A.

b. Similar is the case with the performances of C and D. Suppose C and D aspire to apply for a scholarship. The eligibility criterion for the scholarship is a minimum of 60% marks/6.5 CGPA in the qualifying examination. If their CGPAs are considered, C will qualify for the scholarship.
Table 2. Comparison of Performances of Students in Two Courses of Four Credits Each.

<table>
<thead>
<tr>
<th>Student</th>
<th>Course 1 Marks out of 100 (4 credits)</th>
<th>Course 2 Marks out of 100 (4 credits)</th>
<th>GPA with reference to Table 1</th>
<th>Weighted percentage</th>
<th>Percentage of marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>49</td>
<td>84</td>
<td>6.5</td>
<td>66.5</td>
<td>66.5</td>
</tr>
<tr>
<td>B</td>
<td>41</td>
<td>75</td>
<td>6.5</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>C</td>
<td>49</td>
<td>96</td>
<td>7</td>
<td>72.5</td>
<td>72.5</td>
</tr>
<tr>
<td>D</td>
<td>40</td>
<td>85</td>
<td>7</td>
<td>62.5</td>
<td>62.5</td>
</tr>
</tbody>
</table>

Note. GPA = grade point average.

Table 3. Comparison of Performances of Students in Six Courses With Varying Credits Using GPA, Weighted Percentages, and Percentages.

<table>
<thead>
<tr>
<th>Student</th>
<th>C1 (4 credits)</th>
<th>C2 (4 credits)</th>
<th>C3 (4 credits)</th>
<th>C4 (3 credits)</th>
<th>C5 (3 credits)</th>
<th>C6 (2 credits)</th>
<th>GPA with reference to Table 1</th>
<th>Weighted percentage</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>51</td>
<td>57</td>
<td>56</td>
<td>55</td>
<td>46</td>
<td>56</td>
<td>5.5</td>
<td>53.55</td>
<td>53.50</td>
</tr>
<tr>
<td>B</td>
<td>53</td>
<td>59</td>
<td>57</td>
<td>58</td>
<td>49</td>
<td>54</td>
<td>5.4</td>
<td>55.25</td>
<td>55.00</td>
</tr>
<tr>
<td>C</td>
<td>61</td>
<td>65</td>
<td>58</td>
<td>62</td>
<td>51</td>
<td>50</td>
<td>6.5</td>
<td>58.75</td>
<td>57.83</td>
</tr>
<tr>
<td>D</td>
<td>62</td>
<td>74</td>
<td>59</td>
<td>64</td>
<td>53</td>
<td>49</td>
<td>6.4</td>
<td>61.45</td>
<td>60.17</td>
</tr>
<tr>
<td>E</td>
<td>59</td>
<td>59</td>
<td>59</td>
<td>64</td>
<td>54</td>
<td>59</td>
<td>6.9</td>
<td>59.00</td>
<td>59.00</td>
</tr>
<tr>
<td>F</td>
<td>98</td>
<td>49</td>
<td>64</td>
<td>49</td>
<td>74</td>
<td>54</td>
<td>6.5</td>
<td>66.05</td>
<td>64.67</td>
</tr>
<tr>
<td>G</td>
<td>60</td>
<td>65</td>
<td>55</td>
<td>55</td>
<td>55</td>
<td>60</td>
<td>6.5</td>
<td>57.50</td>
<td>57.50</td>
</tr>
<tr>
<td>H</td>
<td>85</td>
<td>40</td>
<td>60</td>
<td>40</td>
<td>65</td>
<td>50</td>
<td>6.5</td>
<td>57.75</td>
<td>56.67</td>
</tr>
</tbody>
</table>

Note. GPA = grade point average.

Table 4. Letter Grade and Numerical Grade Equivalent of the Grades as Used for the BTech Courses in Jamia Millia Islamia.

<table>
<thead>
<tr>
<th>Range of marks obtained</th>
<th>Letter grades</th>
<th>Grade points</th>
</tr>
</thead>
<tbody>
<tr>
<td>75% and above</td>
<td>A</td>
<td>10</td>
</tr>
<tr>
<td>60% and above but less than 75%</td>
<td>B</td>
<td>8</td>
</tr>
<tr>
<td>45% and above but less than 60%</td>
<td>C</td>
<td>6</td>
</tr>
<tr>
<td>35% and above but less than 45%</td>
<td>D</td>
<td>4</td>
</tr>
<tr>
<td>Less than 35%</td>
<td>F</td>
<td>0</td>
</tr>
</tbody>
</table>


the eligibility criteria whereas D will be ineligible to apply for the scholarship. However, if their percentages are considered, D will qualify the eligibility criteria, and C will be declared ineligible. These situations, if they arise, are detrimental to justice and fair play.

b. The basic idea behind the system of grading is not to differentiate students if they have faltered by one or two marks in the performance. However, GPA discriminates students E and G on the basis of even small difference in their marks. Although the weighted percentage of E is higher than the weighted percentage of G.

c. F and H have secured 64.67% and 57.75%, respectively. However, GPA is not able to distinguish between them. Their GPA is 6.5 each.

Example 3 further illustrates this by utilizing the grading criteria adopted in a BTech course (Jamia Millia Islamia, 2012) as per Table 4. For this course, the GPA of a semester is called Semester Performance Index (SPI).

Example 3. Consider the performance of three students A, B, and C in six courses C1, C2, C3, C4, C5, and C6 with credits four, four, three, three, and two, respectively. The marks obtained by each student in a paper, the GPA, WP, and percentage are shown in Table 5. The GPA and weighted percentage are calculated using Equations 1 and 3, respectively.

Observations from Table 5

a. A performs better than B, but the SPI of A is lower than that of B.
b. The same SPI of 6.5 represents performance of both A and C. However, their percentage has a difference of 14.83.

These three examples show that GPA is neither able to conceal small differences in performance nor is it an efficient instrument to discriminate large differences in actual performance (assessed by the percentage of marks). Moreover, it may reverse the order of performance, say when a student’s performance is better with respect to percentage/WP, the performance with respect to GPA/CGPA may be worse.

**Percentage and Weighted Percentage**

In annual system of evaluation and assessment, usually for each course, the number of classes conducted is equal. In other words, the credit of all the courses is same. So percentage of marks is able to judge the student’s performance in the annual system. From Tables 3 and 5, it is evident that the percentage of marks is not affected by credit of a course. In a credit-based system, a course of high credit requires the student to put greater effort when compared with a course of lesser credit. The scores need to be aggregated to reach a single figure to judge the overall performance of a student. Because individual papers carry credits and the credits also represent the weight of a paper, the aggregate measure should incorporate the weights along with the marks. Therefore, the weighted aggregate measure such as WP is more appropriate for measuring the performance of a student than the CGPA.

**Why the CGPA Cannot Be Converted Back Into a Percentage/Weighted Percentage**

It is a common practice to multiply the CGPA with a constant, say k, which depends on the grading scale to reach a percentage equivalent of CGPA (Central University of Bihar, 2013). Any such direct multiplication of CGPA by a constant “k” cannot be a percentage or an approximation of percentage. It is an irony that even when the original percentage is known, an exercise is carried out to convert CGPA into percentage equivalent of CGPA. Alternatively, sometimes a conversion chart is made available (University of Hyderabad, 2014) or a conversion formula is suggested (Jamia Millia Islamia, 2012).

The examples that were discussed above indicate that no such exact conversion formula can exist that can convert CGPA into real percentage of the student. The crux of the problem lies in the fact that aggregation of grades lacks one-to-one correspondence with the percentages. The reasons for this are enunciated below:

a. If such a conversion formula exists, then that formula (actually a function) must be an increasing function of CGPA as higher CGPA should represent higher percentage/WP. From Table 3, it is clear that A has a higher GPA than B but the weighted percentage of B is more than the weighted percentage of A. Same situation is with the E and G. GPA of G shows that this student is better than E, but WP does not confirm this ordering of E and G.

b. A single value of GPA represents a broad range of WP of marks. For example, in Table 3, F and G, both have the same GPA, that is, 6.5. Nevertheless, the difference in their weighted percentage is 8.55.

c. A large range in defining a grade may result in a large set of percentage that corresponds to the final CGPA. For example, in Table 1 of Central University of Bihar, the largest interval is of size 15, and 6.5 CGPA represents a range of WP from 57.50% to 66.05% (Table 3). In Table 5 of Jamia Millia Islamia, the largest interval is of size 25, and 6.5 CGPA represents a range of WP from 50.50% to 64.95% (Table 5).

This proves that no conversion is possible and any such type of conversion is misleading. Moreover, as CGPA is not a number (“Discussion”), how can it be algebraically manipulated to get a numerical quantity (percentage/WP)? Furthermore, because evaluation of a student’s performance in terms of CGPA and WP reflects different results, an obvious question arises that between the two, the CGPA or the WP, which one is better?

**Discussion**

The spirit that underlies the introduction of grading system should be appreciated. However, it discriminates between...
the students whose scores are at the extremes of the intervals that define a grade. For example, if student X scores 84 marks out of 100 and student Y scores 85 out of 100, then according to Table 1, X gets Grade A and Y gets Grade A− (Ebel & Frisbie, 1991); these are equal to 9 and 10 on numerical scale. This contradicts the basic idea behind introducing the grading system that students with small differences in marks should not be differentiated.

**Numerical Equivalents of Grades (NEG) Are Not Numbers**

The grouping of marks to create broad categories of grades has a scientific basis in the normal distribution with grades/NEG as its ordinal ramifications. However, the NEGs are not numbers (Tables 1 and 4). These are at the most symbols with an ordering defined among them. In contrast, the marks/WPs measure the quantum of performance of a student. There is also an element of arbitrariness involved in assigning a numerical equivalent to ordinal grades. Consequently, any figures obtained by algebraic manipulations of two or more NEGs such as GPA, CGPA, and CGPS cannot be justified. Thus, the grades or their numerical equivalents do not carry any information on the quantum of a student’s performance. To be explicit while calculating CGPA, one is carrying out algebraic exercises with entities that are not numbers. This is a major reason for CGPA falling short of an ideal measure of academic performance.

It has already been shown that CGPA is not able to discriminate between students whose scores differ by very large numbers. Even in some cases, the order of ranking of students is not preserved by CGPA. These discrepancies may lead to discontent among students as the marking system is on the path of reform after the judgment (Supreme Court of India, 2011) that gives the right to the student to see his or her answer script.

**Suggestions on Alternatives**

The performance of a student is affected by various extraneous factors (extrinsic as well as intrinsic) such as the content of question paper/the evaluation method/the teaching method. To make up these kinds of deficiencies, the grading system is recommended. However, the CGPA falls short of an ideal measure of students’ performance. Increasing the number of levels can reduce the loss of information (Das, 2007). Nonetheless, it is undesirable.

The WP as a performance indicator serves the purpose better than CGPA. Thyagarajan (2004), while commenting on the Choice-Based Credit System, has indicated that WP is a true measure of student performance along with the CGPA. However, if it is not possible to completely do away with the CGPA, a university may provide CGPA as along with the WP in the final performance report of the student. Alternatively, because WP is the actual performance of a student but keeping in view of the fact that the performance may be affected by a host of extraneous factors, it may be complimented by an interval of performance. For example, a WP of 49%, may be complimented by an interval say (49 ± x)% where x is the variability factor that can be calculated on the basis of theoretical consideration. The findings, by any means, do not undermine the utility of grades as a symbolic measure of academic performance. Grading should be applied at the final stage when all the algebraic manipulations with marks are done. For example, after calculating the WPs, grades can be attributed to the WPs. These grades shall not only be simple to understand but will also satisfy all the properties of an ideal grading system. The solutions given above are not exhaustive. Any solution, however, has to be unambiguous, universally applicable, and acceptable.

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