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Designing of a flexible Algorithm system for the statistical processing of students' grades

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Abstract

This paper aims to take advantage of advanced information and communications technology (ICT) to make the teaching and learning process electronic with the purpose of meeting the challenges of the twenty first century, threats and future issues in order to ensure the continuity of survival. Such an objective is targeted through the design of a flexible algorithm system for processing student results statistically. This system will work out the statistical treatment according to the model adopted by the Examiners or the educational institution. In addition, such a system presents some standard models and recommends their use.

Keywords: Student's Results; Evaluation Models; Designing Algorithm

1. Introduction

Educational institutions have always made use of various systems to measure achievement levels of students in different educational materials as each institution uses a system whereby students are distributed into different levels following the grade that every student gets. Many uses the grades obtained by the student directly in this distribution, and process the problems with the general educational sense of examiners; whereas others proceed to the adjustment of those grades in a statistical manner in accordance with the administrative and educational justifications agreed upon. However, the ultimate display of the result generally takes on the shape shown in table 1:

Table 1. Grades Distribution

appreciation	*Max*	*Min*	*code*	*Appreciation Points*
Excellent	100	80	A	4
Very good	79	70	B	3
Good	69	60	C	2
Fair	59	50	D	1
Fail	49	0	F	0

This system which uses grades directly is known as the crude/raw system of grades, while the system that modifies those grades according to a specific statistical algorithm that labeled the standard grading system. The differences in the systems of determining the academic level of the student do not often result from the difference in the educational method of measurement, but from ignorance or disregard of many teachers of measurement and evaluation systems. In fact, several teachers or examiners do not consider the necessity or priority of that. It is for this particular reason that we propose the design of an automated system that could be convincing for the examiner and accommodate all the proposed systems. Such a system is distinctive thanks to its clarity, ease of understanding, fairness, and consistency. More importantly, it is based on educational concepts in this area. First, let us begin with the description of the defects and the problems of the crude grading system, as follows:

2. Defects and problems of the Crude grading system

Most of the tests lead to a straightforward quantitative description of a person's performance, and such a quantitative description of performance is called a crude grade. This crude grade may be the set of questions answered by the student rightly or wrongly. Many people adopt crude grades and use them without knowing their shortcomings for the simple reason that these grades are meaningless and do not have any significance. More specifically, they cannot not be interpreted unless one makes appeal to another basis for comparison because

we cannot interpret the grades obtained by the student in the same way as we do with the values we get from measurements of natural phenomena which are standards of the ratio; in other words, they have absolute zero and are composed of equal units. Therefore, we find that the difference between individuals in grades or exams does not necessarily indicate the existence of real distances between them. For example, in a given the student (X) may get the grade 53, and the student (Y) obtains the grade 56, and the student (Z) has the grade 59, which means that the differences between the crude grades are equal. However, this does not necessarily indicate that the difference between (X) and (Y) identically equals the difference between (Y) and (X).

From this perspective, we can reach to such basic flaws in the system of crude grades as is outlined in the following points:

- Crude grades do not show the relative processing among the students clearly.
- Addition of raw grades of different subjects to get the overall mean average that not based on a scientific basis as it is mathematically wrong to make addition of things that do not represent the same genre simply because a grade in a difficult exam does not equal a grade in an easy exam.
- The use of crude grades renders comparison of the level of performance in the exam from year to year which is difficult and not based on a sound standard.
- The level of exam in terms of difficulty or ease has negative impact on the result which is difficult to treat in a fair way in the case of crude grades.
- Raw grades show the actual performance in some subjects in a way that does not reflect the truth; for example, there are subjects with high degrees scale by their nature and cannot be understood because of the lack of clear boundaries in answers of such subjects (essays on history, politics and literature).
- Raw grades do not lead to a statistical indicator to be utilized to analyze the quality of the exam and its manner, nor do they allow for the analysis of performance and its representatively.

It is for all of these indicators that educators have resorted to a system beyond the crude grading system which allow for clear the comparison between the students and the interpretation of their grades and the judgment of their performance. Such a system is widely known as the standard grading system which we will address in the next paragraph.

3. The Standard Grades and their characteristics

If we assume that a student gets 74 degrees in Mathematics and the average grades of students in this subject is 65 degrees and its standard deviation is 7 degrees, and let us also suppose that s/he obtains 90 degrees in Chemistry and the average of students' grades is 79 and the degree of the standard deviation of chemistry is 12 degrees, the assessment of the estimate of this student for many people is as follows:

This student is granted the degree or appreciation of excellence in Chemistry, and the appreciation of very good in Mathematics.

However, when we calculate the relative degree of assimilation by the student of the subject (Z), we find an apparent paradox in the assessment (we mean that the relative grade of the student in the subject (Z) is the standard grade (Z), and it is calculated according to the following equation:

$$Z = \frac{X - \bar{X}}{S} \quad (1)$$

Where:

S: The standard deviation

$\bar{X}$: The arithmetic mean

x: The students' grade

Therefore, we find that the standard grade in Math is: Z = (74-65) / 7 = 1.29, while in Chemistry, the standard grade is (Z = (90-79) / 12), which means that the standard grade for the student in mathematics is higher than its counterpart in Chemistry. This assures the erroneous or inaccurate appreciation given to the student in the first case. It is for this reason that any system that is not based on the distribution or assessment of students according to the standard grade is a poor system that does not lead to sound statistical studies in the comparison of the academic level of different groups and does not indicate the real position of the student among his peers.

The distinguishing characteristics of the standard grading system lie in its easy accommodation of details, fairness and consistency, and it is also primarily based on such constant statistical concepts as the arithmetic mean and the standard deviation. This system reflects the relative level of the student compared with the rest of the students in the sense that assessment is first done through comparing students to each other and dividing them in groups in compliance with a specified educational model. That is why this system enables us to ensure the following:

- Students ensure their full rights in assessment and consequently absorb the deficiencies of teaching, or exam, or the teaching structure.

- Finding different average grades which now have a single standardization as opposed to the previous addition of grades that reflects a clear mathematical defect because of variation of subjects, whence the variation in achievement.

- Addressing the issue of ease and difficulty of the exams mainly because those statistical concepts are largely independent of the type of exam.

- Saving energy and time that are wasted in ongoing meetings devoted to solving the problems of results with the common educational sense.

- Taking into account the psychological factor of the student through providing a clear, just and comprehensive system.

- Increasing the student's motivation for academic achievement and fostering his diligence for not knowing the failing grade exactly because the determination of the failing grade makes the students retrieval or academic achievement bound to the limits of that grade, especially in the case of a student whose ambition is success and only success. More importantly, one of the causes of the student's academic underachievement has been the determination of the lowest grade of success academic (for example, 40 grades at the University of Khartoum) as is documented in the famous saying of students: "if 40 grades are enough, why 41". This amounts to saying that the student focuses all his efforts to ensure only 40 grades, but in the normative system, it just is impossible to determine the minimum grade of success.

- Comparison between different generations becomes feasible and credible; for example, the group who outperformed 90% of the examinees in any generation is granted the same academic competency regardless of the raw grades that they obtained. That is why the student is required to invest all his effort to ensure success.

- Analysis of the quality and the process of the exam as well as the instructor's teaching performance and teaching environment.

4. Assessment Models

Thorandaak's model for the distribution of the students' results is considered to be one of the most famous models. It was designed on the basis of educational experiments on the student community in America. A similar study was elaborated in the Department of Psychology at the University of Khartoum, as a result of which Thorandaak's model was assessed and modified to take a slightly different form with respect to the ends of the curve by increasing the proportion of excellence and repetition at a rate of three degrees and this increase is logical in our Eastern communities as the student's personal effort has more weight in achievement. However, on the whole the paradox seems not to have much impact, but, but we present this amendment as an another alternative to the standard models. See table 2.

Table 2. Alternative Standard

System	Excellent	Very Good	Good	Fair	Fail
Standard Alternative	10%	20%	40%	%20	10%
Thorandaak's	%7	%24	%38	%24	%7

When analyzing the alternative standard model as an example, we find that the assessment of the student is excellent if s/he gets a grade greater than or equal to $\bar{X}$1.28s and s/he fails if s/he gets a grade less than $\bar{X}$1.28s. This takes place through the determination of the rate of standard deviations that make the area enclosed under the curve at the rate of 80% (i.e., the exclusion of 10% of each side of the curve which is the rate of assessing the appreciation of distinction and failure); therefore, we find that:

$$p(-a < z < a) = 0.20, 2p(0 < z < a) = 0.20, p(0 < z < a) = 0.10 \quad (2)$$

From the table of normal distribution, we find that the value of a = 1.28, and so we can come to the conclusion of these distributions from table 3:

Table 3. Normal Distribution

Student Grade	Range of Student degree(x)	Percentage%
Excellent	$X \geq \bar{X} + 1.28s$	10%
Very good	$\bar{X} + 1.28s > X \geq \bar{X} + 0.53s$	20%
Good	$\bar{X} + 0.53s > X \geq \bar{X} - 0.53s$	40%
Fair	$\bar{X} - 0.53s > X \geq \bar{X} - 1.28s$	20%
Fail	$X < \bar{X} - 1.28s$	10%

Additionally, we can make this system more precise and accurate through the exclusion of students who do not make any cognitive or scientific effort in that the exam (for example, the students who scored less than 25%) to ensure normal distribution of the sample so as not to give students the opportunity to agree on the solution to a number of specific questions (although this rarely occurs).

If we assume that the examiners choose to use another model that fits their reality with variables or percentages x_1, x_2, x_3, x_4, x_5 for the appreciations: excellent, very good, good, acceptable and failure respectively, we find, when analyzing this model as another example, that the average of the standard deviations which make the confined space under the curve by $((x_5 - x_1) - 100)$ % (which means the exclusion of x_1% from the right side of the curve and it is the rate of appreciation of excellence in addition to x_5% from the left side of the curve which is the appreciation of failure), we find that the relationship is as follows:

$$x_1 = P(0<z<a) \text{ and } x_5 = P(-b<z<0) \quad (3)$$

It is to be noted that we calculate the value from the table of the normal distribution.

5. The Algorithm

After the distribution of students on the five slides following the selected model or according to the required percentages, we determine by the lower grade and the upper grade for each slice and then we convert the lower and upper grade for each slide to a limited range which complies with what is common in accordance with the following equation of conversion:

$$xnew = min + (x - LR)max - min/max - LR \quad (4)$$

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Where:
X new: student's grade after conversion equation
X: student's raw grade
LR: the minimum grade for each slide
Max and Min: the upper and lower grade of the specified range to which conversion is to be done.

These transfers in accordance with the specified range are considered to have great benefits for the following reasons:

- They maintain the nature of the distribution which is equivalent to Thorandaak's distribution.
- These transfers produce grades similar to the raw grades obtained.
- Such transfers prevent from obtaining any abnormal grade beyond the specified range (0-400)
- The use of any form that determines the range of the five slides for the distribution of students does not change anything in reality.

6. Empirical Study

We have carried out an analysis of the results of 60 students from the University of Khartoum using, in addition to the two standard models, the model form of the Universities of Khartoum and Gezira and the T-standard, and then we compared those results and we came to the table 4:

Table 4. Analysis of Results

system	Excel-cel-lent	Very good	Good	Fair	Fail	Chi-square
Thorandaak's	4	14	24	14	4	
University of Khartoum	17	13	21	8	1	48
University of Gezira	3	9	39	7	2	16
T-Standard	3	9	16	25	7	16
Proposed Alternative	5	15	21	15	4	1

The table indicates that all the systems have led to different appreciations; when comparing their nature, we find that the alternative standard system tends to balance

*Special description of the title. (dispensable)

and nature more than the other systems as illustrated by the value of chi-square amounting to one only , which is of statistical significance at the level of ninety five percent and It, therefore, resembles Thorandaak's system ; as to the model of the University of Khartoum , a model which adopts the raw result processed through the common educational sense, we find that the value of chi-square test of nature has reached forty-eight, which is a great significance proving the lack of nature and balance of this model. Concerning the model of the University of Gezira, which resembles the T-standard somewhat, the value of chi-square has amounted to sixteen, and it also points to its lack of balance and nature to some extent.

7. Conclusion

So far, this paper has shown that commitment to an educational model designed on the basis of a specific statistical processing is indispensable for assessment. The paper presented Thorandaak's model as an ideal choice and provided an alternative model as an option which is more appropriate to our eastern environment another model proposed by Examiners. The system allows for the extraction of detailed reports that enable the examiners to work out sound educational statistical treatment with all ease and convenience.

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