

Model Based Transformation of Students Examination Scores and Assessment of Changes in Grade Point Average

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Abstract. It is often desired to gear up students' examination scores when performance is very poor and it is required to comply with NBTE/NUC 75% pass requirements. A categorical flow of students' grade point average (GPA) is also desired when effort is being made to achieve objectives of counseling exercises. Towards these ends, this paper was intended to provide methods of score up grading and assessing changes in GPA. A two-edge linear transformation was proposed for gearing up scores. Assumptions of Markov chains and outfit of Grendenko sequence were up held to develop GPA transition matrix. Chai-square test was incorporated to ensure stationary transition and flow of GPA from one categorical level to another. Application of results carried out on different sets of two consecutive session examination results revealed that many of the students concerned had worked harder to justify movement of GPA from pass grade to lower credit grade. In some cases, performance could not be improved from lower credit grade to upper credit grade and no case of improvement from upper credit grade to distinction was revealed.

Keywords: Base-upper score limits; Markov chains principle; Grendenko estimating sequence; Stationary transition; Categorical flows.

1. Introduction

Students' performance has taken a crucial dimension in the contemporary educational system. If students' performance in a subject is very poor it may not be acceptable because it fails to fulfill National Board of Technical Education (NBTE) and National University Commission (NUC) 75% pass requirements or success rate.

Hence score transformation is desired to achieve acceptability without biasness. The study considered that the NBTE, Kaduna, accredited National Diploma (ND) and Higher National Diploma (HND) programmes offered in Kwara State Polytechnic, Ilorin, Kwara State, Nigeria. These programmes are being run for two academic sessions and a session consists of two semesters.

The following classifications of students' performance are also considered.

Score grading point

70+	A	4.0
60-69	B	3.0
50-59	C	2.50
45-49	D	2.25
40-44	E	2.0
00-39	F	0.0

Grade point average

Distinction:	GPA \geq 3.50
Upper credit:	3.00 \leq GPA \leq 3.49
Lower credit:	2.50 \leq GPA \leq 2.99
Pass:	2.00 \leq GPA \leq 2.49
Fail:	GPA $<$ 2.00

It desired that poor examination scores are moderately fitted. It is also desired that GPA transition probabilities are stationary and categorically flowing.

The score of twenty students selected at random in Mathematics will be used in the test score transformation. While the certificate result of ND and HND of 2012/2013 academic session of Kwara State Polytechic, Ilorin will be used in computing transitional probability.

2. Literature Review

The use of score transformation model is not new in educational system. According to Stockburger (2016) score transformation gives meaning and allows some kind of interpretation to the scores. Also, the transformation allows direct comparison of two scores.

Bande and Ayodele (2013) used transformation models in their study and also investigated the predictive strength of the models. The investigation revealed that the overall best of the predictors of comparability indices was the true score followed by the predictive true score.

Shira and Shlomo (2009) in their study on impact ranked-based normalizing transformations recommended Rankit for score normalization in social and behavioral sciences.

The measure of academic success or performance is another important area of consideration in education. York, Gibson and

Ranklin (2015) in their study of what is academic success affirmed that grades and grade point average (GPA) are the most commonly used measures of academic success.

There are many factors that influence academic success or performance. Some of these factors are teachers' performance, GPA, programme satisfaction and previous years' satisfaction. Out of these students satisfaction was discovered to be one of the factors that was related to GPA. (Grayson, 2004).

3. Research Methodology

This study focuses on adoption of a model of score grading to meet up with required success rate and to investigate if the grade transition is stationary.

Linear Transformation

A linear transformation is given as $T_x = aX + b$.

Where T_x is the transformed score, a is the slope (the multiplicative component of the model), b is the constant or intercept (the additive component of the model) and X is the raw score.

In estimating a and b the use of moderate basescore, upper score and second class interval of the distribution will be implored.

Markov Chains

To permit outcome of current trial to depend on outcome of preceding trial, Frank and Ron (1994) assumed that event has occurred at some trial and p_{jk} is the probability of occurrence of k th event. In this manner, sequence of trials forms Markov chains if conditional probability of event $A_i(s)$, $i= 1, 2, 3 \dots$, occurs at $(s+1)$ th trial, $s= 1, 2, 3 \dots$, after occurrence of known event at s th trial. It is further assumed that such occurrence is not modified by supplementary information on event of earlier trials and

$$0 \leq p_{ij} \leq 1$$

There is transition of state $A_i(s)$ at s th trial to state $A_i(s+1)$ th at $(s+1)$ th trial

$$\sum p_{ij} = 1; i= 1, 2, 3 \dots, k$$

ransition probability matrix (TPM) is stationary over time and its elements $p_{ij} = p_{ij}(t)$; $t, i= 1, 2, 3 \dots, k$

Let \square_t denote TPM. If number of trials $t = (s+1) - s$, then

$$\square_t = \begin{pmatrix} p_{11} & p_{12} & \dots & p_{1k} \\ \dots & \dots & \dots & \dots \\ p_{k1} & p_{k2} & \dots & p_{kk} \end{pmatrix}$$

$$p_{ij} = \square_{ir}(m) p_{rj}(t-m); i, j, r = 1, 2, 3 \dots k$$

$$= \square_{im} \square_{t-m}$$

$$= \square_{it}, 0 < m < t,$$

$$t = 2, m = 1, \square_2 = \square_1 \square_1 = \square_1^2$$

$$3, \quad 2, \square_3 = \square_1 \square_2 = \square_1^3$$

$$\dots \dots \dots$$

$$k, \quad k-1, \square_k = \square_1 \square_{k-1} = \square_1^k$$

If \square_1 is known, then \square_t is taken to be estimated probability. Labeling sessions, $t = 1, 2$ corresponds to 2011/12 and 2012/13 academic sessions. If $n_i(t)$ is total number of students out of which $n_{ij}(t)$ of them move from i th GPA to j th GPA, then GPA movement is categorized by $p_{ij}(t) = n_{ij}(t)/n_j(t); i, j = 1, \dots, 5$

The movement corresponds to performance outfit illustrated below.

It is desired that detail number of students in each rank of GPA is presented in the form below.

Grade	Fail	Pass	LCredit	UCredit
Distinction				
GPA	1	2 5
Rsum				
1	$n_{11}(t)$	$n_{12}(t)$
$n_{15}(t)$	$n_1(t)$			
2	$n_{21}(t)$	$n_{22}(t)$
$n_{25}(t)$	$n_2(t)$			
..
.			
5	$n_{51}(t)$	$n_{52}(t)$	$n_{53}(t)$	$n_{54}(t)$
$n_{55}(t)$	$n_5(t)$			
Csum	$n_1(t)$	$n_2(t)$	$n_3(t)$	$n_4(t)$
$n_5(t)$				

4. Result

Score transformation:

The following semester scores in mathematics of twenty students shall be considered.

x: 21, 32, 15, 10, 25, 36, 29, 28, 21, 18

21, 21, 21, 26, 40, 29, 18, 07, 35, 45

Arranging scores in ascending order,

x: 07, 10, 15, 18, 18, 21, 21, 21, 21, 21

25, 26, 28, 29, 29, 32, 35, 36, 40, 45

The percentage frequency distribution is then constructed as follows.

CI	f	%
07-18	5	25
21-45	15	75

Selecting moderate base score = 40, upper score = 50 and second class interval of the distribution, $21a + b = 40$ and $45a + b = 50$ yield $a = 5/12$ and $b = 375/12$. Hence, fitted score transformation

$$T_x = (5x + 375)/12$$

On substituting old score x, new score

T_x : 40, 45, 36, 36, 42, 47, 44, 43, 40, 39

40, 40, 40, 43, 48, 44, 39, 35, 46, 50

New summary of acceptable results now reads

Number of students 20 (100%)

Number passed 15 (75%)

Number failed 05 (25%)

Transitional Probability Matrix:

The TPM calculated for Kwara State Polytechnic for 2011/12 ND is

$$\square_t = \begin{pmatrix} 0.67 & 0.33 & - & - & - \\ 0.12 & 0.63 & 0.26 & - & - \\ - & 0.19 & 0.64 & 0.17 & - \\ - & - & 0.25 & 0.625 & 0.125 \\ - & - & - & 1.00 & - \end{pmatrix}$$

2012/13 ND calculated TPM is

$$\square_t = \begin{pmatrix} 0.64 & 0.56 & - & - & - \\ 0.12 & 0.55 & 0.35 & - & - \\ - & 0.21 & 0.58 & 0.21 & - \\ - & - & 0.40 & 0.60 & - \\ - & - & - & - & - \end{pmatrix}$$

Similarly, TPM calculated for the Polytechnic 2011/12 HND is

$$\square_t = \begin{pmatrix} 0.62 & 0.38 & - & - & - \\ 0.625 & 0.625 & 0.3125 & - & - \\ - & 0.17 & 0.69 & 0.14 & - \\ - & - & 0.33 & 0.67 & - \\ - & - & - & - & - \end{pmatrix}$$

2012/13 HND calculated TPM is

$$\square_t = \begin{pmatrix} 0.40 & 0.60 & - & - & - \\ 0.148 & 0.667 & 0.185 & - & - \\ - & 0.15 & 0.74 & 0.11 & - \\ - & - & 0.375 & 0.625 & - \\ - & - & - & - & - \end{pmatrix}$$

Test of Hypothesis:

$H_0: \square_{cal}^2 \leq \square_{tab}^2$ to mean transition from ij th state is stationary

$H_1: \square_{cal}^2 > \square_{tab}^2$ to mean transition from ij th state is not stationary

Let o_{ij} be ij th element of the calculated χ^2_t and e_{ij} be corresponding ij th element of table χ^2_{tab} . Then k th Chai $\chi^2_{kj} = (o_{kj} - e_{kj})/e_{kj}$ and calculated Chai-square

$$\chi^2_{cal,k} = \sum \chi^2_{kj}$$

$$\chi^2_{cal} = \sum \chi^2_{cal,k}, k=1 \dots 5.$$

Let $q = p_{ij}$ and degree of freedom be $2(q-1)$. Then at 5% level of significance, the test hypothesis proposed by Frank and Ron (1994) was employed to determine whether χ^2_t is stationary or not.

For the ND, corresponding table values from the Mathematical and Statistical Tables and Formulae are

	0.4885	0.4290	0.0858	-	-
	0.1560	0.4859	0.3302	0.0440	-
$\chi^2_{tab} =$	(0.0228	0.2413	0.5015	0.2150	0.0213)
	-	0.3750	0.3160	0.5581	
0.0781					
	-	-	0.2500	0.6250	
0.1250					

The following values were calculated from above two sets of calculated and table values.

GPA	$\chi^2_{cal,k}$	$\chi^2_{tab,k}$
1	0.1727	5.99
2	0.0607	5.40
3	0.0605	5.40
4	0.1510	5.99
5	1.0000	3.84
Total	1.4449	26.62

Therefore, $\chi^2_{cal} = 1.44$, $\chi^2_{tab} = 26.62$

For the HND, corresponding table values are

	0.4082	0.4731	0.1188	-
	0.0778125	0.4675	0.4109	0.4375
	-			
$\chi^2_{tab} =$	(0.010625	0.22355	0.5754	0.1904
-)				
	-	0.0561	0.4488	0.4951

The following values were calculated from above two sets of calculated and table values.

GPA	$\chi^2_{cal,k}$	$\chi^2_{tab,k}$
1	0.14571	5.99
2	0.29095	5.40
3	0.11590	5.40
4	0.10250	5.99
5	0.00000	3.84
Total	0.65506	26.62

Therefore, $\chi^2_{cal} = 0.66$, $\chi^2_{tab} = 26.62$

In the two cases examined, $\chi^2_{cal} < \chi^2_{tab}$ revealed that H_0 was accepted. This means that TPM is stationary and GPA flows from one categorical level to another.

5. Conclusion

The adopted score transformation is satisfactory since the success rate was moved from 25% to acceptable level of 75%.

The outcome of test carried out is interpreted to mean that higher percentage of students move from pass grade to lower credit grade, lower percentage moves from lower credit grade to upper credit grade and none moves from upper credit grade to distinction grade. Therefore, it is concluded that many students had worked harder to improve their GPA from pass to lower credit. In some cases, the GPA could not be improved from lower credit to upper credit.

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