Diagnostic Test for Mathematics Students at USP

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Abstract

To see if there is a need to conduct a diagnostic test for MA111 students having different Form Seven Mathematics marks or Foundation Mathematics grades at the University of the South Pacific (USP), an analysis of variance for a one-way classification with unequal numbers is carried. Using data for the years 1998- 2002 the analysis results indicate that there is no need to conduct a mathematics diagnostic test for incoming MA111 students.

Introduction

The University of the South Pacific (USP) is a regional university which has twelve member countries namely, Cook Islands, Fiji Islands, Kiribati, Marshall Islands, Nauru, Niue, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu. It is the premier provider of tertiary education in the Pacific Region with its current academic programmes being well-recognized worldwide, attracting high calibre students and staff from throughout the Pacific Region and internationally.

Currently USP admits into its mathematics programmes all those students who have scored a total of at least 250 marks out of 400 in English, Mathematics plus two other subjects in the Form 7 examination (which is conducted by the Fiji Government and by the governments of most of the other Pacific Island countries in the region) or its equivalent.

[1] We would like to thank Mrs Sundari Muralidhar for suggesting to us this useful and interesting problem and for supplying us the relevant data.

These students are required to start their mathematics programme with the course MA111, which consists of two major components, Calculus and Complex Numbers.

It has been found that many of the students who enrol in the mathematics programme at USP are not able to succeed to completion. This has created some doubts on the credibility of the mathematics marks/grades in Form Seven/Foundation, but especially the Form Seven marks, that students enrol with. The question often raised is whether there is a need to carry out a diagnostic test to determine if a student has the necessary mathematical skills to succeed in a mathematics programme at USP. To answer this question an analysis of variance for a one-way classification with unequal numbers is carried out.

Collection of Data

The following information for the years 1998-2002 was obtained from USP:

(a) *Grade Point Averages for MA111*. Each letter grade has a corresponding GPA associated with it. These are given in Table 1.

Table 1 : Grading Structure at USP

Grade	A+	A	B+	B	C+	C	R	D	E	E(X)	I
GPA	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	0	0	0

Note: The grades A+, A, B+, B, C+, C, and R (for restricted pass) are pass grades; I means 'incomplete'; and the rest are fail grades.

(b) *Form 7 Mathematics mark or Foundation mathematics grade*: Form 7 mathematics marks or Foundation mathematics grades were obtained and divided into 4 classes as follows:

0 if Form 7 mathematics mark is less than 50 or Foundation Mathematics grade is less than C;

1 if Form 7 mathematics mark is in the range 50-63 or Foundation Mathematics Grade is C or C+;

2 if Form 7 mathematics mark is in the range 64-77 or Foundation mathematics Grade is B or B+;

3 if Form 7 mathematics mark is greater than or equal to 78 or Foundation Mathematics grade is A or A+.

Class 0 is not taken into consideration in our analysis as the number of students having a Form 7 mathematics mark or Foundation Mathematics

grade falling in this class was very small when compared to those that had marks falling in the other 3 classes.

Analysis of Variance for a one-way classification with unequal numbers

We consider classes 1, 2 and 3 and their corresponding GPAs for MA111 students for the years 1998-2002. To see if there is a change in the GPAs in MA111 with respect to its class, we first write the model as a one-way classification with unequal number of observations. This is defined as

$$Y_{ij} = \mu + a_i + e_{ij}, \qquad i = 1, 2, \ldots, k, \quad j = 1, 2, \ldots, ni,$$

where Y_{ij} is the GPA in MA111 for the j-th student in the i-th class.

There are ni students in the i-th class. The value of k in our analysis is 3. Hence, i = 1, 2, 3. Moreover, μ is the general mean effect of the classes; a_i is the effect of the i-th class; and e_{ij} is the error component. The data then takes the form shown in Table 2.

Table 2: Data

	1998	1999	2000	2001	2002
1	36 0's	30 0's	46 0's	51 0's	51 0's
2	58 0's	86 0's	73 0's	85 0's	137 0's
3	95 0's	142 0's	38 0's	46 0's	84 0's

In Table 2, O's denote the Observations (GPA values). Moreover, if we denote the number of students in i-th class and the j-th year by n_{ij}, then the values for n_{ij}, i = 1, 2, 3 and j = 1, 2, . . . ,5 (j=1 corresponds to the year 1998, j=2 corresponds to the year 1999, and so on) are given as follows:

$$n_{11} = 36, \quad n_{12} = 30, \quad n_{13} = 46, \quad n_{14} = 51, \quad n_{15} = 51,$$
$$n_{21} = 58, \quad n_{22} = 86, \quad n_{23} = 73, \quad n_{24} = 85, \quad n_{25} = 137,$$
$$n_{31} = 95, \quad n_{32} = 142, \quad n_{33} = 38, \quad n_{34} = 46, \quad n_{35} = 84.$$

For a better understanding of the values given in the ANOVA table later in this section, we include Tables 3 to 7, which contain useful information. We also include a table containing the sums for the different classes.

Table 3 – 1998

	1	2	3
n_{i1}	36	58	95
Sums	33.5	82	254
Sum of Squares	51.25	163	778

Table 4 – 1999

	1	2	3
n_{i2}	30	86	142
Sums	37.5	114.5	329
Sum of Squares	70.25	226.75	871

Table 5 – 2000

	1	2	3
n_{i3}	46	73	38
Sums	64.5	122.5	84
Sum of Squares	140.75	259.25	243.5

Table 6 – 2001

	1	2	3
n_{i4}	51	85	46
Sums	74.5	141.5	114
Sum of Squares	189.25	324.25	345

Table 7 – 2002

	1	2	3
n_{i5}	51	137	84
Sums	54	217.5	193
Sum of Squares	117	480.25	518.5

Table 8: Table of Sums

	1	2	3
n_i	214	439	405
Sums	264	678	974

We shall now carry out the following test.

H_0: There is no significant difference between the GPA of classes 1, 2 and 3.

Table 9 is the ANOVA table.

Table 9 – ANOVA Table

Source	DF	Sum of Squares	MSS
GPA	2	245.39	122.70
Error	1055	1062.80	1.007
Totals	1057	1308.19	

For this hypothesis, F_{cal} =122.70/1.007=121.85. The *P*- value corresponding to F(2,1055) is 0. Hence, we reject the hypothesis. This implies that there is a significant difference between the GPA of the three classes.

Conclusion

The analysis carried out in this paper shows that there is a significant difference between the GPA for the three classes. In other words, students entering USP with high marks in Form Seven mathematics or good grades in Foundation mathematics will achieve high GPAs in MA111. This suggests that there is no need to conduct a diagnostic test for incoming students intending to enrol in mathematics programmes; Form seven mathematics or Foundation mathematics results are sufficient.

References

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