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Mathematics Aptitude, Attitude, Secondary Schools and Student Success in Quantitative Methods for Business Subject in an Australian Catholic University Experience

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Abstract

There is a consensus in the literature that mathematical ability contributes to student success in tertiary education. More importantly, mathematical skills are necessary when successfully completing mathematics- and/or science-based degrees. Social sciences such as psychology and economics require statistical skills which also require knowledge of mathematics. Even business students such as marketing and accounting students need the necessary mathematical skills to successfully complete their degrees at university. This paper suggests that student success in a core business subject is dependent on their mathematical aptitude, attitude and type of secondary schooling whether government or non-government schools. There is urgency for universities to recognise that high failure rates are due to insufficient mathematics exposure in secondary schooling and remedial classes might not be enough. Specifying a minimum (maths, e.g. 2unit) requirement for entry and/or providing bridging programmes to ensure students have the necessary basic mathematical skills would increase student success in quantitative units.

Keywords: *quantitative units, mathematics aptitude, mathematical attitude, secondary schooling*

INTRODUCTION

The University of Notre Dame Australia is a private Catholic university with campuses located in Fremantle, Broome and Sydney. In the Sydney campus, most of the students are from Catholic schools although a great number comes from non-catholic and even public schools. The student population seems to be predominantly female. In particular, for the cohort of students included in this study, 55% and 54% are female for semesters 1 and 2, respectively. The students are from the School of Business undertaking accounting, management and marketing and public relations courses. Quantitative methods for business (QMB) is a foundation unit (i.e. core) for business students and majority of the students find it with most difficulty. In 2009, semesters 1 and 2, there were around 200 students and the failure rate was around 30% for both semesters which was lower compared to previous years, i.e. 2007 and 2008, where the failure rates were allegedly around 40 per cent and 70 per cent, respectively.

There have been questions within the university as to why this particular unit as well as introductory subjects such Economics and Finance have high failure rates. Incidentally, in 2008, all these three subjects were taught by the same lecturer. On one hand, university administrators can point their fingers at lecturers and tutors. On the other hand, the admission process might need a serious review.

During the late 1990s to present, due to lower government funding and support, universities were forced to employ various measures to increase the number of enrolments (i.e. student population). Consequently, the required pre-requisites for a business degree went from specific units such as mathematics (advance, two units) to assumed background. This indirectly lowering of standards created a gap between lecturers' expectation and students' ability. The traditional lecture-tutorial format although can still be utilised, knowing the level of mathematical capabilities of the students are crucial in determining the failure rate. This meant that the content of the unit is watered down. The full unit material cannot be covered in 12 weeks when students do not know how to handle fractions and percentages (even with the aid of calculators).

Although majority of students opted for general mathematics to complete in Year 12, the experience from the two cohorts included in this study suggests that a higher level of

competency in mathematics is required to successfully pass the unit (i.e. quantitative methods for business). Although a few students that have the right attitude towards the unit despite of just completing general mathematics in Year 12 shown that they could pass the unit albeit not easily but with a decent amount of effort.

Hence, in this paper, the importance of attitude towards quantitative subjects especially mathematics and the dismal level of mathematical ability in most of the business students are highlighted. The paper analyses the different factors that might contribute to student success in a quantitative unit such as mathematical ability/aptitude, attitude, secondary schooling, gender, socio-economic status and attendance in tutorials using ordinary least squares (OLS) regression.

LITERATURE REVIEW

Over the last two decades in Australia, the skills and entry requirements to qualify for tertiary education had slowly declined. To date, the stringent mathematics requirements for business students have been relaxed from pre-requisite to assumed knowledge. As a consequence, lecturers have to teach students with different mathematical ability, exposure and perception. In particular, Mallik and Varua (2008) have highlighted the increasing variability in the mathematical background of business students entering university and the abolishment of the 2 unit math requirement for the Bachelor of Business in most universities.

This apparent trend of lower numeracy (and literacy) skills amongst university students and prospective new workers can have a detrimental effect on a country's productivity. Governments and employers have highlighted the importance of numeracy skills in one's ability to find employment, attain job satisfaction, level of remuneration, community participation and well being (Capellari et al 2008). Further, several studies (Bishop 1989; Murnane 1998; Xin Ma, 2001) have observed that proficiency in quantitative skills improve job performance not only due to the array of the computational jobs performed in most jobs but also because of the greater general productivity associated with quantitative literacy.

Several variables influence student academic performance of which intelligence (i.e. ability) seems the most obvious. However, there is a body of knowledge that suggests that factors other than ability explain a substantial portion of the variability in student performances (Nonis et al. 2003). In addition, it has been accepted that students learn differently (Gardner 1983; Kolb 1985). Without denying the significance of traditional lectures and tutorials in undergraduate education, an increasing number of academics are recognising the value of practical sessions, small-group learning and the use of Blackboard.

Nevertheless, numeracy (and literacy) skills can be a significant indicator of success in tertiary education. Previous research suggested that there is the link between students' success in completing economic subjects and mathematics competence (Pozo and Stull 2006) as well as literacy and numeracy skills in students studying accounting (Joyce et al. 2006). The importance of mathematics especially calculus in completing a business statistics course is also recognised (Green et al. 2009; Rochelle and Dotterweich 2007).

The negative perceptions of students towards subjects/courses/majors that are more mathematical such as business, mathematics and science education (Benford and Gess-Newsome 2006) as well as the presence of mathematics anxiety (Taylor and Galligan 2006; Tobias 1993; Yenilmez et al. 2007) have also been examined in the literature. Moreover, the importance of attitude is increasingly being accepted (Coleman and Conrad 2007; Depaolo and Mclaren 2006).

Coleman and Conrad (2007) evaluate the negative perceptions of graduate students towards the required statistic and research methods courses. The study examines the mathematical skills students developed during secondary schooling as well as raises the dilemma lecturers' of mathematical and statistical courses faced in terms of promotion and tenure. Depaolo and Mclaren (2006) examine the attitude and performance in both business statistics and calculus and suggest that attitudes play an important role in business statistics and calculus performance and hence should be addressed.

METHOD AND ANALYSIS

In this paper, a survey was conducted to establish the level of mathematical ability amongst students since the relevant data was not released by the admissions office at Notre Dame before this paper is written. Of the total 200 students, only 25 per cent participated in the survey. Students were asked to indicate the level of mathematics, if any, they have completed in Years 10, 11 and 12. The surveyed data is then added to the student data available in MAZE (such degree, attendance, postal address, which is used as an indicator of socio-economic status) and the assessment marks. Students' attitude is gauged by the lecture and tutor where 1 is positive and 0 is negative. Each student was given an attitude score of either 1 or 0.

The unit is delivered via a lecture-tutorial format. That is, two-hour lectures and one-hour tutorials. Assessment tasks ranged from weekly tutorial exercises, fortnightly quizzes, a mid-semester test (which tested students' basic mathematics, algebra and calculus knowledge) and a final exam (which tested students' statistical knowledge). The weekly tutorial questions are known beforehand to give students plenty of time to prepare. Weekly tutorials are designed to encourage participation based on the exercises provided. Fortnightly quizzes were given to boost confidence by setting questions that were relatively easier and highlighting basic mathematical concepts. The mid-semester test and final exam are typical mathematical exam questions where solutions have to be shown in full.

The collected data was tabulated and examined using ordinary least squares (OLS) regression. It is hypothesised that gender, mathematics aptitude, mathematics attitude, number of classes missed would be significant variables in explaining overall performance in QMB. Mathematically, the relationship can be expressed as follows:

$$\begin{aligned} QMB_i = {} & \beta_1 + \beta_2 Post_i + \beta_3 D_g + \beta_4 GM_i + \beta_5 2UM_i + \\ & \beta_6 Extn_i + \beta_7 Attd_i + \beta_8 Abs_i + \beta_9 SP_i + \beta_{10} SG_i + \beta_{11} MST_i \varepsilon_i \end{aligned} \tag{1}$$

where:

- **QMB** represents the marks (out of 100) of the unit Quantitative Methods for Business. QMB is the first quantitative unit taught to students in the School of Business
- **Post** is the dummy for postcode. 1 for rich postcode defined as those postcodes with an average taxable income of $90,000 and above.
- $\mathbf{D_g}$ is the dummy variable for gender. 1 for male, 0 for female[1].
- **GM** is the dummy for General Mathematics
- **2UM** is the dummy for Two Unit Mathematics
- **Extn** is the dummy for Extension One and Extension two Mathematics
- **Abs** is the number of days absent in tutorials
- **SP** is the dummy for private school
- **SG** is the dummy for government school
- **MST** represents the mid-semester test mark (out of 100).

Since mathematics in Year 12 is not compulsory, around 20% of respondents have not studied mathematics 12 months before commencing at university. Moreover, some students have taken a gap year or longer. Hence, these students would need some refresher course to pass the unit. There is no bridging course offered in Notre Dame for students who do not have the appropriate mathematics background.

Around 9% of the students decided not to study mathematics in Year 11 and around 43% and 46% of students opted to study general mathematics in Years 11 and 12, respectively. Based on the lecturer's and tutor's observation, general mathematics is not adequate to undertake a business degree successfully.

[1] Lumsden and Scott (1987) concluded that female students tend to perform well in essay related assessments while males are performing better in quantitative related tasks. This was supported by the findings of Anderson et al (1994) that men perform better in calculus and functions, whereas women do better in English. The present study attempts to ascertain whether gender affects performance in QMB.

Table 1: Different Levels of Mathematics Subjects in High School

	Year 10	**Year 11**	**Year 12**
Levels	5.1 (Std)	2 units (General)	2 units (General)
	5.2 (Gen)	2 units (Advance)	2 units (Advance)
	5.3 (Adv)	3 units (Extension)	3 units (Extension I)
	5.3 (ext)		4 units (Extension II)

Table 1 shows the different mathematics subjects available to secondary school students. There are four levels of mathematics a student can attempt in Year 12. They are General and Advance, both are two units, Extension 1, which is three units and Extension 2, which is four units. Only 2% and 7% of the students studied Extension 2 and Extension 1, respectively. The other 25% of the students in Year 12 studied Advance Mathematics. Hence, 66% of the students in Year 12 either had not studied mathematics at all or only opted for the minimum mathematics subject which is General Mathematics. This scenario is not so different in Year 11, which stood at 52%. It is not a surprise that failure rates could be as high as 70%.

Amongst the respondents in the survey, 68% had a positive attitude towards mathematics. This is in contrast to the combined average between the two semesters at 41%. It is expected that students with a positive attitude would participate more in the survey. With the actual failure rate in both semesters at 30%, the attitude of students seem to have a significant effect on students' performance in this unit. Tutorial participation and the marks from quizzes plus frequent consultation with tutors and lecturer assisted most students in passing the unit. A number of students had to repeat a few times and required private tutors. The continuous assessment during the semester provided frequent and updated progress for students. Students who were willing to learn and improve managed to pass the course.

Table 2: Regression Result

Dependent Variable: **Final Mark QMB**

Variable Name	*Model 1*	*Model 2*
Post	0.8939 (0.03)	
D_g	2.2355 (1.05)	2.5157 (1.56)
GM	-0.6829* (-1.91)	-4.3593** (-1.98)
2UM	4.1247 (1.58)	
Extn	11.99** (2.05)	8.0265*** (3.02)
Abs	-0.5932 (-0.81)	-0.5693 (-0.85)
SP	4.4685* (1.94)	4.5736** (1.96)
SG	2.8962* (1.83)	2.5157* (1.87)
Attd	3.4609** (2.19)	3.4267** (2.39)
MST	0.1904** (2.22)	0.2064*** (2.65)
Adjusted R^2	0.8056	0.8556
F_{stat}	22.05	37.60
White's Test (p value)	32.90 (0.7796)	23.92 (0.9044)
DW	1.9548	1.9588

Note: ***,**, *significant at 1%, 5% and 10% level of significance respectively. Also, the (values) represents the t-statistics.

Table 2 reports the estimated coefficients obtained from equation (1) using Ordinary Least Square (OLS) method. Overall, the estimated models are reasonably good with an R^2 equal to 0.80 and above. The results of the simple OLS model show that all variables have the right sign. As indicator of performance or success in QMB, private schooling, extension units of mathematics and the mid-semester test score are significant at 5% while attending government schools, general mathematics and attitude are significant at 10%. It is interesting to note that the level of mathematics taken in high school has a significant impact on the student's performance at university. Those who took general mathematics seem to perform poorly compared to those who took either advanced mathematics or extension units. The results obtained in this study are similar to those obtained by Mallik and Varua (2008) for the University of Western Sydney. As to the type of schools, the research found that private school and government school graduates perform better compared to independent and catholic school graduates in QBM.

On the other hand, the result reveals that there is no significant difference between the male and female students in terms of performance in this unit. This result is contrary to most researches including that of Anderson et al (1994) and Lumsden and Scott (1987) which concluded that females perform more poorly than males in Economics/Mathematics units. The research finding though is consistent with the study of Ellis et al (1998). Likewise, number of absences in tutorials proved to be not a significant variable. In addition, socio-economic factor measured by the post code is not significant. This outcome can partly be explained by the fact that around 82% of the students enrolled in the unit resides in areas where the average taxable income is above $90,000. When the insignificant variables were dropped from the model, extension mathematics and mid-semester results become more significant which strongly suggest that a certain level of mathematical ability is required to successfully complete a quantitative unit at university level. Finally, all diagnostic results show that the model results are robust.

SUMMARY

It is apparent from the research findings that the minimum mathematics required for all students in Year 10 and the absence of a required level of mathematics in Year 12 severely affects students' academic performance and attitude towards a quantitative subject at university level.

The paper findings suggest that students' mathematical ability and attitude played an important role in determining the failure rate in quantitative methods for business at university level. Various assessment methods have to be employed to lower failure rates closer to an acceptable level.

Moreover, standards in secondary school would have to be reviewed and looked at. Students who choose to attend universities in similar courses have to have similar capabilities, say, business students. Teaching and assessment procedures would be difficult to administer when you have students with a high and/or adequate knowledge of a subject attempting the same unit with students having either no mathematics background in Year 12 or very little.

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