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Attitude, Secondary Schools and Student Success in a Tertiary Mathematics Unit

Luz Centeno Stenberg
University of Notre Dame Australia,
Sydney, Australia

Maria Estela Varua
University of Western Sydney,
Sydney, Australia

Jackie Yong
University of Newcastle,
Sydney, Australia

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 recognize 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., two units) requirement for entry and/or providing bridging programs 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 cohorts (i.e., three semesters) of students included in this study, 56% are female. 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, and in 2010 semester 1, there were 272 students and the failure rate was around 30% in each semesters which was lower compared to previous years (i.e., 2007 and 2008), where the failure rates were around 40% and 70%, respectively.

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)

Luz Centeno Stenberg, Ph.D., lecturer, School of Business, University of Notre Dame Australia.
Maria Estela Varua, Ph.D., lecturer, School of Economics and Finance, University of Western Sydney.
Jackie Yong, lecturer, Newcastle Business School, Faculty of Business and Law, University of Newcastle.

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 utilized, 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 opt for general mathematics to complete in Year 12, the experience from the three cohorts included in this study suggests that a higher level of competency in mathematics is required to successfully pass the unit (i.e., QMB). 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 two 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 (Cappellari, Lucifora, & Pozzoli, 2008). Further, several studies (Bishop, 1989; Murmane, 1988; Ma, 1997) 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, Hudson, Philhours, & Teng, 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 recognizing 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 & Stull, 2006) as well as literacy and numeracy skills in students studying

accounting (Joyce, Hassall, Montaño, & Anes, 2006). The importance of mathematics especially calculus in completing a business statistics course is also recognized (Green, Stone, Zegeye, & Charles, 2009; Rochelle & Dotterweich, 2007).

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

Coleman and Conrad (2007) evaluated the negative perceptions of graduate students towards the required statistic and research methods courses. The study examined 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) examined the attitude and performance in both business statistics and calculus, and suggested that attitudes play an important role in business statistics and calculus performance and hence should be addressed.

Prior studies also suggested that gender plays a role in student success in economics/statistics courses (Bolch & Fels, 1974; Jackstadt & Grootaert, 1980). Regular attendance in lectures and tutorials is another factor that has been shown to contribute to student scholastic success (Glenda, 2000; Marburger, 2001).

Method and Analysis

In this paper, a survey was conducted to establish the level of mathematical ability amongst students since the relevant data is not accessible. Of the total 272 students, only 22% 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 are then added to the student data available in MAZE (such as degree, attendance, and postal address, which is used as an indicator of socio-economic status) and the assessment marks. Students' attitude is gauged by the lecturer and tutor[1], where 1 is positive and 0 is negative. Each student was given an attitude score of either 1 or 0. Attitude is gauged by observation over a 12-week period, where students' attendance, tutorial participation and general attitude during tutorial class periods are noted.

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 tests students' basic mathematics, algebra, and calculus knowledge) and a final exam (which tests 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.

Generally, students in Notre Dame are from middle-class families however, there is a significant proportion from more affluent families. Hence, in this study, a dummy variable for the post code is used to

[1] During the three semesters included in this study, there were three people involved as lecturer and tutors. The lecturer herself had tutorial classes. In each semester, there was one lecturer and one tutor. This facilitates consistency to ensure that there is no bias in assessing students' attitude.

capture any socio-economic effects. Moreover, most students come from Catholic schools. To capture the effect of secondary schooling, dummy variables are used to examine the effects of the type of school (i.e., government school, private school, religious school, and international students) on tertiary success.

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

$$\begin{aligned} QMB_i = \beta_1 + \beta_2 Post_i + \beta_3 DG_i + \beta_4 GM_i + \beta_5 DM_i + \beta_6 EM_i + \beta_7 Attd_i \\ + \beta_8 Abs_i + \beta_9 SP_i + \beta_{10} SG_i + \beta_{11} SI + \beta_{12} MST_i + \varepsilon_i \end{aligned} \tag{1}$$

where:

QMB = the marks (out of 100) of the unit QMB, QMB is the first quantitative unit taught to students in the School of Business;

Post = dummy variable for postcode, 1 if the average taxable income of the postcode is $60,000 and above, 0 otherwise[2];

DG = dummy variable for gender, 1 for male, and 0 for female[3];

GM = dummy variable, 1 if the student completed General Mathematics, and 0 otherwise;

DM = dummy variable, 1 if the student have completed Mathematics (two units), and 0 otherwise;

EM = dummy variable, 1 if the student completed Mathematics extension 1 or 2, and 0 otherwise;

Attd = dummy variable, 1 the student has positive attitude towards the unit, and 0 otherwise;

Abs = the number of days absent in tutorials;

SP = dummy variable, 1 if the student studied in a private school, and 0 otherwise;

SG = dummy variable, 1 if the student studied in a government school, and 0 otherwise;

SI = dummy variable, 1 if the student studied in a school outside Australia, and 0 otherwise;

SR = dummy variable, 1 if the student studied in a religious school, and 0 otherwise;

MST = the mid-semester test mark (out of 100).

Since mathematics in Year 12 is not compulsory, 18% 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.

Amongst the respondents, around 8% of the students decided not to study mathematics in Year 11, 54% and 51% 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.

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 15% of the students in Year 12 studied Advance

[2] The data was taken from the Australian Taxation Office Taxation [ATO] Statistics 2003-2004, where the median income is reported for each suburb in NSW (ATO, 2006).

[3] 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 in 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.

Mathematics. Hence, 21% of the students in Year 12 had not studied mathematics at all. International students (i.e., 4%) cannot indicate what level of mathematics they have completed. This suggests that around 70% of students had not studied mathematics in Year 12 and only opted for the minimum mathematics subject which is General Mathematics. It is not a surprise that failure rates could be as high as 70%.

Table 1
Different Levels of Mathematics Subjects in High School

	Year 10	Year 11	Year 12
Levels	5.1 (Std)	2 units General Mathematics	2 units General Mathematics
	5.2 (Gen)	2 units Mathematics	2 units Mathematics
	5.3 (Adv)	3 units Mathematics Extension 1	3 units Mathematics Extension I
	5.3 (Ext)		4 units Mathematics Extension II

Amongst the respondents in the survey, 75% had a positive attitude towards mathematics. It is expected that students with a positive attitude would participate more in the survey. With the actual failure rate in all three 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 semesters provided frequent and updated progress for students. Students who were willing to learn and improve managed to pass the course.

Table 2 reports the estimated coefficients obtained from Equation (1) using OLS method. Overall, the estimated models are reasonably good with an R^2 equal to 0.70 and above. As indicator of performance or success in QMB, mid-semester test score, Year 12 mathematics (Mathematics, two units), attendance and attitude are significant at 1% while gender and international students are significant at 5% (Model 1). Model 1 is the most general specification considered in the study. 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 any level of mathematics perform better compared to those who did not take any mathematics in Year 12. In particular, Model 1 and its variants show that studying Mathematics (two units) in Year 12 is an important predictor of success in QMB. Models 3 and 4 also highlight the significance of studying mathematics in Year 12 whether it is General Mathematics, Mathematics Extension 1 or Mathematics Extension 2. The results obtained in this study are similar to those obtained by Mallik and Varua (2008) for the University of Western Sydney.

Unlike previous studies, the type of school is not significant. The students included in the study mainly came from Catholic and private high schools. In particular, 47% came from private schools and 44% from Catholic schools. The results cannot be generalized in the sense that the variables for the type of schooling changed signs except for international students[4]. Hence, type of schooling is irrelevant. Exposure to mathematics in high school seems to be more important in predicting student success.

The results also suggest that gender plays an important role. The results for all four models reveal that males perform better than females. This result is consistent with the literature (Anderson, Benjamin, & Fuss, 1994; Lumsden & Scott, 1987) that suggested that females perform more poorly than males in

[4] There were only three international students out of 61 students who responded to the survey. Generally, international students only account for 5% of the student population each semester.

Economics/Mathematics units. Dancer and Kamvounias (2003) found that male students from private schools received 3.4 extra marks on average compared to male students from a government school. The research finding though is contrary with that of Ellis, Dunden, and Gaynor (1998).

Likewise, number of absences in tutorials proved to be a significant variable. This result is similar to that of Rochelle and Dotterweich (2007) for a Business Statistics course at a medium size, regional state university. In contrast, socio-economic factor measured by the post code is not significant. Almost 30% of the students included in the sample reside in areas where the average taxable income is above $60,000.

Models 1 and 2 have the same specification except for the number of observations. Some students in the sample have not completed a first year Economics unit hence, the sample size is reduced from 61 to 45.

Table 2

Regression Result (Dependent Variable: Final Mark QMB)

Variable name	Model 1[a] (n = 61)	Model 2[b] (n = 45)	Model 3[b] (n = 45)	Model 4[b] (n = 45)
Constant	25.90***	25.43***	38.27***	17.19**
	(7.09)	(6.04)	(8.69)	(1.80)
Post	-1.45	-2.72		
	(-0.71)	(-1.14)		
DG	5.14**	8.04***	7.21**	5.44*
	(2.25)	(3.07)	(2.00)	(1.74)
GM	2.86	3.44	10.08***	10.14***
	(1.07)	(1.14)	(2.89)	(3.05)
DM	9.45***	10.37***	19.52***	17.99***
	(2.92)	(2.87)	(4.75)	(4.62)
EM	1.42	1.26	14.64***	13.83***
	(0.34)	(0.26)	(3.18)	(2.74)
Abs	-1.96***	-1.64**	-1.08*	-0.79
	(-3.31)	(-2.46)	(-1.77)	(-0.97)
SP	0.29	0.20	-2.18	-0.86
	(0.16)	(0.09)	(-1.09)	(-0.33)
SG	1.44	-0.86	-0.99	0.43
	(0.46)	(-0.18)	(-0.16)	(0.07)
SI	-9.64**	-3.17	-6.70	-6.22
	(-2.26)	(-0.58)	(-1.10)	(-0.94)
Attd	6.78***	5.79***	9.52***	6.80**
	(3.34)	(2.55)	(3.39)	(2.39)
MST	0.43***	0.41***		
	(7.19)	(5.07)		
ECON (final mark in economics)				0.38**
				(2.46)
Diagnostic tests				
Adjusted R^2	0.7491	0.7213	0.7189	0.7055
F_{stat}	17.28	11.35	9.74	8.54
White's Test (*p*-value)	0.5588	0.6799	0.6321	0.9799
Ramsay RESET test for omitted variables (*p*-value)	0.5000	0.9832	0.8923	0.7288

Notes. ***, **, * significant at 1%, 5%, and 10% level, respectively. Also, the values in parentheses represent the *t*-values. [a] includes all students that took QMB, [b] includes all students who did QMB and Econ.

Consequently, dropping the dummy variable for post code and the variable for mid-semester test resulted in all the high school mathematics' variables becoming significant as shown in Model 3. The results strongly suggest that a certain level of mathematical ability is required to successfully complete a quantitative unit at university level. However, the type of school continues to be insignificant. Likewise, gender, attitude and absences are still significant.

In Model 4, another variable is added, final mark in a first year economics (ECON mark), as an explanatory variable. The results reveal that in addition to gender, Year 12 mathematics as well as attitude, ECON mark is also a significant factor in determining student's success in QMB. Finally, all diagnostic results show that the model results are robust.

Limitation of the Study

The present study has some limitations. Firstly, the population size is small, that is, 272 students. In general, the School of Business in Notre Dame would have a much smaller student population compared to other business schools in more established universities. To remedy this problem, a longitudinal study would have to be conducted to increase the sample size. Secondly, there is a possibility of selection bias. As mentioned earlier, only 22% of the total student population in three semesters responded to the survey. It might be that students that responded are the ones that did better in the unit. Hence, to address the problem of selection bias, an analysis of variance (ANOVA) is conducted to compare the three cohorts of students (i.e., semester 1, 2009, semester 2, 2009, and semester 1, 2010). At 5% level of significance, based on either the final mark or the mid-semester mark, there is no variance between the three cohorts.

In addition, the final mark distribution (i.e., pass, fail, credit, distinction, and high distinction) of respondents to the survey is compared to that of non-respondents. It is found that the relativities of the mark distribution are very similar between the two groups. Notwithstanding the fact that students who failed the unit would less likely to respond while students who pass the unit would respond more likely. Moreover, students who received a credit or a distinction also responded more. Hence, it is suggested that selectivity bias should not be a concern.

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 QMB 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.

References

Anderson, G., Benjamin, D., & Fuss, M. A. (1994). The determinants of success in university introductory economics courses. *The Journal of Economic Education, 25*(2), 99-119.

Australian Taxation Office [ATO]. (2006). *Taxation statistics 2003-2004: A summary of tax returns for the 2003-2004 income year and collections for the 2004-2005 financial year*. Retrieved July 20, 2010 from http://www.ato.gov.au/corporate/content.aspx?menuid=0&doc=/content/70906.htm&page=7&H7

Benford, R., & Gess-Newsome, J. (2006). *Factors affecting student academic success in gateway courses at Northern Arizona University*. Retrieved May 7, 2010 from http://www2.nau.edu/~facdev-p/TR/Factors.pdf

Bishop, J. H. (1989). Is the test score decline responsible for the productivity growth decline? *American Economic Review, 79*(1), 178-197.

Bolch, B. W., & Fels, R. (1974). A note on sex and economic education. *Journal of Economic Education, 6*, 64-67.

Cappellari, L., Lucifora, C., & Pozzoli, D. (2008). *Determinants of grades in maths for students in economics*. Retrieved November 30, 2009 from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1127227

Coleman, C., & Conrad, C. (2007). Understanding the negative graduate student perceptions of required statistics and research methods courses: Implications for programs and faculty. *Journal of College Teaching & Learning, 4*(3), 11-20.

Dancer, D. M., & Kamvounias, P. (2003). *Predicting success in a first-year unit of study*. Retrieved October 25, 2010 from http://www.fyhe.com.au/past_papers/papers08/FYHE2008/content/pdfs/2b.pdf

Depaolo, C., & Mclaren, C. H. (2006). The relationship between attitudes and performance in business calculus. *INFORMS Transactions on Education, 6*(2), 8-22.

Ellis, L. V., Dunden, G. C., & Gaynor, P. E. (1998). *Evidence of factors that influence probability of good performance in the principles of economics course*. Retrieved November 30, 2009 from http://www.westgate.edu/~bquest/1998

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic Books.

Glenda, A. (2000). Factors influencing first year student's success in mathematics. *International Journal of Mathematical Education in Science and Technology, 31*, 3-12.

Green, J. J., Stone, C. C., Zegeye, A., & Charles, T. A. (2009). *How much math do students need to succeed in business and economics statistics? An ordered probit analysis.* Retrieved June 1, 2010 from http://www.amstat.org/publications/jse/v17n3/green.html

Jackstadt, S. L., & Grootaert, C. (1980). Gender, gender stereotyping and socio-economic background as determinants of economic knowledge and learning. *Journal of Economic Education, 12*, 34-40.

Joyce, J., Hassall, T., Montaño, J. L. A., & Anes, J. A. D. (2006). Communication apprehension and maths anxiety as barriers to communication and numeracy skills development in accounting and business education. *Education and Training, 48*(6), 454-464.

Kolb, D. A. (1985). *Learning styles inventory*. Boston: McBeer and Co..

Lumsden, K. G., & Scott, A. (1987). The economics student re-examined: Male-female differences in comprehension. *Journal of Economic Education, 18*, 365-375.

Ma, X. (1997). *A national assessment of mathematics participants in the United States: A survival analysis model for describing students' academic careers*. Lewiston, NY: Edwin Mellen.

Mallik, G., & Varua, M. (2008). HSC mathematics results and tertiary success in quantitative units: An Australian experience. *Australasian Journal of Economic Education, 5*(1/2), 1-10.

Marburger, D. R. (2001). Absenteeism and undergraduate exam performance. *Journal of Economic Education, 32*, 34-40.

Murmane, R. J. (1988). Education and the productivity of workforce: Looking ahead. In M. N. Baily (Ed.), *American living standards: Threats and challenges*. Washington D.C.: The Brooklings Institution.

Nonis, A. S., Hudson, G. I., Philhours, M. J., & Teng, J. K. (2003). Changes in college student composition and implications for marketing education: Revisiting predictors of academic success. *Journal of Business Research, 56*(4), 321-329.

Pozo, S., & Stull, C. A. (2006). Requiring a math skills unit: Results of a randomized experiment. *The American Economic Review, 96*(2), 437-441.

Rochelle, C. F., & Dotterweich, D. (2007). Student success in business statistics. *Journal of Economics and Finance Education, 6*(1), 19-24.

Taylor, J. A., & Galligan, L. (2006). Mathematics for maths anxious tertiary students: Integrating the cognitive and affective domains using interactive multimedia. *Literacy and Numeracy Studies, 15*(1), 23-42.

Tobias, S. (1993). *Overcoming math anxiety*. New York: W. W. Norton & Company.

Yenilmez, K., Girginer, N., & Uzun, O. (2007). Mathematics anxiety and attitude level of students of the faculty of economics and business administrator: The Turkey model. *International Mathematical Forum, 2*(41), 1997-2021.