THE IMPORTANCE OF THE ROLE PLAYED BY THE STUDENT IN INTRODUCTORY STATISTICS EDUCATION: MOVING BEYOND THE STUDENT AS CUSTOMER

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In many universities, the adoption of Total Quality Management has led to an increased focus on students as customers. However, this view of students fails to acknowledge the multiplicity of roles they play in the educational process - as inputs, outputs, customers and co-workers. In this research, first year statistics students in the Department of Econometrics and Business Statistics at Australia's Monash University for 1994 and 1995 were studied. Regression models were used to examine relationships between the students as inputs and co-workers in the educational process, and their learning outcomes in the subject. Significant factors included mathematical aptitude, language spoken at home, type of school attended, living arrangements during semester and attendance. The models demonstrate the importance of the role of the student in the process of introductory statistics education.

INTRODUCTION

As with many management 'breakthroughs', the management philosophy of Total Quality Management (TQM) has been adopted by many universities around the world to assist with the changing environment within which they operate. Features of the new environment include higher cost resources, increased global competition in saturated or dwindling markets, consumers with changing values and who are more interested in quality, the need for rapid introduction of new products, and the need to lower the break-even point, as government funding tightens. In such a climate, a more customer-oriented and resource-conscious strategy is required. TQM is regarded by many as providing an appropriate strategy (including Zahn 1990; Higgins et al.1991; Chizmar 1994; Wild 1995).

However, there is the potential for misuse of TQM, not the least of which is its enshrinement to the detriment of lateral or creative thinking. Mizuno (1988, p. 27) identifies four managerial types that obstruct the effective implementation of TQM. He believes that the worst of these is the manager who thinks that TQM is being applied when it actually is not. Universities that treat students solely as customers of a teaching process are apparently falling into the trap of this management style. If quality assurance processes are limited, by the view of students as customers, to student evaluations of teachers, then this cannot be regarded as a true application of TQM.

While the current trend to ‘user pays’ funding models for universities reinforces the view of students as customers, this attitude is detrimental to student learning. Applying TQM terminology, students are one of the customers of the educational process, but they are also inputs, outputs and most importantly, co-workers. This research investigates the contribution of students to the teaching and learning processes, and identifies factors that are important contributors to performance in an introductory statistics subject at Monash University, Australia for the years 1994 and 1995.

BACKGROUND TO THE RESEARCH

The first year econometrics unit in the Department of Econometrics and Business Statistics at Monash University services a number of degrees, including the Bachelor of Economics, Bachelor of Commerce, Graduate Diploma in Economic Studies and a number of joint degrees. There is a mathematics prerequisite to most, but not all, courses serviced by the subject.

The department has a history of using the techniques of TQM to continuously improve its teaching. As a result of the collection of student feedback, which began in 1988, measures have been taken to improve the quality of the teaching process. These include training in teaching skills for all staff employed in the department, variation in the content of the subject and a shift to more assignment work being used for assessment purposes (King, 1993a, 1993b; Buchanan and King, 1994). In 1993, after a number of years of continuous improvement to the process of teaching first year statistics there was still a failure rate that the department regarded as unacceptably high, although noticeable improvements had been achieved.

This study represents the next stage and focuses on the first year econometrics classes in 1994 and 1995, examining the students as inputs and co-workers in the educational process. Learning models are used to detect relationships between student attributes including ability and effort and their performance in the subject.

STUDY DESIGN

Lecturers in the subject were surveyed to discover what they thought or hoped that students might know on entry. The topics nominated by the lecturers included indices, the

linear model, quadratic functions, logarithms, sigma notation, basic statistics (mean and median), simple differentiation, the derivative as slope function and simple integration. A two-part questionnaire was designed which was composed of a multiple choice test covering the areas of mathematics identified by the lecturers plus questions relating to other attributes.

The second part of the questionnaire was designed to collect data on attributes including the ability variable of result in Year 12, and personal details such as type of school attended (state, private or Catholic private), educational background (school leaver, some prior tertiary study or incomplete secondary education), home address (Melbourne, other Australia, overseas); language spoken, gender and age. Finally, at the end of semester, data on final percentage score and attendance were collected from departmental registers and added to each record.

Using these variables, a learning model was estimated based upon the specification first suggested by Becker (1983),

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_K X_{Ki} + \varepsilon_i$$

where Y_i is an accurately measured continuous post-test score (or difference between pre- and post-test) for the *i*th subject,

X_{Ki} is the Kth covariate,

β_k is a parameter to be estimated,

ε_i is the error term.

For this research, final percentage score in the subject, incorporating both examination and assignment marks, was chosen as the dependent variable. As it comprised a range of assessment strategies, it is considered more likely to measure overall performance in the subject, rather than just examination performance, which may depend on variables other than aptitude and study time.

Explanatory variables considered in the learning models included the ability variables, the range of attributes, and student contribution as measured by attendance. Full details of all variables considered are contained in Table 1.

Table 1. Variable Names and Descriptions for All Elements of the Database

VARIABLE	DESCRIPTION
FINSCOR	Final percentage score in the subject, ranging from 0 to 1.00. The dependent variable.
EXPLANATORY VARIABLES	
ATTEND	Tutorial attendance, a discrete variable ranging from 0 to 12
PRETEST	Score in the pre-test, a discrete variable ranging from 0 to 19
VCESCOR	Score in the year 12 Victorian Certificate of Education (VCE), a discrete variable ranging up to 168 in 1994, and up to 100 in 1995.
Topics within the Pre-test	
STATS	A score out of 3 on the statistics questions
CALCULUS	A score out of 5
LOGS	A score out of 4
LINDEM	A score out of 1 on the linear demand function
Indicator variables	
LANGDUM	1 = non-English speaking background, 0 = English speaking background
GENDER	1 = male, 0 = female
HOMDUM	1 = Australian home address, 0 = overseas home address
PSCHDUM	1 = private school, 0 = other
SSCHDUM	1 = state school, 0 = other
CSCHDUM	1 = Catholic school, 0 = other
PREF	1 = first preference course, 0 = not in course of first preference
INTERAC	An interactive variable which identifies Australian residents and citizens of non-English speaking background. Obtained by multiplying HOMDUM x LANGDUM.
DROPDUM	1 = started, but did not complete the subject, 0 = completed the subject

REGRESSION MODELS

In recognition of estimation problems related to the nature of the data, a number of model formulations were tried. These included a logistic transformation of the dependent variable in recognition of its bounded nature, and estimation using instrumental variables in recognition of the possible exogeneity of the attendance variable (Romer 1993). The resulting models, which are not reported in this paper, produced results which were very consistent in magnitude of effect, sign and degree of significance of the estimates, with the linear regression models shown in Table 2. Hence the results are quite robust to different model formulations. The results for the linear regression models are shown due to the ease of interpretation.

Table 2. Final OLS Models for Monash 1994 and 1995
*(Standard errors in brackets) * - significant at ? = 0.05*

Variable	Monash 1994	Monash 1995
CONSTANT	-0.3331 (0.133)*	-0.3780 (0.0770)*
ATTEND	0.0228 (0.0054)*	0.0176 (0.0044)*
INTERAC	-0.0698 (0.025)*	
VCESCOR	0.0035 (0.0009)*	0.0089 (0.0009)*
PRETEST		0.0082 (0.0023)*
STATS	0.0451 (0.0108)*	
DROPDUM	-0.3593 (0.0660)*	-0.5158 (0.0648)*
PSCHDUM		-0.0463 (0.0130)*
COLLDUM		0.0625 (0.0180)*
Sample Size	127	262
B-P	6.846 (df = 5)	32.339 (df = 6)
$\overline{R}^2$	55.23%	54.97%
Loglikelihood	117.450	235.229
AIC	-1.75512	-1.74221
PC	0.0101232	0.0102542
F	32.083	54.12
SEE	0.0983	0.0999

DISCUSSION

Variables which featured in the models for both years include attendance and VCE entry score, both producing a positive effect on final score in the subject. ATTEND had a coefficient of 2.28% in 1994 and 1.76% in 1995; VCESCOR had a coefficient of 0.35% in 1994 when score was out of a possible 167, compared to 0.9% in 1995 when score was out of a possible 100. The ability variable PRETEST, or one of its components, STATS, also appeared in both years. The variable which was significant in 1994 and which did not feature in 1995 was the indicator variable for Australian citizens and residents of non-English speaking background (NESB), INTERAC.

Further investigation of this last factor revealed that the 1994 exam contained essay style questions and others of a problem solving nature which were written in detailed paragraphs. It was found that NESB students fared less well on essay type questions in the 1994 examination. In response to this result, greater care was taken with the design of questions for the 1995 examinations. This included ensuring that the wording of questions was very clear, as well as paying close attention to cultural issues in providing the context for problems to be solved.

Type of school attended entered the equation in 1995, with students attending private schools scoring, on average, 4.6 marks less than students from any other school background. The new variables indicating accommodation arrangements during semester also entered the 1995 model. The model with an indicator variable for living in colleges or halls of residence showed that, compared to all other living arrangements, this group scored an average 6.3 marks more.

In neither year, were effects for gender and whether or not the course of enrollment was first preference able to be detected.

CONCLUSION

The intelligence provided by the learning models provides valuable input when planning the delivery of such introductory statistics courses. It is the responsibility of the teaching department and the teachers to address those problems with the process that are evidenced by the data, such as the problems of NESB students and those without adequate mathematics background, in order to continuously improve the delivery of the course. Over the period studied, steps were taken including involving senior staff who are inspiring teachers in the presentation of first year subjects, improved lecture presentation formats and tutorial guidelines and continuing training and mentoring of new teaching staff. Failure rates continue to decline and the numbers of students continuing into second and third year electives in econometrics is increasing. Another positive initiative was the university funded placement of a senior secondary teacher from the private school system in the department for a semester. Her function was to assist in providing a link with the main suppliers to the tertiary system and also to aid the transition to tertiary study.

The significance of the attendance and ability variables in these models also reinforces the importance of the contribution of the student to the educational process.

The implication is that it is not solely the responsibility of the teachers to ensure good performance in the subject - students should not be viewed simply as customers of the process. It is a joint undertaking between co-workers.

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