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ROSS GUEST

Griffith University, Queensland, Australia

ABSTRACT *This paper presents both theoretical and survey evidence on the effect of flexible learning—in particular, the shift to a more student-centred approach to learning—on academic achievement by students. A survey was conducted of 577 business students at a major Australian university in order to elicit their preferences for academic achievement and effort. The results support the theoretical predictions that the effect on academic achievement of greater student autonomy over their learning environment is ambiguous. More academically motivated students and females have a significantly higher probability of choosing a learning technology that provides greater academic reward for effort.*

KEY WORDS: Flexible learning; student-centred learning; utility; educational economics

Introduction

There are two dimensions to the modern practice of flexible learning. One is the empowering of students to make decisions about all aspects of their learning environment, 'from design of courses through to forms of assessment' (Wade *et al.*, 1994, p. 12). Students may negotiate with their instructors on matters such as choice of topic areas, use of support materials such as textbook and web resources, timetable and venues for meetings with their instructors, and the nature and weighting of individual assessment tasks. In essence, students have some autonomy over how, when, where and what to learn. In this way, flexible learning takes account of the individual needs of students and therefore implies a more 'student-centred' approach to learning. The second dimension of flexible learning concerns the institutional arrangements for delivery of student-centred learning. Increasingly this has involved applications of advances in information technology and, indeed, this has been a key driver for the growing trend to flexible learning. For instance, web-based delivery of subjects and courses is becoming more widespread. This has allowed flexibility in the frequency of face-to-face lectures and has widened the scope of off-campus delivery of courses. Hence flexible learning practices tend to be implemented hand in hand with applications of the new technologies.

Correspondence Address: Ross Guest, Associate Professor of Economics, Griffith Business School, Griffith University, PMB 50, Gold Coast Mail Centre, Queensland 9726, Australia. Email: R.Guest@mailbox.gu.edu.au

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This paper is concerned with the student-centred aspect of flexible learning. It asks the question: will the greater learner control that is inherent in flexible learning improve learning outcomes as measured by student achievement levels? Yes, seems to be the generally accepted answer to this question among educators. For example, Marton *et al.* (1997, p. 155) suggest that a wide range of learning options is pedagogically desirable. Smith and Brown (1995) argue that student-centred learning has long been regarded as the more effective approach to learning.

The effect on student achievement of the other dimension of flexible learning—namely, improvements in the technology of learning that increase the productivity of time allocated to learning—is well established in the literature. An increase in the productivity of time allocated to learning amounts to a fall in the relative price of learning measured in units of time. Staaf (1972) showed that a fall in the relative price of learning could result in lower academic achievement if learning is an inferior good and therefore the negative output effect outweighs the positive substitution effect on learning. Moreover, Becker (1982) demonstrated that lower achievement can result even if learning is not an inferior good, in the case where the technological change is non-neutral (affecting one course but not another). But there is no reported analysis of the implications of the other dimension of flexible learning; that is, the effect of greater student involvement in decisions about the curriculum, teaching resources and assessment. The purpose of the model in this paper is to investigate whether this second dimension of flexible learning also has an ambiguous effect on student achievement.

The theoretical model posited here is an adaptation of the model in Correa and Gruver (1987). There have been a number of related studies of optimal behaviour of students and teachers. Bacdayan (1997), Epstein and Spiegel (1996), Oosterbeek (1995) and Becker (1982) studied the optimal allocation of student and/or faculty time in maximizing learning outcomes. Huang (1981), Becker (1975, 1979), and McDonough and Kannenberg (1977) modelled the optimal allocation of faculty time between teaching and research in maximizing faculty utility. None of these papers, however, modelled the effect of greater student autonomy over the learning environment.

The Theoretical Framework

The technology for producing academic achievement from student learning time can be broadly interpreted as the teaching and learning environment. This encompasses everything from curriculum choices in terms of knowledge and skills objectives, teaching materials including choice of texts and electronic resources, and the nature, timing and weighting of the assessment items. It is assumed that a number of alternatives exist for each of these aspects of the learning environment. At the beginning of the course a combination of these aspects is chosen to apply for the duration of the course. For example, the learning objectives, texts and assessment items are all chosen at the start of the course and cannot be changed during the course. This set of aspects of the learning environment is defined as the technology of learning.

There is likely to be variation among the students in their prior conceptual understanding of key concepts and ideas; and this will affect their approach to learning and therefore the quality of their learning outcomes (Prosser and

Trigwell, 1999). This also implies that some learning technologies will be appropriate for some students but not others. For example, a given textbook might assume too much prior conceptual understanding for some students but for others it may be not sufficiently challenging. To illustrate the relationship between learning technology and academic achievement, denote P as the technology of learning and consider two P values, P_A and P_B, that differ in that P_B has an elementary textbook and P_A a more advanced textbook. It is assumed that the elementary text yields a higher achievement level than the advanced text if the student allocates little time to learning, but diminishing returns to time set in relatively early.[1] For the advanced text it is assumed that the returns to time, in terms of achievement outcomes, are lower for a short time spent on learning as the student grapples with the more difficult concepts, but higher for longer time spent learning. That is, diminishing returns takes longer to set in for the advanced text.[2] Figure 1 illustrates the point. In this figure the student can allocate time between academic learning and alternative pursuits that we collectively call leisure. There are two production possibility frontiers. The more bowed out frontier, labelled P_B, represents the technology with the elementary textbook and the other frontier, labelled P_A, represents the technology with the advanced textbook. The maximum possible achievement level occurs where all available time is allocated to learning and this achievement level is lower for the elementary textbook. However, in the case where the student spends very little time on learning, the achievement level is higher for the elementary textbook.

Assume that the student is initially at point X and is therefore using the technology represented by the advanced textbook. Flexible learning implies giving

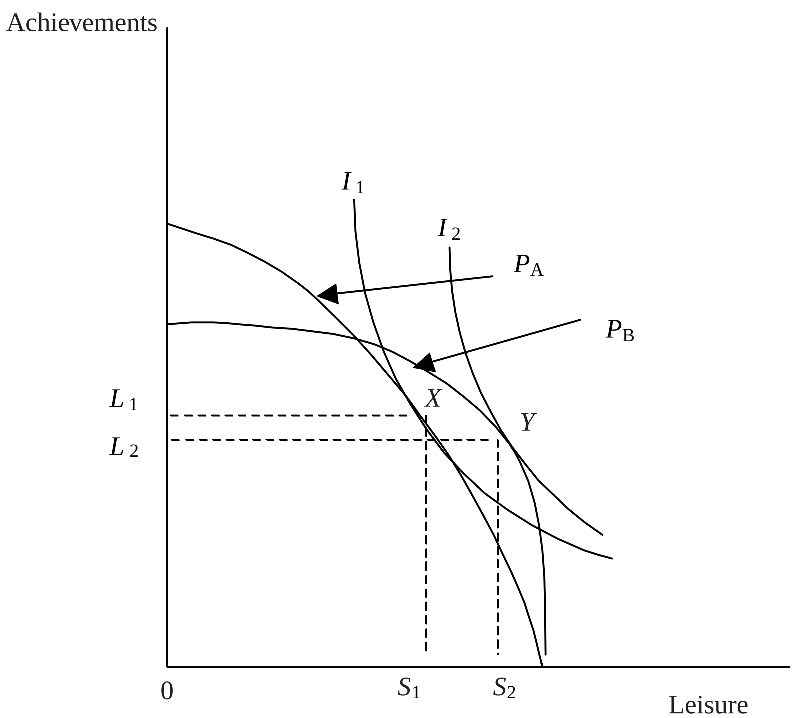

Figure 1. The achievement–leisure trade-off

the student the choice to move to the alternative technology, P_B. At the student's current time allocation, S_1, the alternative technology P_B offers a lower price of leisure. The likelihood of students choosing a lower price of leisure is the issue to be explored empirically in this paper.

Correa and Gruver (1987) considered an analogous case in which the teacher adopts a remedial programme, albeit with no student choice. In that case the teacher concentrates effort on getting all students to a minimum level of achievement, but the nature of the teacher's intervention is such that is it more difficult for students to achieve at levels higher than the minimum.

In practice there is likely to be a discrete number of technologies from which to choose. For example, there will probably be only a few potential textbooks, limited scope for varying the learning objectives subject to the requirements of the major, and limited options for assessment. In the theoretical model presented here, however, and with no qualitative impact on the results, an infinite number of technologies are assumed to be available from which one is chosen. It is also assumed that the choice of technology does not affect the student's preferences for achievement and leisure, and that there is no interaction between the teacher and student in negotiating the technology. Correa and Gruver (1987) extend their analysis to the case where there is interaction and negotiation between teacher and student. The implications of this are briefly considered here in the conclusion.

The model is formalized as follows. Adopting the model of student utility in Correa and Gruver (1987), with different notation, a representative student maximizes utility from both academic achievement, L, and an alternative composite good that we will call leisure, S.[3] The student has a fixed time budget, T, to be allocated between learning, T_L, and leisure, T_S. Correa and Gruver specify a student achievement production function of the form $L = L(a, T_L)$, where L is academic achievement and a is teacher effort including 'assignments and other instructional activities' (1987, p. 21). Both a and T_L are measured in hours and $L_a, L_{T_L} > 0;\ L_{aa}, L_{T_L T_L} L_{aa},$ In this paper a is replaced by the learning technology variable, P. The P values are assigned numerical values and then ranked from low to high productivity for a given level of student effort. The ranking can change as the level of student effort changes. This implies that, unlike the case in Correa and Gruver (1987), the production possibility frontiers can overlap as shown in Figure 1. The student's problem is to maximize $U = U(L, S)$ subject to $T = T_L + T_S$ and $L = L(P, T_L)$ where $U_S, U_L > 0;\ U_{SS}, U_{LL} < 0$.

As already noted, it has long been known that an improvement in the technology of learning that shifts the production function outwards can reduce academic achievement if the latter is an inferior good for the student. In that case, the reduction in the price of achievement generates a positive substitution effect on achievement that is outweighed the negative income effect. Correa and Gruver (1987) also show, however, that this is possible if there is a high elasticity of substitution in the production function between student effort and, in this case, the technology parameter, P. Correa and Gruver establish the result that student effort will fall in response to a positive change in technology if the elasticity of substitution between achievement and leisure in the student's utility function is less than the elasticity of substitution in the production function.[4] This condition can be written as: $dT_L/dP < 0$ if $\sigma^S < \sigma^L$, where σ^S and σ^L are the elasticities of substitution in the utility function and production function, respectively. Figure 1 illustrates such a case where the move from point X to point Y represents a reduction in student effort, and in this case the reduction in student effort is sufficient to reduce academic achievement. This scenario is more likely, the lower the elasticity of substitution in the utility function and the higher the elasticity of substitution in the production function. This will, in turn, occur: (a) the greater the degree of complementarity between academic achievement and leisure in generating student utility, implying a greater degree of convexity in the indifference curves in Figure 1; and (b) the greater the degree of substitutability between student effort and technology in producing achievement, implying a greater degree of concavity of the production possibility curve in Figure 1. These are empirical questions.

The Empirical Method and Data

An experimental method was adopted to elicit student preferences for additional achievement relative to additional leisure. A survey was conducted of business students taking an introductory economics unit at a major Australian university. The survey was conducted without prior notice during lectures towards the end of the semester. One hundred per cent of students who attended the lectures were surveyed, amounting to 577 survey responses. This represented 80% of the total enrolment for the course. A limitation of these data arises from the potential for sample selection bias because lecture attendance is voluntary. A bias would occur if there are unobserved characteristics of students that determine academic preferences for achievement and that also determine lecture attendance. In that case, the expectation of the error term in the regression equation is not zero.[5] However, because only 20% of the total enrolment for the course did not attend the lecture and therefore did not complete the survey, any bias can be expected to be small.

Students were given hypothetical trade-offs between additional effort and achievement under two alternative production technologies. Asking students to implicitly value marginal improvements in academic achievement is an example of stated preference analysis. This method of analysing consumer preferences is often used where either revealed preference data are not available because the product cannot be purchased or the particular product attributes of interest cannot be separated out. This is the case in this study given that little or no market data exists on the 'purchase' of academic achievement through sacrifice of time. See Calfee *et al*. (2001) for further discussion of the stated preference method and of econometric issues in estimation using this method.[6]

Students were asked to choose between the two technologies given the following scenario:

> *Assume that you have more control over your level of effort and expected achievement in this course. The table below gives two options for changing your level of effort and expected achievement in this course—Option A and Option B. The change in effort is measured in hours of learning time per week (class time plus private study) and expected change in achievement is measured in terms of your final mark. For example, the first row in the table says that if you spent 4 hours less learning time than you currently spend on this course, you could expect to achieve a final mark 10% lower under Option A and 5% lower under Option B.*

Change in hours of learning per week	*Expected change in final mark*	
	Option A	*Option B*
4 hours less	☐ *10% less*	☐ *5% less*
2 hours less	☐ *5% less*	☐ *no change*
no change	☐ *no change*	☐ *5% more*
2 hours more	☐ *20% more*	☐ *10% more*
4 hours more	☐ *35% more*	☐ *15% more*

The two options, A and B, represent two alternative trade-offs between additional leisure and additional achievement as illustrated in Figure 2 and, in stylized form, in Figure 1. In Figure 2, Option B (denoted by P_B) gives slightly more achievement than the student is currently experiencing with no loss of leisure. Equivalently, the student can enjoy more leisure for the same achievement level. On the other hand, reductions in leisure yield a smaller gain in achievement under P_B than under P_A. Hence Option B represents a lower price of leisure than Option A. This is the sort of choice that a student could face in deciding, for example, whether to adopt an advanced text or an elementary text, as discussed earlier. The choice can be represented in Figure 1, where point X is the student's current level of leisure and achievement, P_A is the current technology, and S_1 is the current level of leisure. At this initial point X, P_B implies a lower relative price of leisure.

Students with a higher degree of motivation to achieve academically (captured by X_1) can be expected to have a lower marginal rate of substitution between achievement and leisure, represented by flatter indifference curves. This implies that they can be expected to choose the technology that offers a higher reward for effort, which is P_A. To test this hypothesis the following ordered logit regression was run:

$$L_a, L_{T_L} > 0;\ L_{aa}, L_{T_L T_L} L_{aa}, L_{T_L T_L} < 0$$

where Y is the ordered response to the question on the choice of Option A or Option B, from 1 for 'strongly prefer B to A' to 5 for 'strongly prefer A to B'; and

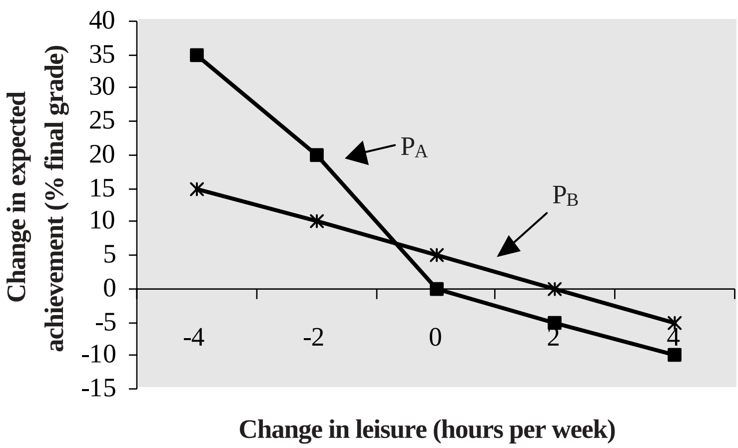

Figure 2. The two alternative leisure–achievement trade-offs given to students in the survey

X_1 is the response to the following question, on a five-point Likert scale: 'In general I am motivated to the best of my ability in my academic studies', where 1 is 'strongly disagree' and 5 is 'strongly agree'. The remaining control variables are as follows: $X_2 = 1$ if the student is female (0 otherwise); $X_3 = 1$ if the student is enrolled part-time (0 otherwise); X_4 is the response to the following question, on a five-point Likert scale: 'In this course I realistically expect to achieve the following grade', where 1 is 'fail' and 5 is 'high distinction'; $X_5 = 1$ if the student would prefer to reduce time spent studying another course rather than reduce non-academic time in order to 'spend more time studying for this course'. Non-academic time includes time in paid employment as well as leisure time.

The inclusion of gender as an explanatory variable is of interest both for its own sake and because of the mixed evidence from research in education regarding gender differences in academic motivation. Cokley *et al.* (2001) cite a number of studies that find that female students exhibit a more motivational orientation than males, although they express concerns about the reliability of these findings, and in their own study they find no gender differences in motivation. A study by Mau and Bikos (2000), on the other hand, finds evidence that female students have higher educational aspirations. Given the possibility that female students are more academically motivated, it is important to control for gender in evaluating the influence of motivation through the variable X_1.

The remaining control variables were chosen for the following reasons. Part-time students ($X_3 = 1$) may be expected to have more binding time constraints on their leisure time. To the extent to which this constrains their ability to reduce leisure in order to raise their achievement levels, they would be more likely to choose P_B. It is also necessary to control for the level of achievement that the student expects (X_4) because, for example, a student who already expects to achieve a final grade of 90% cannot expect to achieve more than another 10% and may indeed expect even an extra 10% to be impossible in practice. Conversely, very low achievers may feel that to achieve 10% lower would result in a fail grade and perhaps disqualification from their degree programme, which may not be a realistic alternative. Finally, because the survey questions referred to achievement in a particular course (unit of study), it is possible that students could substitute effort between courses rather than substituting between leisure and academic effort. To control for this possibility, students were asked whether, if they were to spend more time studying for this particular course, they would spend less time on another course or spend less time on non-academic activities (X_5).

The above *a priori* expectations imply the following null and alternative hypotheses:

(i) H_0: $\beta_1 = 0$; H_A: :$\beta_1 > 0$;
(ii) H_0: $\beta_2 = 0$; H_A: :$\beta_2 \neq 0$;
(iii) H_0: $\beta_3 = 0$; H_A: :$\beta_3 < 0$;
(iv) H_0: $\beta_4 = 0$; H_A: :$\beta_4 \neq 0$;
(v) H_0: $\beta_5 = 0$; H_A: :$\beta_5 \neq 0$;

Results

The frequencies of the five responses given by the students to the earlier question about their preferences for Options B and A are plotted in Figure 3. Approximately the same proportion (12%) of students strongly preferred Option A to

Option B as those who preferred Option B to Option A. A total of 35% of students expressed a preference, strong or otherwise, for Option B and 40% for Option A. This is a statistically different proportion at a 5% level of significance, implying that a statistically higher proportion of students have a preference for Option A than Option B. Recalling that Option B represents a lower price of leisure, these results suggest that a smaller proportion of students would prefer a learning technology that yields a lower price of leisure. In terms of our earlier example, this result indicates that fewer students would choose the elementary textbook compared with the advanced textbook. The proponents of flexible learning might be encouraged by such a finding. On the other hand, the proportion of students who prefer Option B to Option A may, at 35%, may be considered to be unacceptably high.

The regression results are presented in Table 1. The estimate on the variable for academic motivation, X_1, is positive, as expected, and statistically significant (one-tailed test) at 5%. This result is consistent with the hypothesized model of student utility maximization, which implies that more academically motivated students, who have higher marginal rates of substitution, will be more likely to choose the technology that offers higher rewards for effort. It adds further support to the inference drawn from frequency distribution in Figure 3—that is, that some students will choose a lower relative price of leisure as implied in P_B relative to P_A, even if this implies lower academic achievement. The results also indicate that females are more likely to choose P_A over P_B, which implies that they are more likely to have a higher elasticity of substitution between achievement and leisure. This result suggests that females have a stronger preference for academic challenge if this means the opportunity to achieve higher results. There is no evidence that part-time enrolment status makes a difference to students' choices among the alternative learning technologies.

Conclusion

The theoretical and empirical analysis in this paper indicates that a shift to a more student-centred approach to teaching and learning that gives students greater choice over their learning environment or technology is likely to improve academic achievement for some students but not others. The empirical results

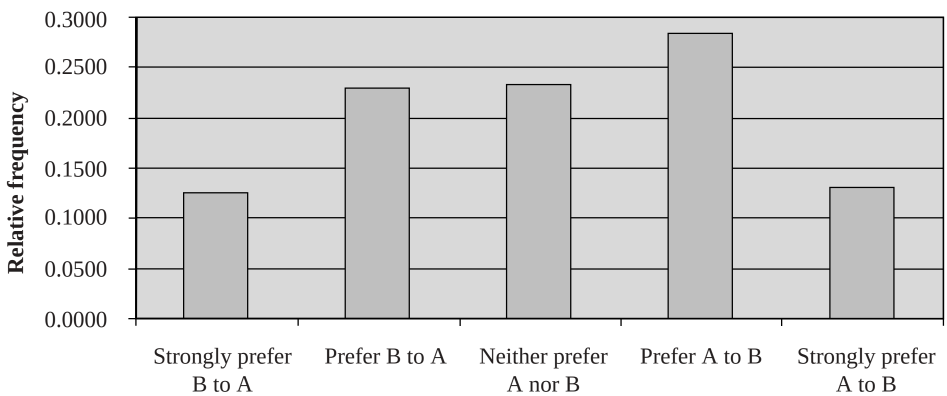

Figure 3. Student preferences for additional achievement relative to additional leisure

Table 1. Ordered logit model

	Logit estimate	*P* value
Constant		
α_1	–0.47	0.28
α_2	0.90	0.04
α_3	1.87	0.00
α_4	3.46	0.00
Variable		
X_1	0.22	0.03
X_2	0.52	0.00
X_3	–0.11	0.62
X_4	0.13	0.13
X_5	–0.17	0.43
Fit	$\chi^2 = 23.20$	0.00

suggest that, given a choice of learning technologies, a slim majority of students will choose the technology that provides opportunity for higher achievement from higher effort. The more academically motivated students are likely to choose this option, as are female students. A substantial minority of students, however, will choose the technology that gives a lower price of leisure and that may result in lower achievement.

There are several possibilities not considered here that could affect the analysis. First, there is the possibility that a change in the technology of learning could alter student preferences for achievement and leisure. Second there is the possibility that simply being given autonomy over their learning environment can alter students' preferences. There is some evidence that students do appreciate being granted such autonomy (Wade *et al.*, 1994). To the extent that these factors are reflected in an increase in the marginal utility of achievement relative to leisure the effect would be to increase time allocated to learning and therefore to increase achievement. Also, there is the possibility that interaction between student and teacher, in the process of negotiating the teaching and learning environment, can have dynamic effects on student effort and achievement. This sort of interaction was considered by Correa and Gruver (1987). They conclude that effective cooperation between student and teacher is necessary for the Nash equilibrium outcomes to be Pareto optimal, although there will be incentives for both teacher and student to break their agreements.

On balance, the analysis presented here cautions against unbridled optimism about the benefits of a more student-centred approach to university education that is inherent in the trend toward so-called flexible learning. Further careful empirical analysis will be required to determine the extent and the incidence of any improvements in student achievement from the implementation of flexible learning initiatives.

Notes

1. The assumption of diminishing returns to time and/or effort spent engaged on learning tasks is quite common in the literature on learning production functions (Correa and Gruver, 1987;

Epstein and Spiegel, 1996; Bacdayan, 1997) and has received some empirical support as cited in Correa (1997, p.22).
2. It is also assumed that students know the shape of their production possibilities under different learning technologies. This is a limitation of the theoretical model given that lack of self-knowledge about learning is a characteristic of low achievers (Meyer *et al.*, 1990). I am grateful to an anonymous referee for pointing this out.
3. Since leisure represents any alternative allocation of time, it may in fact include work for income.
4. This condition assumes constant elasticity of substitution in both the production and utility functions.
5. Moon and Stotsky (1993) discuss this further in the context of a model where the dependent variable is an ordered categorical variable as in the present study.
6. As noted in Calfee *et al.* (2001), a common problem in stated preference analysis is that respondents can respond strategically, especially if they think their response might lead to desirable policy outcomes. This is arguably of less concern here because the survey was conducted towards the end of the course when all choices about learning technologies had already been made.

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